



**Federal Energy
Regulatory
Commission**

**Office of
Energy
Projects**

October 2003

FERC/FEIS - 0162F

Final Environmental Impact Statement



**Bull Run Project
Oregon
(FERC Project No. 477-024)**

888 First Street N.E., Washington, DC 20426

FERC/FEIS-0162F

**FINAL
ENVIRONMENTAL IMPACT STATEMENT**

APPLICATION FOR SURRENDER OF LICENSE

**Bull Run Hydroelectric Project
FERC Project No. 477-024--Oregon
Applicant: Portland General Electric Company**

**Federal Energy Regulatory Commission
Office of Energy Projects
Division of Hydropower Environmental and Engineering
888 First Street, NE
Washington, D.C. 20426**

October 2003

**FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426**

TO THE PARTY ADDRESSED:

Attached is the Final Environmental Impact Statement (FEIS) for the proposed surrender of the Bull Run Hydroelectric Project (No. 477-024). The project is located on the Sandy, Little Sandy, and Bull Run Rivers, near the Town of Sandy, Clackamas County, Oregon. The project is located on lands administered by the Forest Service (Mt. Hood National Forest) and the Bureau of Land Management.

Before the Commission makes a decision on the proposal, it will take into account all concerns relevant to the public interest. The FEIS will be part of the record from which the Commission will make its decision.

The Commission may issue its decision less than 30 days after publication of this FEIS. This FEIS was sent to the Environmental Protection Agency and made available to the public on or about November 7, 2003.

Any Commission order on the proposed action and alternatives considered in this FEIS will be subject to the Commission's rehearing process under 18 CFR 385.713. Requests for rehearing must be filed within 30 days of the date of issuance of the Commission's order.

A copy of the surrender application, settlement agreement, and FEIS is available for review at the Commission in the Public Reference Room or may be viewed on the Commission's website at <http://www.ferc.gov> using the "eLibrary" link. Enter the docket number excluding the last three digits in the docket number field to access the document. For assistance, contact FERC Online Support at FERCOnlineSupport@ferc.gov or toll-free at 1-866-208-3676, or for TTY, (202) 502-8659.

You may also register online at <http://www.ferc.gov/esubscribenow.htm> to be notified via email of new filings and issuances related to this or other pending projects. For assistance, contact FERC Online Support.

Attachment: Final Environmental Impact Statement

COVER SHEET

- a. **Title:** Bull Run Hydroelectric Project (FERC Project No. 477-024)--
 Oregon
- b. **Subject:** Final Environmental Impact Statement (FEIS)
- c. **Lead Agency:** Federal Energy Regulatory Commission
- d. **Abstract:** Portland General Electric Company (PGE) proposes to
 decommission its Bull Run Project and remove all project
 facilities, including Marmot dam and Little Sandy diversion dam
 and Roslyn Lake. The project is located on the Sandy, Little
 Sandy, and Bull Run Rivers, near the Town of Sandy, Clackamas
 County, Oregon. The project is located partially on lands
 administered by the Forest Service (Mt. Hood National Forest)
 and the Bureau of Land Management.
- The proposed action would result in short-term adverse impacts,
 particularly adverse impacts to water quality and fisheries habitat.
 Long-term fisheries and conservation benefits would result. The
 loss of Roslyn Lake would have long-term adverse impacts on
 recreation and potential impacts on residential water wells.
- The Commission staff recommends project decommissioning, as
 proposed by PGE, with modifications.
- e. **Contact:** Alan Mitchnick
 Federal Energy Regulatory Commission
 Office of Energy Projects
 888 First Street, N.E.
 Washington, D.C. 20426
 (202) 502-6074
- f. **Transmittal:** This FEIS, prepared by the Commission's staff on the surrender of
 license application for the Bull Run Hydroelectric Project, is being
 made available to the public on or about November 7, 2003, as

required by the National Environmental Policy Act of 1969¹ and the Commission's Regulations Implementing the National Environmental Policy Act (18 CFR Part 380).

¹ National Environmental Policy Act of 1969, as amended (Pub. L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. L. 97-258, §4(b), September 13, 1982).

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LIST OF ACRONYMS AND ABBREVIATIONS

ACHP	Advisory Council for Historic Preservation
ACS	aquatic conservation strategy
ANB	annual net benefit
APE	area of potential effect
APEA	Applicant-prepared Environmental Assessment
BO	biological opinion
BOD	biological oxygen demand
BLM	Bureau of Land Management
BMP	best management practices
CFR	Code of Federal Regulations
cfs	cubic feet per second
Commission	Federal Energy Regulatory Commission
CORPS	U.S. Army Corps of Engineers
CZMA	Coastal Zone Management Act
CWA	Clean Water Act
DEA	draft environmental assessment
DEIS	draft environmental impact statement
DO	dissolved oxygen
DOC	dissolved organic carbon
DOE	determination of eligibility
DPS	distinct population segment
DSL	Division of State Lands
DWG	Decommissioning Work Group
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESU	evolutionary significant unit
FEIS	final environmental impact statement
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act
HPMP	Historic Properties Management Plan
LRW	Lower River Wild
kV	kilovolt
LWD	large woody debris
MHNF	Mt. Hood National Forest
MIT	Monitoring Implementation Team
mg/l	milligrams per liter
MOA	memorandum of agreement
MSA	Magnuson-Stevens Act

msl	mean sea level
MW	megawatt
MWh	megawatthours
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ONHP	Oregon Natural Heritage Program
PGE	Portland General Electric Company
PFMC	Pacific Fish Management Council
ppm	parts per million
PRL&P	Portland Railway Light & Power Company
RCC	roller-compacted concrete
RM	river mile
ROW	right-of-way
SD1	scoping document 1
SD2	scoping document 2
SDMMDM	seven day moving mean of daily maximum
SHPO	State Historic Preservation Officer
S/M	survey and manage
TCP	traditional cultural properties
TES	threatened, endangered, and sensitive
TSS	total suspended solids
TOC	total organic carbon
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VRM	visual resource management
WSR	wild and scenic river
WY	water year

SUMMARY

On November 12, 2002, Portland General Electric (PGE) filed an application to amend its existing license for the Bull Run Project (P-477), an application to surrender its license, and a settlement agreement and decommissioning plan.

The project is located on the Sandy, Little Sandy, and Bull Run Rivers, near the Town of Sandy, Clackamas County, Oregon. The project is partially located on lands administered by the Forest Service (Mt. Hood National Forest) and the Bureau of Land Management.

PGE proposes to: (i) extend the term of the license from November 16, 2004, to November 16, 2017; (ii) continue generation until removal of the Little Sandy dam in 2008; (iii) implement a program of geomorphological and water quality monitoring continuing until Marmot dam removal; (iv) continue operation of the fish ladder and sorting facility at Marmot dam until Marmot dam removal; and (v) modify the operation of the diversion canal at Marmot dam to provide protection of threatened fish species from November 2004 until November 2007.

The Project works include: Marmot dam, located at River Mile (RM) 30 on the Sandy River; a 3.1-mile-long series of canals and tunnels leading from Marmot dam to the Little Sandy River just upstream of the Little Sandy diversion dam; the Little Sandy diversion dam, located at RM 1.7 on the Little Sandy River; a 2.8-mile-long box flume leading from the Little Sandy diversion dam to the manmade forebay, Roslyn Lake; two 1,400-foot-long penstocks; and a powerhouse containing four generators with a total capacity of 22 megawatts. The powerhouse discharges to the Bull Run River 1.5 miles above its confluence with the Sandy River at RM 18.4.

PGE proposes the complete removal of both Marmot and Little Sandy diversion dams, starting with the removal of Marmot dam in 2007 and the Little Sandy diversion dam in 2008, along with the dismantling of their associated water conveyance structures. In addition, Roslyn Lake would be drained and backfilled, the powerhouse generating equipment would be disabled, and the powerhouse structure would be demolished--if no reuse could be determined. All private project and non-project lands, except those associated with Roslyn Lake, would be conveyed to the Western Rivers Conservancy once the license is surrendered and the project is removed, and used to protect and conserve fish and wildlife habitat, public access, and recreation opportunities in the Sandy River Basin. Project water rights would be relinquished and would revert to instream use. Overall, this action would result in the cessation of all project energy generation and water diversions, resulting in the Sandy and Little Sandy Rivers reverting back to a free-

flowing state.

PGE filed a settlement agreement concerning the removal of the project. The signatories include PGE, 10 federal, state, and local agencies, and 12 non-governmental organizations. The agreement includes a decommissioning plan consistent with the applications for amendment of license and surrender.

This FEIS evaluates the potential natural resource benefits, the economic costs, and the environmental impacts associated with the proposed action and alternatives. The proposed action is to surrender the operating license for the Bull Run Hydroelectric Project and to decommission the project. Alternatives for accomplishing removal of Marmot dam are also presented in this document. This FEIS also evaluates the proposed action with staff modifications, and the no-action alternative.

Additional staff requirements include: development of an erosion and sedimentation control plan; development fish facility design and operation plan; development of a final revegetation, noxious weed control, and site restoration plan; development of a plan to implement the terms and conditions outlined in the Biological Opinions issued by the U.S. Fish and Wildlife Service and NOAA Fisheries; development of a spotted owl protection plan; requiring PGE to give homeowners sufficient advance notice of its specific plans and schedule to drain Roslyn Lake; implementation of the final historic properties management plan; and investigation of alternative sources of water for fire-fighting purposes.

The issues addressed in this document are impacts to and effects on: (1) geologic and soil resources, (2) water resources, (3) fisheries resources, (4) terrestrial resources, (5) threatened and endangered species, (6) recreational resources, (7) land use and aesthetic resources, (8) cultural resources, (9) and socioeconomics. Cumulative impacts of the proposed action and alternatives on water quality, river geomorphology, fisheries, terrestrial, and recreation resources have also been analyzed.

The proposed action would eliminate ongoing adverse effects, including mortality of juvenile and adult anadromous salmonids that pass Marmot dam. Decommissioning would provide access for anadromous fish to 6.5 miles of habitat upstream of the Little Sandy diversion dam and the 1.7-mile-long bypass reach and would restore flows to 10 miles of the Sandy River downstream of Marmot dam. The management of about 1,500 acres of lands for conservation and conversion of PGE's instream water right would promote long-term protection of the Sandy and Little Sandy Rivers ecosystems.

Decommissioning of the project would cost about \$17.3 million and would result

in the loss of the generation of about 111,000 MWh per year.

Decommissioning the project would result in short-term impacts to water quality and fisheries as a result of removing the two dams and movement of up to 960,000 cubic yards of sediment from the project reservoirs. PGE has developed a comprehensive Endangered Species Act Fish Monitoring and Contingencies Plan to mitigate impacts.

The proposed action would also result in the removal of the man-made Roslyn Lake, which would eliminate substantial local recreational opportunities, open-water habitat for wildlife, the loss of 20 acres of riparian habitat and 2 acres of scrub-shrub wetland and hydrological effects on 4-acre forested wetland, reduced water yields from as many as 58 water wells, and the removal of a source of water for fire fighting. No alternative sources of water for the lake or managing entity have been identified.

Under the no-action alternative, the project would continue to operate under existing license conditions. Impacts to upstream- and downstream-migrating fish populations and water quality would continue to occur.

Based on the long-term benefits to the aquatic ecosystem and river corridor, Staff recommends that the project be decommissioned and Marmot dam and Little Sandy diversion removed, as proposed, with additional measures recommended by staff.

FINAL ENVIRONMENTAL IMPACT STATEMENT

FEDERAL ENERGY REGULATORY COMMISSION Office of Energy Projects Division of Hydropower Environmental and Engineering Washington, D.C.

Bull Run Hydroelectric Project FERC Project No. 477-024

1.0 APPLICATION

On November 12, 2002, Portland General Electric Company (PGE) filed applications with the Federal Energy Regulatory Commission (FERC or Commission) to amend (PGE 2002a) and to surrender (PGE 2002b) the license for the Bull Run Hydroelectric Project.¹ The existing license expires on November 16, 2004.² The project, located on the Sandy, Little Sandy, and Bull Run Rivers, near the Town of Sandy, Clackamas County, Oregon (see figure 1), has been in operation since 1912. The project is located on lands administered by the Forest Service (USFS) (Mt. Hood National Forest) and the Bureau of Land Management (BLM). Of the 606 acres of land within the project boundary, approximately 55 acres are managed by BLM, and 18 acres is managed by USFS.

PGE proposes to amend its license to: (1) extend the term of the license from November 16, 2004, to November 16, 2017; (2) continue generation until removal of the Little Sandy diversion in 2008; (3) implement a program of geomorphological and water quality monitoring continuing until Marmot dam removal; (4) continue operation of the

¹ Copies of the applications can be accessed online at:
<http://ferris.ferc.gov/idmws/common/opennat.asp?fileID=9593359> (part 1 of 2) and
<http://ferris.ferc.gov/idmws/common/opennat.asp?fileID=9593378> (part 2 of 2).

² On November 12, 1999, PGE filed with the Commission a Notice of Intent Not to File Application for a New License. The Commission issued a public notice in the Federal Register on March 9, 2000 (Federal Register, volume 65, number 47, page 12544).

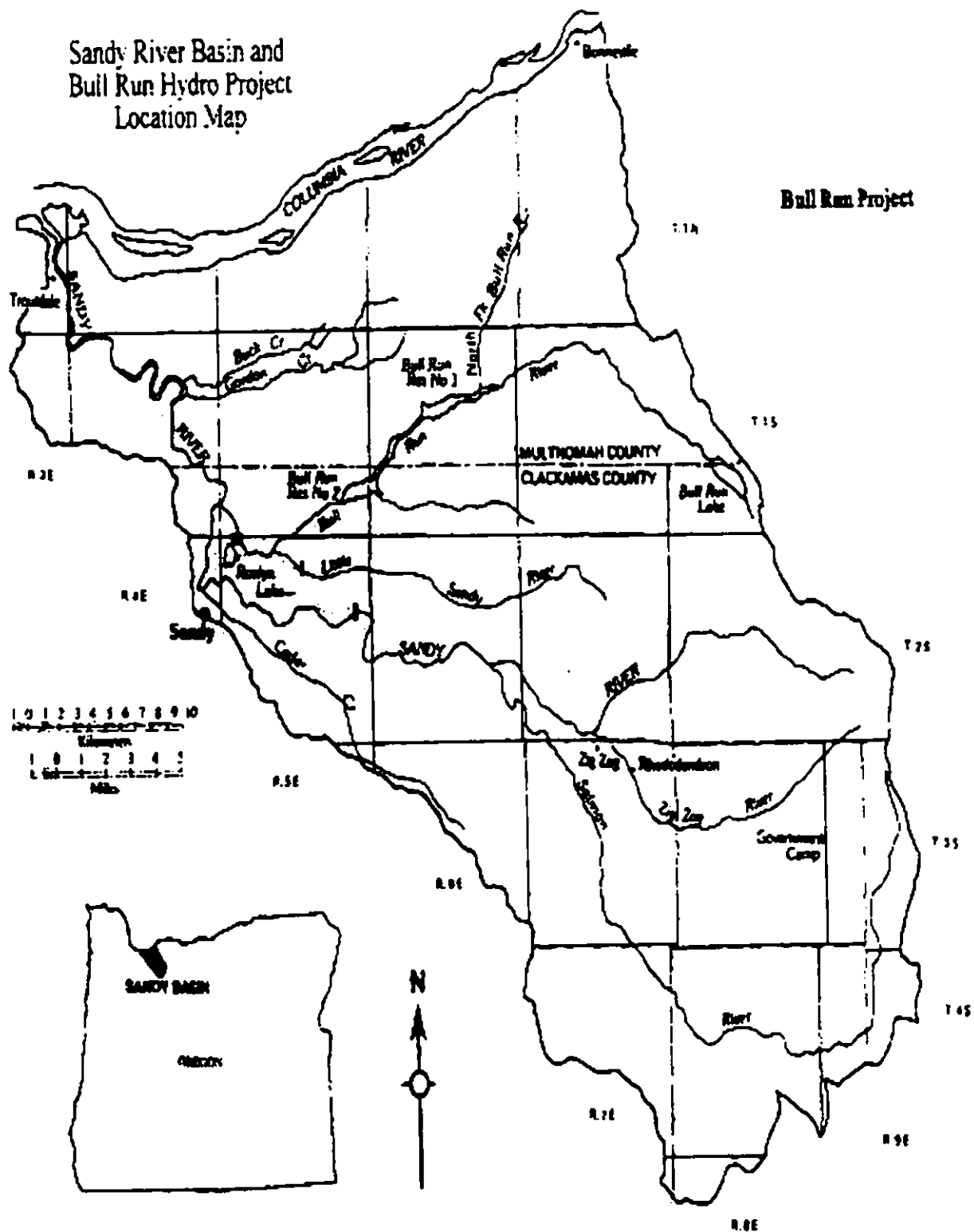


Figure 1. Map showing location of the Sandy River Basin and Bull Run Hydroelectric Project.

fish ladder and sorting facility at Marmot dam until Marmot dam removal; and (5) modify the operation of the diversion canal at Marmot dam to provide protection of threatened fish species from November 2004 until November 2007.

PGE also proposes the complete removal of both Marmot and the Little Sandy diversion dams, starting in 2007, along with the dismantling of their associated water conveyance structures. In addition, Roslyn Lake would be drained, the powerhouse generating equipment would be disabled, and the powerhouse structure would be demolished. All PGE-owned lands within the existing project boundary, with the exception of the lands associated with Roslyn Lake, would be conveyed to the Western Rivers Conservancy once the license is surrendered and the project is removed, and used to protect and conserve fish and wildlife habitat, public access, and recreation opportunities in the Sandy River Basin. Project water rights would be relinquished and would revert to instream use.

PGE filed a settlement agreement concerning the removal of the project that was developed through a cooperative consultation process among the stakeholders. The signatories include PGE, 10 federal, state, and local agencies, and 12 non-governmental organizations (PGE 2002f).³ The agreement includes a decommissioning plan consistent with the applications for amendment of license and surrender.

The settlement agreement was developed collaboratively as part of the alternative licensing process. As part of the process, PGE prepared and filed a draft environmental assessment (PGE 2002e).

The proposals outlined in the settlement agreement are discussed in more detail in section 3.

³ Signatories are Alder Creek Kayak Supply, Inc., American Rivers, American Whitewater, Association of Northwest Steelheaders, City of Sandy, Oregon, National Marine Fisheries Service, The Native Fish Society, Northwest Sportfishing Industry Association, Oregon Council of Trout Unlimited, State of Oregon, Oregon Department of Environmental Quality, Oregon Department of Fish and Wildlife, Oregon Division of State Lands, Oregon Trout, Oregon Water Resources Department, Portland General Electric Company, Sandy River Basin Watershed Council, Trout Unlimited, U.S. Department of Agriculture–Forest Service, U.S. Department of the Interior–Bureau of Land Management, U.S. Department of the Interior–Fish and Wildlife Service, Waterwatch of Oregon, and Western Rivers Conservancy.

If the Commission grants the application to surrender the license, there will be no relicense proceeding.

2.0 PURPOSE AND NEED FOR ACTION

2.1 PURPOSE OF ACTION

The purpose of the proposed action is the surrender of the Bull Run Hydroelectric Project license, and removal of the project facilities in order to achieve the protection and improvement of the natural and human environment. This FEIS analyzes the environmental and economic effects of decommissioning the Bull Run Hydroelectric Project. The analysis in the document will be used to inform a final decision on whether to issue a surrender order, as well as determine a preferred alternative for project decommissioning activities.

2.2 NEED FOR ACTION

PGE is an investor-owned utility regulated by the Oregon Public Utilities Commission which regulates its rates. PGE serves approximately 700,000 retail electric customers in and around the Portland Metropolitan Area and within the Willamette Valley corridor south to Salem. PGE's service territory covers an area of approximately 3,170 square miles.

PGE proposes to decommission the Bull Run Hydroelectric Project because PGE believes it would become uneconomical to operate the project as a result of relicensing. This is due mainly to high anticipated operations and maintenance costs associated with relicensing the project for another license term and increased environmental protection and enhancement requirements. The project has a maximum generating capacity of 22 MW, which is a small part of PGE's overall energy production. PGE relies on a variety of electric generating resources to meet the load requirements of its retail and wholesale customers. PGE owns approximately 2,100 MW of generating capacity comprised of hydroelectric, natural gas, and coal-fired plants. Lost generating capacity associated with project decommissioning would be replaced by low-cost power from the open market, which over the long-term PGE's believes would be more economical for ratepayers than continuing to operate the project.

In addition, there is a need for natural habitat for several species of salmonids that have recently been listed under the Federal Endangered Species Act (ESA). Removal of the Little Sandy diversion dam would restore access to approximately 6.5 miles of upstream habitat and 1.7 miles of habitat below the dam. Removal of Marmot dam would

restore natural flows to approximately 10 miles of the main stem Sandy River below Marmot dam.

3.0 PROPOSED ACTION AND ALTERNATIVES

3.1 DESCRIPTION OF EXISTING FACILITIES

PGE's Bull Run Hydroelectric Project is associated with three sub-drainages in the Sandy River Basin: the Sandy River, Little Sandy River, and Bull Run River. All three rivers originate on the west slope of Mt. Hood in Northwestern Oregon. The Little Sandy flows into the Bull Run, and the Bull Run empties into the Sandy at RM 18.4 (see figure 1).

The Bull Run Hydroelectric Project (figure 2) includes two diversion dams-- Marmot dam and the Little Sandy diversion dam on the Sandy and Little Sandy Rivers, respectively. While minimum flows are maintained on the Sandy River downstream of Marmot dam, all of the Little Sandy is diverted, except in times of high water. Water is diverted from these two rivers through a complex system of tunnels, and flumes, and routed to Roslyn Lake, the project forebay. From the forebay, flow is delivered to the Bull Run powerhouse through two penstocks. The diverted water is discharged to the Bull Run River after passing through the powerhouse.

Located at RM 30 on the Sandy River, Marmot dam is the most upstream structure of the Bull Run Hydroelectric Project. Marmot dam is a 47-foot high concrete gravity dam with a spillway crest length of 345 feet with a spillway crest elevation ranging from 732.1 feet mean sea level (msl) to 735.5 feet msl. The main section of the dam is 195 feet long. The reservoir area is about 18 acres. Sand and gravel have settled behind the dam so there is no reservoir or storage capacity. A fish ladder operates on the south side of Marmot dam for upstream migrants. On the north end of the dam, a concrete gravity-section wing dam extends downstream to provide 140 feet of additional spillway, and to direct water to an intake structure. The intake structure has a trash rack and two tainter gates that regulate the diversion flow into a canal system. Approximately 700 feet below this diversion point, a traveling-screen facility bypasses downstream migrating fish back into the Sandy River approximately 700 feet below Marmot dam. Water then flows westerly through a series of concrete canals, flumes, and tunnels for approximately 2 miles, and then ultimately in a northerly direction through a 4,702-foot long tunnel carved through a mountain. The tunnel ends at the Little Sandy River, where the diverted Sandy River water joins the Little Sandy just upstream of the Little Sandy diversion dam.

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The Little Sandy diversion dam is 15.75 feet high, with a spillway crest at elevation 702.75 feet. The free-overflow spillway is 114 feet long, 1.5 feet thick at its crest and approximately 18 feet thick at its base. The reservoir area is about 3 acres and has no usable storage capacity. At the Little Sandy diversion dam, the combined waters of the Sandy and Little Sandy Rivers enter a 16,810-foot-long wooden-box flume and flow westerly before discharging into Roslyn Lake, the project forebay. Twelve-inch flashboards minimize the time that water is spilled past the dam and allow the wooden flume to be filled to capacity.

Roslyn Lake is a 160-acre man-made lake that is supplied with water entirely from the Sandy and Little Sandy River water conveyance system, and from the City of Portland's municipal water supply conduits. The City of Portland's facility is capable of supplying up to 260 cfs from the Bull Run watershed into Roslyn Lake during periods of excess capacity. There is no significant drainage area for Roslyn Lake so the lake is normally maintained at its full elevation of 655 feet msl. From that elevation, 7 feet of allowable drawdown provides 928 acre-feet of usable storage. An intake structure on the east side of the lake allows water to flow through two 1,400-foot-long penstocks down to the four unit, 22-MW powerhouse on the Bull Run River, developing a 320-foot head. Water is then discharged into the Bull Run River and travels downstream 1.5 miles where it joins the Sandy River at approximately RM 18. Project works also consist of a transformer building adjacent to the powerhouse with two 9,000-kVA, 57/6.6-kV transformer banks; an outdoor switchyard with a single circuit 57-kV transmission line extending approximately 2.8 miles to a switching substation; a 12.5-kV line providing auxiliary power; and appurtenant facilities.

3.2 EXISTING PROJECT OPERATIONS

PGE is authorized to use up to 800 cfs of combined flow from the Sandy and Little Sandy Rivers for the Bull Run Hydroelectric Project. Little Sandy River flow, up to 800 cfs, is diverted first into Roslyn Lake via the flume. When Little Sandy flow is less than 800 cfs, which occurs throughout most of the year, Sandy River flow is diverted at Marmot dam to supplement the Little Sandy River flow into Roslyn Lake.

The Bull Run watershed has been the main source of water for the City of Portland and the surrounding communities since 1895. Over the years, the City of Portland has constructed two reservoirs to provide storage to meet the demands of a growing population of approximately 750,000 people. Current useable storage capacity in the Bull Run watershed is approximately 10.2 billion gallons. Both PGE (1992) and the City of Portland (1992) have filed water rights on the Little Sandy River based on "vested rights" to pre-1909 water appropriation.

Minimum flow requirements below Marmot dam can further limit the amount of Sandy River water diverted. Since 1976, PGE has been required under its current license to provide the following minimum flows below Marmot dam: 5200 cfs-June 16 through October 15; 400 cfs-October 16 through October 31; and 460 cfs-November 1 through June 15. Additionally, the canal level is restricted to 4.7 feet (maximum canal level is 5.8 feet) from March 1 to May 31 by FERC Order dated August 19, 1997, to protect salmonid fry during movement downstream (80 FERC 62,161).

Since 1998, ODFW has conducted a trapping and sorting operation for several species of salmonids at Marmot dam. The purpose of this operation is to capture and sort hatchery-reared and wild salmonids, allowing only wild fish to pass upstream to spawn.

On the Little Sandy River, there is no minimum flow release below the diversion dam. There is some leakage, and with accretion flows the summer low-flow at the mouth is about 5 cfs. To ensure that 800 cfs of flow can enter the wood-box flume without any flow over the spillway, PGE uses 12-inch flashboards on the Little Sandy diversion dam. Minimizing spill is desired to avoid stranding fish below the Little Sandy diversion dam as water levels recede after spill events.

At full generation, the Bull Run Hydroelectric Project draws approximately 900 cfs of flow from Roslyn Lake. The project's average annual generation for the period 1995-99 was 110,979 MWH.

3.3 PROPOSED ACTION

The proposed action is to surrender the operating license for the Bull Run Hydroelectric Project and to decommission the project. The action would consist of the complete removal of both Marmot and the Little Sandy diversion dams, along with the dismantling of their associated water conveyance structures. In addition, Roslyn Lake would be drained and the powerhouse and appurtenant structures would be removed unless alternative uses for the powerhouse is found. Descriptions of this proposed action are discussed below by major project feature. All private project and non-project lands, except those associated with Roslyn Lake, would be conveyed to the Western Rivers Conservancy once the project is surrendered and removed, with the expressed intent that these lands be used to protect and conserve fish and wildlife habitat, public access, and recreation opportunities along the Sandy River. Project water rights would be relinquished and as a consequence these rights would revert to instream use. Overall, this proposed action would result in the cessation of all project energy generation and water diversions; thus, resulting in the Sandy and Little Rivers reverting back to a free-flowing state. The proposed action is described in more detail in PGE's decommissioning plan

(PGE 2002c).

3.3.1 Marmot Dam

PGE's proposal is to remove Marmot dam and Crib dam, with minimal sediment removal (alternative 1). Other alternatives are described in section 3.4.2 and evaluated throughout this document.

PGE's proposal includes complete removal of the roller-compacted concrete (RCC) dam, older timber crib dam just upstream, canal and fish ladder in one in-water construction season. The only sediment (sand, gravel, and cobbles) to be removed with this alternative is that which is required for the planned demolition (i.e. that which is in the immediate vicinity of the RCC and timber crib dams). About 20,000 to 30,000 cubic yards of sediment would be excavated. In order to perform the demolition of the instream structures, a cofferdam would be placed a sufficient distance upstream to permit removal of the old timber crib dam, a portion of which was abandon in place, and another downstream of the RCC dam.

Upstream migrating fish would be accommodated with a trap and haul program throughout the construction period. A temporary fish barrier, denil ladder and trap would be installed 600 to 800 feet downstream of Marmot dam, near the evaluator structure. Migrating fish would travel up the denil ladder near the right bank and into the trap. The trap would be lifted onto a truck to transport the fish for release back into the Sandy River.

Streamflows would be diverted through the existing approach channel during construction. Fifty to sixty cfs of this flow would be used for attraction water at the fish ladder/trap. This attraction flow would be piped from the canal into the trap and cascade down the ladder to the stream. The remainder of the diverted stream flow would spill back to the stream through the wing wall near the inlet to the canal.

It is anticipated that controlled blasting and excavators would be used to remove the two existing dams and fish ladder. The concrete would be rubblized and stockpiled on-site for a beneficial end use, such as road surfacing, structural fill material and/or concrete production. The minimal volume of excavated sediment would be stockpiled on BLM land north of the dam in a mutually agreeable fashion. The proposed excavation of upstream sediments is intended to be accomplished by employing track mounted excavators, rubber tired loaders and off-highway end dump vehicles. The off-site stockpile would be shaped by a track mounted dozer. After the dam, structures and planned sediments are removed, the downstream fish barrier would be removed and the

cofferdams would be breached to return the river flow to the streambed.

The cofferdam would be designed to transmit a maximum discharge of 1,750 cfs with 3 feet of freeboard for dam safety issues. The cofferdam would be breached at approximately 2,500 cfs. Once it has been breached, the material making up the cofferdam would be transported downstream with the reservoir sediment.

3.3.2 Little Sandy Diversion Dam

The Little Sandy diversion would be removed during the second low-water season, after Marmot dam has been removed and flows are no longer being diverted through the canal system to the Little Sandy. The relatively short height of dam and historic low stream flows during the dry season is expected to preclude the need for cofferdams for this work. It is anticipated that demolition of the dam can be accomplished by working from both the upstream and downstream faces simultaneously, with controlled blasting and conventional air hammers and excavating equipment. The concrete would be rubblized and transported off site for a beneficial end use, such as road surfacing, structural fill material and/or concrete production.

3.3.3 Canals, Tunnels, Flume, and Ancillary Structures

The concrete canal linings would be ripped, folded into the canal, and covered with fill. The fill would be compacted, sloped to drain and seeded to control erosion. The fill would be contoured where required to allow existing streams to cross the existing canal alignment and the stream channel at such crossings would be protected to prevent erosion. The estimated period for the canal demolition is 5 months.

Except for the end of Tunnel No. 1 near the Little Sandy diversion dam, the tunnels would be closed with concrete plugs anchored into the surrounding rock at or near each opening. Any loose or unstable rock blocks at the portals would be stabilized by scaling and/or rock bolting. Tunnel No. 1 would have a louvered opening at the end near the Little Sandy diversion dam to provide access for bats to the potential habitat within the tunnel. A concrete tunnel plug would be installed a suitable distance upstream of the louvered opening. The estimated time for the decommissioning of the tunnels is 7 months.

The time estimated to decommission the wood flume is 13 months. This work would consist of demolition and removal of the wooden flume, wooden columns, foot bridges, and inspection walkways. The concrete footings would be left in place, except that the four large footings within the Little Sandy River would be removed during the

low-flow period. It is anticipated that this work would be accomplished by cranes operated from within the flume box, with transportation of much of the material provided by the speeder car on the existing rail system. Longer sections may helicopter lifted from the site. Other removal activities include the notching or removal of five concrete tributary dams, removal of concrete slabs from concrete-lined channel, enlarging an outlet trench to drain a closed depression under the flume, and remove wire baskets from a gabion wall (leaving rock in place).

3.3.4 Project Powerhouse

The powerhouse, tailrace, transformer building, shop building, office building, fences, pavements and switchyard would be removed and the area would be backfilled and seeded. Standard demolition techniques would be employed. This work is expected to be completed within approximately 10 months. The powerhouse may be reused if suitable reuse could be determined.

3.3.5 Roslyn Lake

The dam, dikes and outlet structure would be removed over a projected 8-month construction period. The outlet structure would be removed/demolished and disposed of off-site. The portion of the penstocks under Roslyn Lake, under the adjacent roadway, and under the powerhouse would be sealed with concrete. All exposed sections of the penstocks would be removed. The material from the dam and dikes would be spread out over the existing lake area, graded and seeded to facilitate drainage and minimize erosion.

3.3.6 Disposition of PGE Lands

PGE would donate all of PGE-owned land in the Bull Run area of the Sandy River Basin, with the exception of the lands associated with Roslyn Lake, to the Western Rivers Conservancy. The lands totals about 650 acres associated with the project and 880 acres of non-project lands. The management goals would be to protect and restore riparian habitat; protect the integrity of the river ecosystem; establish connections between habitat units for terrestrial wildlife; and provide low-impact public access to the rivers and lands.

3.3.7 Transfer of Water Rights

PGE would initiate a process to convert its surface water registration to an instream water right (200 cfs for the Little Sandy River and 600 cfs for Sandy River). The instream water right would be conditioned to maintain up to 40 cfs of existing uses upstream from Marmot dam, up to 3 cfs of existing uses between Marmot dam and the

confluence of the Sandy river and the Bull Run River, and 16.3 cfs of the City of Sandy's permit on the Salmon River.

3.3.8 Mitigative and Monitoring Measures

Prior to Dam Removal

The existing license conditions would be in effect until Marmot dam is removed. PGE proposes the following measures prior to project removal (see PGE 2002c, decommissioning plan for more details):

- to protect downstream-migrating juvenile salmonids, beginning in 2005, limit the canal level to 4.7 feet from February 15 until March 15; from March 15 and continuing for 8 weeks, operate the canal levels at 4.2 feet for 8 hours during this period; and at no more than 4.7 feet all other hours during this period
- continue to fund the operation and maintenance of the fish ladder and fish trap at Marmot dam until that dam is removed (PGE 2002c, exhibit C, appendix A).

Project Removal

PGE proposes the following measures to mitigate the effects of project removal (see PGE 2002c, decommissioning plan for more details):

Revegetation, Noxious Weed Control, and Site Restoration

- implement a revegetation, noxious weed control, and site restoration plan (PGE 2002c, exhibit A).

Fish Passage

- provide temporary fish passage for upstream migrants by constructing a trap and haul facility downstream of Marmot dam (PGE 2002c, exhibit C, appendix A).

Endangered Species Aquatic Habitat Impact Minimization Measures

- remove Marmot dam during single season; remove the cofferdam at the end

of the first in-water construction season prior to high winter flows; maximize discharge to breach the cofferdam and cause rapid sediment scour; shape sediment banks to minimize dry season bank sloughing; provide fish passage during inwater dam removal activities; and provide minimum flows downstream in the Sandy River

Sandy River Fall Chinook Salmon Conservation Program

- fund (\$25,000) a fall chinook salmon conservation program to be implemented by ODFW to mitigate adverse impacts to fall chinook salmon (PGE 2002c, exhibit C, appendix B).

Historic Preservation

- undertake measures to minimize or mitigate adverse effects to properties determined eligible for inclusion in the National Register of Historic Places, including possible reuse of the Bull Run powerhouse; recordation of and opportunities for the public to tour project facilities prior to removal; salvaging historically significant architectural elements of certain project features for public education, curation, or reuse; and protection of archaeological resources

Navigation and Boater Safety

- provide signs to warn boaters and provide portage facilities during deconstruction and after Marmot dam is removed

Monitoring

PGE proposes the following monitoring measures (see PGE 2002c, decommissioning plan for more details):

Pre-removal Geomorphic Monitoring

- conduct two geomorphological studies: one to provide information on baseline conditions and one to provide a geomorphic context for considering the ecological implication of Marmot dam removal

Water Quality

- monitor turbidity prior to dam removal, during structure removal, and after dam removal

Sediment Monitoring

- monitor sediment released after removal of Marmot dam

Stream Gages

- fund the maintenance of the existing gage at Little Sandy River and the existing gage on Sandy River near Marmot

Site Restoration and Monitoring

- address bank stability in the areas behind Marmot dam, erosion in areas that are not behind Marmot dam or in areas that are considered to be stable, revegetation of erodible materials, and presence of noxious weeds in areas disturbed by removal activities

Endangered Species Monitoring and Contingencies Plan

- implement detailed monitoring and contingency actions to evaluate post-dam fish passage barriers and address any blockages in a rapid and effective manner to minimize incidental take of listed fish species (Appendix A). The contingency measures would address mechanical removal of passage barriers, creating channel complexity, emergency fish recovery, and lower river trap and haul.

Monitoring Channel Complexity and Fish Passage to Determine Endpoint

- measure channel complexity as an indicator of potential fish barriers following the removal of Marmot dam and determine when post-Marmot dam conditions in the Sandy River have returned to baseline conditions

Endangered and Threatened Terrestrial Species

- survey spotted owls in 2005 and 2006 and adjust timing and intensity of decommissioning activities accordingly

Coordinating Committee

- formation of a coordinating committee to oversee implementation of the settlement agreement and decommissioning plan

Endangered Species Monitoring and Implementation Team

- convene a monitoring and implementation team (MIT) to oversee the endangered species fish monitoring and contingencies measures

Other Basin Monitoring and Research Program

PGE proposes to contribute \$100,000 before January 14, 2004, and \$200,000 before January 15, 2008, to:

- develop information that would help guide future recovery or restoration decisions in the Sandy or Little Sandy rivers
- research opportunities related to dam removal issues
- other research opportunities in the Sandy and Little Sandy Rivers

3.3.9 Proposed Schedule for Decommissioning

PGE proposes the following schedule for decommissioning the project:

Activity	Schedule
Pre-removal geomorphological and water quality monitoring	August 2002 - August 2006
Permitting	November 2002 - March 2007
Removal of Marmot dam	July 2007 - October 2007
Removal of Little Sandy diversion dam	July 2008 - October 2008
Removal of canals	November 2007 - July 2008
Removal of tunnels	November 2007 - September 2008
Removal of flume	July 2008 - June 2009

Demolition of project powerhouse	August 2008 - June 2009
Removal of Roslyn Lake	July 2008 - November 2008
Post-removal monitoring and contingency response	October 2007 -

3.4 ALTERNATIVES TO THE PROPOSED ACTION

This section describes the alternatives to the proposed action that were considered as part of the environmental and economic analyses and the no-action alternative. Details regarding the analyses are provided later in the document under Sections 5 and 6.

3.4.1 No-action Alternative

The no-action alternative represents the environmental status quo, in this case the continued operation of the project under its existing license granted by FERC, with no new environmental protection, mitigation, or enhancement measures. We use this alternative to establish baseline environmental and economic conditions for comparison with the proposed action and other alternatives.

3.4.2 Marmot Dam Removal Alternatives

The Decommissioning Working Group developed three dam removal alternatives. The proposed alternative (alternative 1) is discussed in section 3.3.1 (Remove Marmot dam and the Crib dam, with minimal sediment removal). The two other alternatives are described in this section and are evaluated in subsequent sections of this FEIS.

Alternative 2. Step down the dam to provide controlled release of the upper layer of upstream sediment. Remove the remainder of the dam and the sandy sediments to a point approximately 2,700 feet upstream during the following construction season.

The year prior to lowering the Marmot dam crest, a fish barrier dam and trapping/sorting facility suitable for continuous use would be constructed. The fish barrier dam would be capable of surviving high flows and would be installed approximately 800 to 1,500 feet downstream of the Marmot dam. The construction of this structure would require the installation of cofferdams, built on each side of the stream, above and below the new barrier structure. An RCC leveling slab would be constructed across the river channel for the installation of either an Obermeyer rubber dam or a "Chiwawa River"

type of barrier structure. Either of these two types of structures can be raised or lowered depending on the need and/or river levels. Concrete non-overflow sections would be constructed at each end of the barrier structure to protect the abutments from flows up to approximately 10,000 cfs. A concrete fish ladder would be constructed along the north bank of the river just downstream of the barrier structure. At the upstream end of the ladder would be a trap, a hydraulic lift, an anesthetic tank, a 10-foot by 20-foot by 6-foot deep holding/sorting tank and a recovery tank. Attraction flow water would be pumped from just upstream of the barrier structure to the upper tanks and then cascade down the ladder to the stream. The sorting tank would allow sorting of hatchery fish from wild fish. It is anticipated that hatchery fish would be transported back downstream. During the construction period, wild fish would be transported upstream for release. After construction, wild fish would travel down a pipe slide from the recovery tank into the stream upstream of the barrier structure.

During the first deconstruction season the top portion of the dam would be removed. Other work to be performed during the first construction season would include demolition and removal of the timber crib dam and concrete fish ladder. In order to perform the demolition of the instream structures, a cofferdam would be placed a sufficient distance upstream to permit removal of the old timber crib dam, a portion of which was abandoned in place, and another downstream of the RCC dam.

Normal construction period stream flows during the first deconstruction season would be diverted through the existing approach channel and spilled back to the stream through the wing wall near the inlet to the canal. An armored overflow section would be provided in the upstream cofferdam to pass summer high flows during construction of 2,000 cfs or greater.

The purpose of completing the demolition of the RCC dam over two construction seasons is to allow the upper portion of the upstream gravelly sediments to wash downstream under the higher, winter flows. The gravel nature of this portion of the sediment make it desirable for downstream spawning habitat. Therefore after the instream demolition work is completed for the first deconstruction season, the cofferdams upstream and downstream of the RCC dam would be breached.

During the second in-water deconstruction season, the remainder of the RCC dam and sediment from the dam to a point approximately 2,700 feet upstream would be removed. This sediment is primarily sandy in nature and its volume is currently estimated at 340,000 cubic yards. In order to remove the remainder of the RCC dam, cofferdams extending part way across the river would be required upstream and downstream of the dam. It is anticipated that the work would be staged to remove one side of the dam at a

time, with the cofferdams extending only part way across the river to protect the side being worked on. The river would be diverted to pass over the dam not being worked on at that time. After the first side is removed, the streamflow would be routed to the new channel and the downstream cofferdam would be relocated, then the remaining side of the dam would be removed. The cofferdams would be removed from the river after the demolition is complete.

It is anticipated that controlled blasting and excavators would be used to remove the two existing dams and fish ladder and to lower the crest of the RCC dam the first year. The concrete would be rubblized and stockpiled on-site for a beneficial end use, such as road surfacing, structural fill material and/or concrete production.

The excavated sediment would be stockpiled on land north of the dam. The proposed excavation of upstream sediments is intended to be accomplished by employing track mounted excavators, rubber-tired loaders, and off-highway end dump vehicles. The off-site stockpile would be shaped by a track mounted dozer.

Erosion of the stockpile would be controlled by compacting the sediment and a ditch would be constructed around the stockpile to collect drainage from the wet sediments for discharge into a settling pond. Flows would discharge over the top of a weir at the far end of the pond and then piped back to the river. After the sediment is drained, it would be spread over the available 100-acre area that would have been previously stripped of topsoil. The estimated 2.7-foot high sediment mound would be compacted, covered with topsoil and seeded to control erosion.

Alternative 3. Remove the maximum amount of sediment possible during one in-water construction period

Under this alternative, between 125,000 and 300,000 cubic yards of sediment would be removed during the in-water work period, making between 680,000 and 855,000 cubic yards of sediment available for downstream transport. The specific amount of sediment that could be removed depends upon the timing of the first storm, any instream turbidity issues, and any other construction issues that may arise.

Upstream migrating fish would be accommodated with a trap and haul program throughout the construction period. A temporary fish barrier, denil ladder and trap would be installed 600 to 800 feet downstream of Marmot dam, near the evaluator structure. Migrating fish would travel up the denil ladder near the right bank and into the trap. The trap would be lifted onto a truck to transport the fish for release back into the Sandy River.

Stream flows would be diverted through the existing approach channel during construction. Fifty to sixty cfs of this flow would be used for attraction water at the fish ladder/trap. This attraction flow would be piped from the canal into the trap and cascade down the ladder to the stream. The remainder of the diverted stream flow would spill back to the stream through the wing wall near the inlet to the canal.

It is anticipated that controlled blasting and excavators would be used to remove the two existing dams and fish ladder. The concrete would be rubblized and stockpiled on-site for a beneficial end use, such as road surfacing, structural fill material and/or concrete production.

Temporary channel alignments upstream of the upstream cofferdam would be excavated to facilitate removal of the reservoir sediments, by moving the channel flow away from the area where sediment is being removed. The excavated sediment would be hauled down the streambed to the right bank and stockpiled on an area of land on the north bank about 2,500 feet upstream of the dam. The proposed excavation of upstream sediments is intended to be accomplished by employing track mounted excavators, rubber-tired loaders, and off-highway end dump vehicles. The off-site stockpile would be shaped by a track mounted dozer.

Erosion of the stockpile would be controlled by compacting the sediment and a ditch would be constructed around the stockpile to collect drainage from the wet sediments for discharge into a settling pond. Flows would discharge over the top of a weir at the far end of the pond and then be piped back to the river. After the sediment is drained it would be spread over a 100-acre area that would have been previously stripped of topsoil. The estimated 5.3-foot high sediment mound would be compacted, covered with topsoil and seeded to control erosion. As a modification to this disposal plan, off-site disposal options are also being considered.

The cofferdam would be designed to transmit a maximum discharge of 1,750 cfs with 3 feet of freeboard for dam safety issues. The cofferdam would be breached at approximately 2,500 cfs. Once it has been breached, the material making up the cofferdam would be transported downstream with the reservoir sediment.

3.4.3 PGE's Proposal with Staff Modifications

In addition to the measures proposed by PGE, staff recommends the following measures:

- development of an erosion and sediment control plan

- requiring PGE to give homeowners sufficient advance notice of its specific plans and schedule to drain Roslyn Lake in order to give these homeowners adequate time to implement necessary measures, such as redrilling, to meet their water supply needs
- development of a fish facility design and operation plan
- development of a final revegetation, noxious weed control, and site restoration plan
- development of a plan to implement the terms and conditions outlined in the Biological Opinions (BOs) issued by the U.S. Fish and Wildlife Service and NOAA Fisheries
- development of a spotted owl protection plan
- implementation of the final historic properties management plan
- investigation of alternative sources of water for fire-fighting purposes

3.5 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED STUDY

Decommissioning the Project and Leaving Dams in Place

We've eliminated decommissioning the project and leaving both Marmot dam and Little Sandy diversion dam in place as an alternative.

The reservoirs created by the two dams receive minimal recreational use because of their small size and because they are filled with sediment. Also, no residences are located along the shoreline that would be adversely affected by dam removal. Such an alternative also would not avoid any of the impacts associated with the removal of Lake Roslyn. Although leaving the dams in place would minimize the short-term effects due to the release of stored sediment and would avoid removing structures that are eligible for listing in the National Register of Historic Places, such an alternative would not accomplish the primary goal of unrestricted fish passage, improved wildlife movement, and unobstructed boating opportunities. Further, no entity recommended such an alternative during scoping. It is likely that no entity would be interested in taking over management responsibilities for the two dams. It is also likely that USFS and BLM would want facilities located on their lands removed.

Retaining Roslyn Lake

The alternative of reconfiguring Roslyn Lake and supplying it with water from the City of Portland's conduit was considered and rejected. This would have been the same as the proposed action except that Roslyn Lake would remain intact; however, the lake would be reconfigured resulting in a reduction in its overall size and extent. In addition, rather than replenishing Roslyn Lake levels with water from the Sandy and Little Sandy River diversions, lake levels would be maintained from the City of Portland's municipal water supply conduits. The viability of this alternative depended on the supply of water by the City of Portland, which has determined that it cannot provide such a supply. In addition, a responsible operator for the park could not be identified. Accordingly, this alternative is no longer considered to be feasible and has been dropped from further evaluation and consideration.

4.0 CONSULTATION AND COMPLIANCE

4.1 AGENCY CONSULTATION

PGE has coordinated its efforts with FERC staff and with the Bull Run Decommissioning Working Group, which consists of representatives from resource agencies, non-governmental organizations, and the public. PGE prepared a preliminary draft environmental assessment and the Commission requested comments.⁴

4.2 SCOPING

PGE and Commission staff conducted scoping prior to PGE's preparation of a draft environmental assessment that was filed with the Commission as part of the surrender application.⁵ Scoping document 1 was issued on July 30, 1999. On September 1, 1999, scoping meetings were held in Sandy, Oregon, and in Portland, Oregon. In addition to comments provided at the meetings, the following entities filed scoping comments:

⁴ Notice of Draft License Surrender Application and Preliminary Draft Environmental Assessment and Request for Preliminary Terms and Conditions was published in the Federal Register on March 8, 2000 (Federal Register, volume 65, number 50, page 13747-13748).

⁵ Notice of Scoping was published in the Federal Register on July 23, 1999 (Federal Register, volume 64, number 145, pages 411101-411102).

Commentor	Date of Letter
Oregon Department of Environmental Quality	September 11, 1999
BLM	September 28, 1999
USFS-Mt. Hood National Forest	September 29, 1999
Oregon Water Resources Department	September 29, 1999
U.S. Fish and Wildlife Service	September 30, 1999
National Marine Fisheries Service	September 30, 1999
Oregon Department of Fish and Wildlife	September 30, 1999
American Whitewater Affiliation	October 1, 1999
Northwest Sportfishing Industry Association	October 1, 1999
Association of Northwest Steelheaders	October 1, 1999
American Rivers	October 15, 1999
Sandy Fire District No. 72	undated

Scoping document 2, which addressed comments received during scoping, was issued on November 4, 1999.

On March 26, 2003, the Commission issued a Notice of Intent to Prepare an EIS and Soliciting Additional Scoping Comments.⁶ Comments were received from USFS-Mt. Hood National Forest in support of the surrender application on April 23, 2003. By letter dated April 18, 2003, the Bull Run Community Association listed four items that should be addressed in the FEIS: the effect of draining Roslyn Lake on water wells; the effect of draining Roslyn Lake on fire-fighting activities; continued public access to the lands currently occupied by the lake; and loss of the existing rural and scenic character of the area. These issues are discussed in the resource sections of this FEIS.

⁶ Notice was published in the Federal Register on April 2, 2003 (Federal Register, volume 68, number 63, pages 16019-16020).

4.3 INTERVENTIONS AND COMMENTS

Organizations and individuals may petition to intervene and become a party to subsequent proceedings. On November 21, 2002, the Commission issued a Notice of Applications for Amendment of License and Surrender of License and Settlement Agreement and Decommissioning Plan and Soliciting Comments, Motions to Intervene, and Protests.⁷

In response to the Commission's public notice, the following interventions were filed:

Intervenor	Date of Filing
American Whitewater Affiliation, Alder Creek Kayak Supply, Inc. and WaterWatch of Oregon	12/19/02
State of Oregon	12/24/02
Department of the Interior	1/10/03; 1/17/03
National Marine Fisheries Service	1/16/03
American Rivers, Oregon Trout, Trout Unlimited, Oregon Council Trout Unlimited, and the Native Fish Society	1/17/03
Department of Agriculture	1/17/03
Sandy River Basin Watershed Council	1/17/03

The intervenors were supportive of PGE's proposal to surrender the project. No specific recommendations were provided.

4.4 COMMENTS ON THE FEIS

The draft EIS (DEIS) was noticed by the Environmental Protection Agency on July 25, 2003.⁸ Comments were due no later than September 8, 2003.

⁷ Notice was published in the Federal Register on November 27, 2002 (Federal Register, volume 67, number 229, pages 70942-70943).

⁸ Notice of availability, Federal Register, volume 68, number 143, pages 44080-

The following entities filed comments on the DEIS in response to the notice:

Entity	Date of Letter
State of Oregon	September 4, 2003
U.S. Forest Service	September 5, 2003
Environmental Protection Agency (EPA)	September 5, 2003
Sandy River Basin Watershed Council	September 7, 2003
American Rivers, Oregon Trout, Trout Unlimited, Oregon Council trout Unlimited, Native Fish Society	September 8, 2003
U.S. Department of the Interior (Interior)	September 8, 2003
Portland General Electric	September 8, 2003
Joseph L. Miller, Jr., M.D. (retired)	October 2, 2003

All the commenting entities, with the exception of EPA, disagreed with what they believed was a staff recommendation that the license term not be extended until 2017. The entities provided limited support but strongly believe that extending the license term is necessary to ensure that the terms of the settlement and decommissioning plan are met, particularly those conditions dealing with endangered species protection during and after the removal of the project. Oregon commented that the license term must be of adequate duration to satisfy any water quality certification conditions.

Staff did not recommend against extending the license term, but rather noted that the goal of ensuring that the settlement's monitoring requirements and corresponding implementation of measures related to the monitoring conceivably could also be accomplished by delaying the effectiveness of any surrender until the monitoring and implementation of measures are complete. This policy/legal issue will be addressed in any Commission order on the applications.

EPA supports the selection and implementation of the settlement alternative with staff-recommended modifications and assigned the DEIS a rating of LO (lack of

⁸(...continued)

44081.

objections).

The commenting entities do not object to the additional staff environmental recommendations, though PGE believes that these measures would cost more than the staff estimates.

Interior commented that BLM is interested in retaining the footbridge that crosses the Sandy River immediately downstream from Marmot dam. Interior noted that the bridge is structurally sound and could be a key component in the development of future opportunities in the area. The Commission can't require the long-term preservation of the bridge since such a requirement would cover a period following the Commission's loss of jurisdiction to enforce the requirement. Surrender of the project, however, would not prevent BLM and PGE from themselves addressing the matter.

USFS provided a number of technical additions and revisions, including clarification of the removal of the large concrete footing in the Little Sandy River, identification of current fish management objectives, presence of bull trout in lower Sandy River, the effect of wild fish and hatchery strays on resident fish upstream of Little Sandy diversion dam, changes in angler pressure, restoration of federal lands, the status of survey and manage species, the potential for the spread of exotic and invasive species, and the location of archeological sites. These suggested changes have been incorporated into this document.

Dr. Miller expressed concern that the public may be provided access to the Little Sandy and Bull Run Rivers and this access would affect the public health or safety of Portland's water supply.

Transferring ownership of the PGE lands associated with the surrender application to the Western Rivers Conservancy would not impact the public health or safety of the City of Portland's water supply located in the Bull Run Watershed. The lands involved in the surrender are either located outside of the Bull Run Watershed or located in the Bull Run Watershed but well downstream of the areas containing the City's water supply. Therefore, no potential effects to the quality of Portland's water supply would result.

4.5 COMPLIANCE WITH APPLICABLE LAWS AND POLICIES

4.5.1 Clean Water Act—Section 404

Under Section 404 of the Clean Water Act (CWA), the United States Army Corps of Engineers (Corps) issues dredge and fill permits for specified types of construction in

wetlands. These permits generally include conditions applicable to project construction activities. Since the decommissioning of the Bull Run Hydroelectric Project would include construction activities within wetland areas, a Section 404 Permit would be required. PGE will apply for a Section 404 Dredge and Fill Permit from the Corps after the Commission issues an order establishing the terms and conditions for project removal.

4.5.2 Clean Water Act—Section 401

Section 401(a)(1) of the Clean Water Act [33 U.S.C. §1341(a)(1) (1982)] prohibits the Commission from taking action unless the state water quality certifying agency has granted or waived water quality certification. Certification is waived if the certifying agency fails to act on the certification request within 1 year of receiving it. [See also 18 C.F.R. § 4.38(f)(7)(ii) (2000).]

The Oregon Department of Environmental Quality (ODEQ) received PGE's application for a water quality certificate on November 7, 2002. Thus ODEQ has 1 year to act on the certification request or the certificate is considered to be waived.

ODEQ anticipates that project removal consistent with the settlement agreement would comply with water quality standards and protect beneficial uses (PGE 2002f).

4.5.3 National Historic Preservation Act

The National Historic Preservation Act of 1966, as amended (16 U.S.C. §470) requires Federal agencies to take into account the effect of their undertakings on properties included in or eligible for inclusion in the National Register of Historic Places (National Register) and to afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings. Section 106 of the Act sets forth the process on how the Federal agencies meet these statutory responsibilities. The process seeks to accommodate historic preservation concerns with the needs of Federal undertakings.

FERC regulations require an applicant to submit information on the identification of any historical or archeological sites either listed or determined to be eligible for inclusion in the National Register of Historic Places that are located in the project area, or that would be affected by operation of the project. FERC delegates this responsibility to the applicant and requires that all information be prepared in consultation with the State Historic Preservation Officer (SHPO) and other consulting parties. Under the Section 106 process FERC may invite the Advisory Council to participate; however, FERC holds final responsibility for decisions made regarding historic properties.

In September 1999, PGE completed a historic structure's evaluation and prepared a Request for Determination of Eligibility for the National Register of Historic Places. PGE submitted the Determination of Eligibility to the Oregon State Historic Preservation Office requesting concurrence. The following structures have been determined eligible for the National Register of Historic Places.

- Marmot dam
- Little Sandy diversion dam
- Bull Run water conveyance systems
- Roslyn Lake earth-fill dikes
- Powerhouse intake
- Penstocks and surge tank
- Bull Run powerhouse
- Bull Run transformer building
- Machine shop

Structures not eligible for the National Register of Historic Places include Marmot dam fish ladder and associated structures, and Roslyn Lake Park recreation buildings. PGE conducted an archeological survey and evaluation of Bull Run Project lands. Three archeological sites were identified during the subsurface testing. Additionally, four locations with isolated prehistoric artifacts and two locations with modern or historic refuse were documented.

PGE has prepared a Memorandum of Agreement (MOA) to address unresolved issues relating to the historic properties at the Bull Run Hydroelectric Project.

By letter dated February 21, 2003, staff requested PGE to prepare a Historic Properties Management Plan (HPMP). PGE filed the draft HPMP on May 21, 2003 (PGE 2003c). On August 21, 2003, Staff issued a draft standard FERC MOA requiring implementation of the proposed measures.

4.5.4 Endangered Species Act (ESA)

Section 7 of the ESA requires that federal agencies consult with NMFS⁹ or USFWS when a proposed action may affect federally listed threatened species. The NMFS has jurisdiction over anadromous fish species, while the USFWS has jurisdiction over all terrestrial and freshwater biota.

⁹ NMFS is now known as NOAA Fisheries.

In a letter dated, November 15, 1999, FERC designated PGE as the non-Federal representative for conducting consultation with NMFS and USFWS. PGE, in consultation with NMFS and USFWS, drafted a Biological Evaluation (PGE 2002d).

Salmonid populations, their listing status, and descriptions of the evolutionarily significant units (ESU's), are shown in table 1. The listed salmonid populations are chinook salmon (including both spring and fall-runs), and winter steelhead (hatchery summer steelhead are excluded). Coho salmon are listed as a candidate species. Coastal cutthroat trout, which may be present in the lower reaches of the Sandy River, were originally proposed for listing, but the proposal was withdrawn in July 2002. The bald eagle and northern spotted owl are also located in the project area.

Table 1. Special Status Salmonids in the Sandy River Basin.

SPECIES	ESU	FEDERAL STATUS	NOTES
Chinook Salmon	Lower Columbia River	Threatened	Description of ESU: ESU includes all naturally spawned fall- and spring-run chinook salmon from mouth of Columbia River to crest of Cascade Range (including tributaries), excluding areas above Willamette Falls. Includes spring-run, tule, and late-fall "bright" populations. Progeny of naturally spawning hatchery fish are treated as listed for the purposes of the ESA. Affected Runs in the Sandy River Basin: Listing includes both fall- and spring-run chinook salmon in the Sandy River Basin, despite introductions of spring-run fish from the Upper Willamette River ESU. Listing excludes Sandy River spring-run hatchery stock, which was determined not to be essential for recovery.
Steelhead	Lower Columbia River	Threatened	Description of ESU: ESU includes all naturally spawned winter- and summer-run steelhead in the Columbia River Basin and tributaries between Cowlitz and Wind Rivers in Washington and Willamette and Hood Rivers in Oregon, excluding upper Willamette River Basin above Willamette Falls. Hatchery stocks were included in the ESU, but no hatchery populations were determined essential for recovery and they are, therefore, not covered under the listing. Affected Runs in the Sandy River Basin: Listing includes later-returning native winter steelhead in the Sandy River Basin. Listing excludes early-run hatchery winter steelhead stock in the Sandy River Basin. Listing excludes Skamania-origin summer-run steelhead in the Sandy River Basin.

SPECIES	ESU	FEDERAL STATUS	NOTES
Coho Salmon	Lower Columbia River/ Southwestern Washington	Candidate Species	Description of ESU: ESU includes all naturally spawning populations from all tributaries of the Columbia River below approximately the Klickitat and Deschutes Rivers, as well as coastal drainages in southwest Washington. Affected Populations in the Sandy River Basin: Listing of this ESU would likely include on later returning native coho salmon in the Sandy River Basin.
Bull Trout	Columbia River DPS	Threatened	Description of ESU: Columbia River DPS includes all populations occurring throughout entire Columbia River Basin within U.S. and all tributaries, excluding bull trout found in Jarbridge River, NV. Subpopulations in Willamette and Deschutes Rivers are included in this listing (USFWS 1998). Affected Populations in the Sandy River Basin: The Sandy River was not mentioned in the most recent listing (USFWS 1998) as historically supporting a bull trout population. Critical habitat for bull trout has not been designated (USFWS 2001).

Source: Stillwater Sciences 1999.

We conclude, based on the analysis in the BE (PGE 2002d), that the proposed action is likely to adversely affect the following listed, proposed, or candidate salmonid evolutionary significant units (ESUs) and distinct population segments (DPSs):

- Northern spotted owl (threatened)
- Columbia River bull trout DPS (threatened)
- Lower Columbia River chinook salmon ESU (threatened)
- Lower Columbia River steelhead ESU (threatened)
- Lower Columbia River/Southwest Washington Coast coho salmon ESU (candidate)

By letter April 11, 2003, we initiated formal consultation with NOAA Fisheries and USFWS on the four threatened species and requested a conference opinion on the candidate species.

On October 15, 2003, USFWS provided a BO, concluding the proposed action would not jeopardize the continued existence of the bull trout and northern spotted owl. The BO contained the following terms and conditions to minimize the take of bull trout and spotted owls:

Bull Trout

The first term and condition requires the convening of the Endangered Species Act Monitoring and Implementation Team to review dam removal activities and review any new information.

The second term and condition requires that: best management practices shall be used to prevent concrete products mobilized by dam removal activities from entering flowing or standing waters; construction activities associated with habitat enhancement and erosion control measures shall meet or exceed best management practices; erosion control and sediment containment measures shall be employed at the Marmot dam and Little Sandy diversion structure prior to the onset of construction; erosion control and sediment containment materials shall be available for emergency needs; vehicles operated within 150 feet of the construction site waterways will be free of fluid leaks; no pollutants of any kind shall come in contact with the water body nor their substrate below the mean high water elevation or 10-year flood elevation, whichever is greater; any areas used for staging, access roads, or storage are to be evacuated and all materials, equipment, and fuel shall be removed if flooding is expected; vehicle and equipment maintenance, refueling, and storage of fuel shall be done at least 150 feet from the waterway; vehicles shall not be stored overnight within the waterway; prior to operating in the waterway, all equipment shall be cleaned of external oil, grease, dirt, or mud; temporary erosion and sediment controls will be used on all exposed slopes during any hiatus exceeding 7 days; material removed during excavation will only be placed where it cannot enter sensitive aquatic resources; alteration of the stream banks and existing riparian vegetation will be minimized to the extent possible; no herbicide shall occur; clearing limits shall be identified and marked; and all existing native vegetation within 150 feet of the edge of the bank should be retained to the greatest extent practicable.

Spotted Owl

The first term and condition requires the convening of the Endangered Species Act Monitoring and Implementation Team to review dam removal activities and review any new information.

The second term and condition requires that: disturbance should be minimized to the extent practicable within the critical nesting period (March 1-July 15); if potential owl nest trees must be removed, removal should occur outside of critical nesting period; if a potential nest tree must be removed during the critical nesting period, all reasonable efforts shall be taken to determine that the tree is unoccupied prior to removal; if nesting owls are discovered during surveys that may be harassed by the proposed action, PGE

shall monitor the nests and document the owls' response to the actions.

On October 21, 2003, NOAA Fisheries filed its BO, concluding that the proposed action would not be likely to jeopardize the continuing existence of the listed salmon and steelhead species. NOAA Fisheries included two terms and conditions similar to the conditions that USFWS provided for bull trout described above.

We also conclude that the proposed action would not be likely to adversely affect the threatened bald eagle. By letter dated April 11, 2003, we requested concurrence from USFWS with our finding. In the BO, USFWS concurred with our determination.

4.5.5 Wild and Scenic Rivers Act-Section 7

The upper Sandy River upstream from the project is a designated Wild and Scenic River (WSR) from its headwaters to the Mt. Hood Forest Boundary (about 14 miles upstream of Marmot dam) under jurisdiction of the USFS. In addition, the entire Salmon River, a tributary of the Sandy River upstream from the project, is a designated Wild and Scenic River, jointly managed by USFS and BLM. The 12.5-mile segment of the lower Sandy River from Dodge Park to Dabney Park (i.e., below the Sandy River's confluence with the Bull Run River and about 9 miles downstream of Marmot dam) is designated as a National Wild and Scenic River and a State Scenic Waterway under the jurisdiction of BLM. Under these designations, these river reaches are managed to maintain and enhance fisheries, wildlife, and water quality. Recreational activities are managed to preserve and enhance the natural values of the river. None of the project facilities are located within the wild and scenic river corridor nor would any of the deconstruction activities occur within the corridor.

On October 24, 2002, BLM, in conjunction with the USFS, prepared a preliminary Section 7 determination pursuant to the Wild and Scenic Rivers Act for the appropriate reaches of the Sandy and Salmon Rivers. The managing agencies concluded that "removal of the project will have no effect or will have positive effects to the scenery, recreation, and wildlife values of the Salmon and Sandy WSRs" and "project removal does not unreasonably diminish the fish resource of the Salmon and Sandy Rivers." USFS will file its final Section 7(a) determination in response to this FEIS.

4.5.6 Magnuson-Stevens Act

The consultation requirements of § 305(b)(2) of the Magnuson-Stevens Act provide that federal agencies must consult with the Secretary of Commerce on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely

affect essential fish habitat (EFH). The Pacific Fisheries Management Council (PFMC) has designated EFH for the Pacific Salmon fishery (Washington, Oregon, and California coho and chinook salmon) that includes those waters and substrate necessary to ensure the production needed to support a long-term sustainable fishery.

We believe that decommissioning of the project and removal of the two dams would have short-term impacts on salmon from increased sedimentation (see section 5.2.3.3). Long-term effects of restoring salmon would be beneficial.

On July 29, 2003, we requested that NOAA Fisheries provide us with their EFH conservation recommendations. On October 21, 2003, NOAA Fisheries, as part of their BO, concluded that the proposed action would adversely affect EFH for coho and chinook salmon. NOAA Fisheries recommends that the measures included in the final BO, described in Section 4.5.4 of this FEIS, be adopted as EFH conservation measures.

4.5.7 Coastal Zone Management Act

Under Section 307(c)(3)(A) of the Coastal Zone Management Act (CZMA),¹⁰ the Commission cannot issue an order for an action within or affecting a state's coastal zone, unless the state CZMA agency concurs with the license applicant's certification of consistency with the state's CZMA program, or the agency's concurrence is conclusively presumed by its failure to act within 180 days of receipt of the applicant's certification.¹¹

The Bull Run Project is not located within the state-designated Coastal Management Zone (see www.lcd.state.or.us/coast), which extends inland to the crest of the Coast Mountain Range, and the proposed action would not affect Oregon's coastal resources. Therefore, the project is not subject to Oregon coastal zone program review and no coastal zone consistency certification is needed for this action.

4.5.8 Restoration of Federal Lands

Section 6.2 of the Commission's regulations (18 CFR 6.2) requires a licensee for a project located on Federal lands to restore the lands to a condition satisfactory to the Department having supervision over such lands and annual charges will continue until such restoration has been satisfactory completed. Implementation of the

¹⁰ 16 U.S.C. §1456(3)(A).

¹¹ JDJ Energy Company, 69 FERC ¶62,034 (1994).

decommissioning plan and additional staff recommended measures would ensure that Federal lands are adequately restored.

5.0 ENVIRONMENTAL ANALYSIS

In this section, we first describe the general environmental setting in the project vicinity and any environmental resources that could be cumulatively affected by the proposed action. Then, we address each affected environmental resource. For each resource, we first describe the affected environment—the existing condition and the baseline against which to measure the effects of the proposed action and any alternative actions—and then environmental effects of the proposed action, alternative Marmot dam options, and additional measures recommended by staff.¹²

5.1 GENERAL DESCRIPTION OF THE SANDY RIVER BASIN

The Sandy River Basin drains approximately 508 square miles (330,000 acres) in northwestern Oregon. The Sandy River originates from glaciers on the western slopes of Mt. Hood at an elevation of about 6,200 feet above sea level and travels 56 miles before flowing into the Columbia River near the City of Troutdale.

Approximately 70 percent of the basin is managed by USFS—Mt Hood National Forest, 22 percent is in private ownership, 4 percent is managed by BLM, 2 percent is owned by City of Portland, and the remainder owned by State, local government, or PGE. About 19.5 percent is designated as wilderness.

Forests cover about 78 percent of the basin, including most of the upper and middle watershed. Fertile plateaus and rolling hills cover much of the lower watershed.

A small portion of the watershed is intensively farmed. Intensive agriculture includes productive cultivated land such as row crops, nursery stock, caneberries, grasses, irrigated hay and pasture, and specialty crops (i.e., herbs). Its waters provide outstanding recreational opportunities and a large percentage of the drinking water supply for people in the Portland metropolitan area.

5.2 SCOPE OF CUMULATIVE IMPACT ANALYSIS

According to the Council on Environmental Quality's regulations for implementing

¹² Much of the environmental analysis is adopted from PGE (2002e).

NEPA (§1508.7), an action may cause cumulative impacts on the environment if its impacts overlap in time and/or space with the impacts of other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time, including hydropower and other land and water development activities.

The cumulative effects discussion within applicable resource sections in Section 5.3 summarizes how the project decommissioning of the Bull Run Hydroelectric Project, in combination with past and reasonably foreseeable future actions in the Sandy River Basin, may affect resources within and outside of the Project Effects Scope.

The scope of cumulative impacts is composed of two general areas: geographic scope and temporal scope. The geographic scope of analysis defines the physical limits or boundaries of the proposed actions' effects on the resources. Defining this boundary is resource-specific, and includes: (1) the area potentially impacted directly or indirectly by the project, and (2) areas outside the project effects scope if the other activities in this larger area also impact the resources affected by the project. The resources that were deemed to be appropriate for the cumulative impact analysis include, water quality, river geomorphology, fisheries, terrestrial, and recreation (see cumulative impacts section within each resource area).

The temporal scope of analysis includes a discussion of the past, present and reasonably foreseeable future actions on affected resources including, water quality, river geomorphology, fisheries, terrestrial, and recreation. The temporal scope will look into the future, concentrating on the effects on the resources from reasonable foreseeable future actions. The historical discussion will, by necessity, be limited to the amount of available information for each resource.

5.3 PROPOSED ACTION AND ACTION ALTERNATIVES

In this section we discuss the effects of PGE's proposal, alternative to remove Marmot dam, and staff's modification to PGE's proposal.

5.3.1 Geological Resources

5.3.1.1 *Affected Environment*

Current conditions for geological resources in the Sandy River Basin were evaluated through field surveys, literature review, and aerial photograph analysis.

Additional detail on the methods used in this analysis is presented in Stillwater Sciences (2000a), from which the material presented below pertaining to geology, background sediment yield, and fluvial geomorphology and aquatic habitat is drawn.

Geology

The geology of the Sandy River Basin reflects Tertiary (Miocene and Pliocene) and Quaternary (Pleistocene and Holocene) volcanic events and Pleistocene glaciations. Structurally, the Sandy River Basin is located within the Yakima fold belt, which is characterized by a series of east-west by southwest-northeast trending synclines and anticlines, which are cut diagonally by numerous north-northwest trending fault zones and lineaments (Williams 1982). The upper Sandy River, above Brightwood (PGE 2002e, figure 5.2.1-1), lies within the High Cascade geologic province and was carved by formation of Mt. Hood (Priest 1982) and glaciations in the Pleistocene. Below Brightwood, the Sandy River valley is dominated by Quaternary lahar deposits¹³, slopes are less steep, and bedrock of the Western Cascade province underlies the basin. There are over 31 geologic units in the basin, with the most extensive units being Pliocene volcanics (basaltic andesite lava flows); the Miocene Rhododendron Formation, which is composed of weak andesitic tuffs and breccias (volcanic rock) and is common in the upper basin; and the Miocene Troutdale Formation, which is a sedimentary formation that is fluvially derived from the erosion of local volcanic rocks and is common in the lower part of the Sandy River Basin (USFS 1996).

During the Pleistocene epoch, a series of large glaciers extended as far down the Sandy River valley as Brightwood (USFS 1996). These glaciers carved a U-shaped valley in the upper part of the basin and deposited terminal and recessional moraines near Alder Creek (Allen 1989). At the last glacial maximum (15,000 years ago), a 1,000-foot thick glacier extended 20 miles down the Sandy River valley. Meltwater from this glacier overflowed into the Little Sandy Basin through three saddles in the ridge between Marmot and Brightwood.

Over the last 500,000 years, Mt. Hood has extruded a series of dacitic lava domes, whose collapse triggered eruptions and at least six volcanic mudflows (lahars). On the Sandy River, lahars traveled as far as the confluence with the Columbia River, leaving

¹³ Lahars are mixtures of volcanic debris and water that typically occur as a result of a volcanic eruption in which ejected material melts snow and ice from the slopes of the volcano (in this case Mt. Hood), resulting in a rapidly moving mudflow that can travel substantial distances and bury river valleys (Summerfield 1991).

terraces up to 500 feet high (Allen 1988). Most of the present-day valley-bottom topography is a result of a series of mudflows and pyroclastic flows that occurred during an eruptive period 12,000–15,000 years ago (Allen 1988).

The last two episodes of eruptive activity occurred approximately 1,500 and 200 years ago (the Timberline and Old Maid episodes, respectively), when numerous pyroclastic flows and lahars occurred and built a smooth debris fan on the south and southwest flanks of Mt. Hood. During the most recent (Old Maid) eruptive period, the Sandy River became choked with sediment over 65 feet deep that completely buried the pre-eruption valley floor between Sandy and Troutdale. Since then, channels have incised into these deposits, leaving behind several-foot-high terraces with actively eroding banks. In addition, buried old-growth forests are now being fluvially exhumed by the river (Cameron and Pringle 1991). Lahars and sediment-rich floods that flowed to the Columbia River during past eruptive periods built a delta at the mouth of the Sandy River. In 1805 and 1806, likely shortly after the Old Maid event, Lewis and Clark noted braided conditions at the mouth of the Sandy River, indicating very high sediment loading (Cameron and Pringle 1987). The ongoing influence of past lahatic events, Mt. Hood glaciers, and the basin's underlying lithology result in naturally sediment rich conditions in the Sandy River.

The Bull Run Watershed has experienced some minor glaciation (USFS 1997) but less than the upper Sandy River Basin. Except for the very uppermost reaches of the watershed (approximately 10 percent of the drainage area), the Bull Run Basin is in the Western Cascade province. In addition, whereas lahars have left deposits along much of the Sandy River and have had a substantial geomorphic influence, lahars have not occurred in the Bull Run Basin (in some areas, lahars originating in the upper Sandy Basin may have spilled over into the Bull Run Basin). Stratigraphically, the Bull Run Basin is underlain by the same competent rock assemblages as the rest of the Sandy River Basin (consisting primarily of Pliocene volcanic bedrock in addition to Rhododendron and Troutdale formations) (Peck 1961, USFS 1997), although the lack of lahars in valley floors and the lesser glacial influence likely result in lower natural sediment yields in the Bull Run Basin.

Estimates of Background Sediment Yield in the Sandy River

Stillwater Sciences developed rough estimates of background annual sediment flux in the Sandy River, based on literature review, in order to assist assessment of the potential impacts of the reservoir sediment release into the Sandy River. No data on sediment yield are available for the Sandy River, PGE therefore evaluated measurements of sediment yield from other rivers in Oregon's Western Cascade Range. These

measurements are highly varied, depending on lithology, glaciation history, land use, and climatic conditions. Swanson et al. (1982) found that in 30 small undisturbed watersheds in the H.J. Andrews Experimental Forest, Oregon, sediment yields averaged 250 tons/square mile/year. Other measurements of sediment flux in undisturbed basins vary between 66 tons/square mile/year in the H.J. Andrews Forest (Grant and Wolf 1991) and 61–302 tons/square mile/year elsewhere in the western Cascades (Larsen and Sidle 1980). Much higher sediment yields have been measured in intensively managed watersheds, including estimates of 650 tons/square/year in the H.J. Andrews Forest (Swanson and Dyrness 1975) and up to 1,270 tons/square/year elsewhere in the western Cascades (Curtiss 1975, Larsen and Sidle 1980, McBain and Trush 1998).

In the Sandy River Basin, sediment yields may be substantially higher on average than in the H.J. Andrews Forest (and elsewhere in the western Cascades) due to Mt. Hood glaciers, the presence of semi-consolidated lahar deposits, steep topography, and land uses. Swanson et al.'s (1982) average value for the H.J. Andrews Forest of about 250 tons/square mile/year may therefore be considered a minimum estimate for the Sandy River; average sediment yields may in fact be two to three times higher than this.

Approximately 980,000 cubic yards of sediment is stored behind Marmot dam (Squier Associates 2000), which corresponds to about 1.2 million tons assuming a bulk density of 100 lbs/cubic foot, based on literature review and Squier Associates (2000). These estimates suggest that the reservoir sediments upstream of Marmot dam, which has a drainage area of 260 square miles, represent a maximum of 20 years of annual average sediment flux and possibly much less. This is a simplified comparison that does not account for factors such as the trapping efficiency of Marmot dam, the bedload versus suspended load fraction of sediment yield, and temporal variations in sediment yield, but it does give a rough sense of how the volume of sediment stored behind Marmot dam compares to background sediment yield in the Sandy River.

Landslides

The USFS has developed estimates of landslide potential on Forest Service lands in the Sandy River Basin based on qualitative analysis of various types of landforms in the basin. The Upper Sandy, Bull Run/Little Sandy, and Zigzag River subwatersheds of the Sandy River Basin are characterized by low landslide potential. The Salmon River subwatershed has a relatively high landslide potential. In general, areas of high landslide potential are located in the steeply sloping, upper reaches of Sandy River Basin, while more stable areas are located in the lower portion of the basin. Table 2 illustrates the landslide potential of the Sandy River Basin subwatersheds (USFS 1996).

Table 2. Landslide Potential of Sandy River Basin Watersheds

Subwatershed	High	Moderate	Low
Upper Sandy	21%	19%	53%
Bull Run/Little Sandy	17%	27%	55%
Salmon River	62%	18%	20%
Zigzag River	20%	35%	45%

Fluvial Geomorphology and Physical Aquatic Habitat

Sandy River

The Sandy River is characterized by naturally high sediment loading as a result of past laharc events, Mt. Hood glaciers, and lithology. The Sandy River exhibits many characteristics typical of alluvial rivers, including a concave-up longitudinal profile that decreases in gradient in a downstream direction, and a decrease in channel bed particle sizes in a downstream direction. Wolman pebble counts conducted at 11 sites upstream and downstream of Marmot dam indicate median grain sizes (D50) ranging from about 4.7 inches (RM 31.8) to about 1.9 inches (RM 2.5).

For the purposes of geomorphic analysis, the Sandy River from Marmot dam downstream to the Columbia River can be delineated into five reaches, with the reach immediately upstream of the dam representing a sixth reach of concern. These geomorphic reaches are shown in figure 3, a longitudinal profile view of the Sandy River.

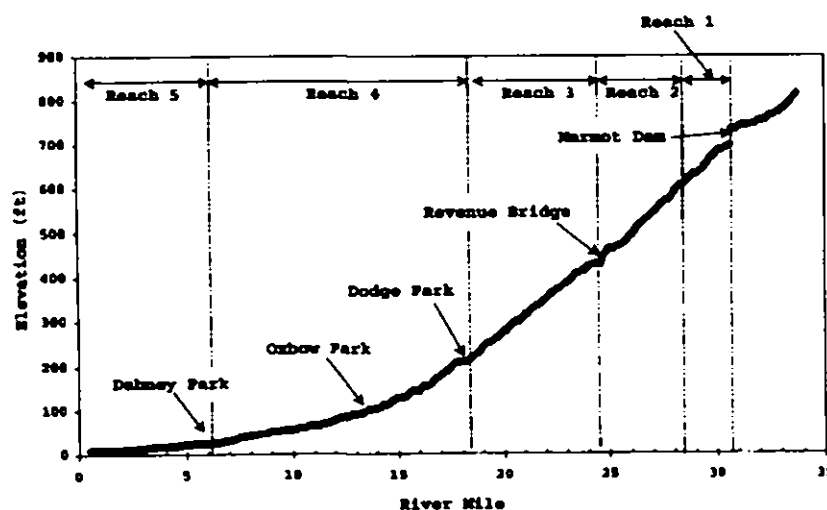


Figure 3. Sandy River longitudinal profile.

The following section provides a description of current geomorphic conditions in each of these reaches, including discussion of the following: (1) geomorphic characteristics such as substrate sizes, confinement, gradient, and morphologic type; (2) the relative sensitivities of each reach to increases in sediment supply resulting from dam removal; and (3) salmonid habitat characteristics (see Section 5.3.3 for detailed discussion of salmonid distribution in the Sandy River Basin and use of these geomorphic reaches). The geomorphic characteristics of each of these reaches are summarized in table 3.

Table 3. Summary of Geomorphic Characteristics of Sandy River Reaches.

Reach	Length (miles)	Average width (feet)	Average gradient	Confinement	Morphology	Estimate of active alluvial storage ^a (yard ³)	Total length of side channels ^b (feet)
Upstream of Marmot dam (reservoir influenced reach)	1.6-2	150	0.002	High	Pool-riffle	980,000 ^c	0
Marmot Dam to gorge (Reach 1)	1.5	100	0.008	Medium	Forced pool riffle/plane bed	180,000	230
Sandy River gorge (Reach 2)	4	100	0.01	High	Step pool	410,000	0
Downstream end of Sandy River gorge to Bull Run River (Reach 3)	6	160	0.006	Medium	Forced pool riffle/plane bed	1,300,000	1,640
Bull Run River to Dabney Park (Reach 4)	12.5	230	0.0025	Medium/low	Pool riffle/plane bed	4,400,000	17,300
Dabney Park to mouth (Reach 5)	6	330	0.0007	Medium/low	Pool riffle/dune riffle	2,200,000	1,770

a These estimates are based on aerial photograph analysis and are intended to provide insight into the amount of sediment in each reach that could be mobilized under moderate flows, to provide a basis for comparison to the amount of sediment that would be released from behind Marmot Dam.

b Stillwater Sciences estimated the total length of side channels in each geomorphic reach in order to assist evaluation of current habitat conditions in these reaches and sensitivity to sediment impacts.

c This volume represents the amount of sediment stored behind Marmot Dam (Squier Associates 2000).

Upstream of Marmot dam/reservoir-influenced reach: The impoundment formed by Marmot dam has filled to near the dam's crest with sediment and now functions as an alluvial river reach. Compared to upstream and downstream reaches, the reach immediately upstream of Marmot dam has a lower gradient (about 0.002) and smaller bed substrates with a higher percentage of gravels under current conditions. These differences are a result of the grade control provided by the dam and the backwater effect of the dam's impoundment. The Sandy River upstream of Marmot dam is affected by the backwater effect of the dam for a distance of approximately 1.6-2 miles. This estimate is based on field observation and analysis of the Sandy River longitudinal profile

by Stillwater Sciences. Evidence of aggradation (buried tree trunks) and substrate characteristics that differ from those upstream and downstream of the dam provide evidence of this backwater effect. The reservoir-influenced reach has pool-riffle/plane-bed morphology, with a higher frequency of pools (Cramer et. al. 1998) than upstream and downstream reaches. Substrates in the reservoir-influenced reach consist of cobbles, small boulders, and gravel, and the sand content in the subsurface (i.e., in the sediment that has accumulated in the reservoir) is high.

Approximately 980,000 cubic yards of sediment are stored behind Marmot dam (Squier Associates 2000). The grain size distribution of this sediment, which has an important influence on its downstream transport patterns and associated impacts, was determined based on sampling conducted by Squier Associates in October 1999. Sampling of the reservoir sediment consisted of drilling a series of cores into the sediment wedge upstream of the dam and mapping of various sediment units deposited on the bedrock below the old river channel. The reservoir sediment consists of two main units, with the pre-dam channel bed representing a third distinct unit (figure 4) (Squier Associates 2000). The uppermost unit (Unit 1) ranges from approximately 6–18 feet in thickness and is composed of a sandy gravel with cobbles and boulders, becoming thicker toward the dam. The next unit (Unit 2) is predominantly fine sediment (silty-sand to sand with gravel, ranging from 13–35 feet thick). Unit 3 represents the pre-dam channel bed

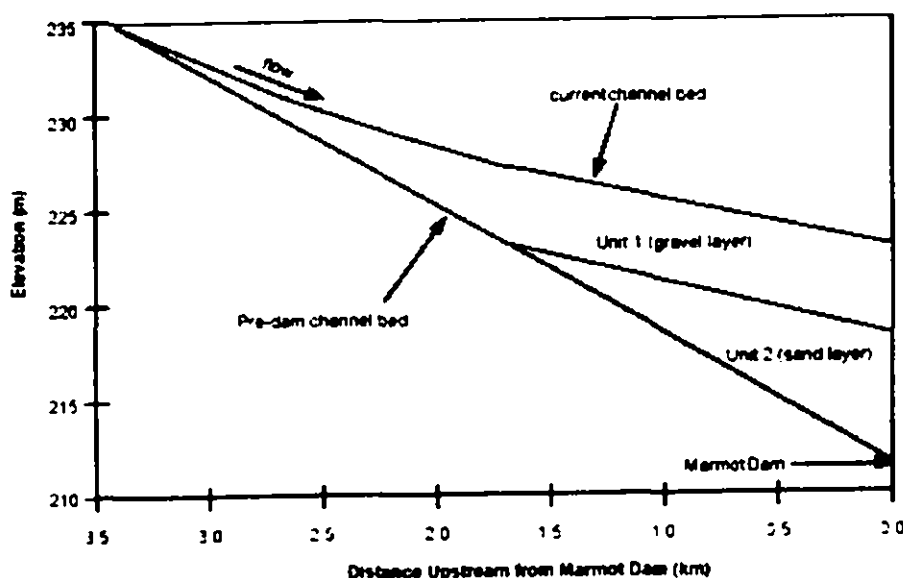


Figure 4. Simplified representation of stratigraphy of Marmot reservoir sediment deposit, based on Squier Associates coring study.

and lies below Unit 2. Unit 3 consists primarily of coarse sediment and its thickness ranges from 2.5 to 10 feet.

The pool-riffle morphology that characterizes the reservoir-influenced reach provides habitat that is suitable for salmonid spawning, rearing, and holding. Gravel suitable for spawning is relatively abundant in this reach compared to reaches immediately upstream and downstream, likely due to the grade control and backwater effect created by Marmot dam and the associated low shear stresses. Most of the fall chinook salmon that pass over Marmot dam likely spawn in this reach (Cramer et. al. 1998). Spring chinook also spawn in this reach. Deep pools (< 10 feet) are present in this reach and provide habitat suitable for adult holding and summer rearing habitat for chinook salmon, coho salmon, and steelhead.

Reach 1, Marmot dam to the upstream end of the gorge: This reach is 1.5 miles long and is bounded by an approximately 65-foot-high terrace on the left bank that is actively eroding in places. Reach 1 is characterized by a 0.01 gradient, moderate confinement at bankfull flow, and moderately pronounced forced pool-riffle morphology with a few small lateral cobble/boulder bars. The bed surface consists mainly of cobbles and boulders; gravels are limited. Sand content in the bed subsurface is generally very low. This reach represents a transitional area between the High Cascade and Western Cascade geologic provinces. Bank material is characterized by both Rhododendron Formation (relatively competent fractured andesite) and alluvial terraces (which are noncohesive, consisting primarily of matrix-supported gravels with lenses of conglomerates).

Reach 1 contains two main depositional areas: (1) a large alder-vegetated bar and side channel known as Beaver Island (RM 29.4–29.2) and (2) a large alcove/backwater pool at the downstream end of the reach (RM 28.7). The alder bar/side channel (Beaver Island) is located 0.6 mile downstream of Marmot dam, has a large woody debris (LWD) jam at its head, and is associated with a local, very coarse sediment deposit that may have been formed during the last lahar event (approximately 200 years ago). The alcove/backwater pool (RM 28.7) is forced by constriction of the channel and a bedrock wall at the head of the gorge and may be a valuable salmonid rearing and holding site. Adjacent to this alcove/backwater pool, the channel contains a LWD jam that was apparently uncovered during the 1964 flood and is referred to as the “1964 jam.” The channel and valley walls become narrower immediately downstream of this LWD jam, marking the beginning of the gorge. As part of the assessment of in-channel sediment storage downstream of Marmot dam, Stillwater Sciences estimated the amount of active sediment storage in Reach 1 as approximately 180,000 cubic yards; on a linear basis, this corresponds to approximately 120,000 cubic yards/mile.

A small amount of gravel patches suitable for spawning are present in Reach 1, and spring chinook spawning has been observed in this reach. Overall, however, the channel bed in Reach 1 is dominated by boulder and cobble bed substrates, relatively few depositional areas of gravel suitable for salmonid spawning are present, and the reach likely supports little spawning. The reach does provide suitable rearing habitat for several salmonid species, including side channels and backwaters at the alder-vegetated bar described above (which would be expected to be used by coho salmon), deep pools (which would be used by chinook and coho salmon), and coarse substrates with interstitial spaces that are suitable for chinook salmon and steelhead winter rearing. Deep pools present in this reach also provide adult holding habitat for spring chinook and summer steelhead.

Reach 2, Sandy River gorge: The gorge reach is 4 miles in length and is bounded by 65–100 feet high bedrock strath¹⁴ terraces with steep hillslopes above. Banks are very competent (usually welded volcanic bedrock of the Rhododendron formation). Reach 2 is characterized by a 0.01 gradient, high confinement, and step-pool morphology with only patchy cobble/boulder deposits and long, deep bedrock pools that are separated by coarse-bedded riffles and boulder rapids. Large (house-sized) boulders are present in the channel, likely originating from the canyon walls. These boulders form momentum defects, but often deposition behind them is limited. In general, few deposition areas are present in this reach: (1) a moderately confined reach approximately 0.9 mile long is present in the upstream end of Reach 2 (RM 28.5–27.6), where much of the alluvial sediment storage in Reach 2 is concentrated; (2) micro-deposition areas with sand bars are scattered throughout the gorge (sand deposits 0.3–1-foot thick have formed at the margins of some bedrock pools); and (3) some cobble/boulder bars are present. Bedrock exposure is more common in the channel bed in this reach than in other reaches of the Sandy River, and the bed is highly armored. Sand content in the bed subsurface is generally very low. The steep gradient and high confinement in this reach create very high shear stresses, resulting in high sediment transport capacity. Active sediment storage in this reach is estimated to be approximately 410,000 cubic yards (on a linear basis, 100,000 cubic yards/mile), much of which is located in the moderately confined section at RM 28.5–27.6; in the rest of the gorge, channel sediment storage is low.

The deep, bedrock scour pools in the gorge are the primary salmonid habitat within the gorge, in particular providing suitable habitat for adult holding during upstream

¹⁴ Strath terraces are river terraces that are cut into bedrock (rather than into alluvial valley fill) and that may be covered by a thin veneer of sediment over the bedrock (Summerfield 1991).

migration. Pools may also be used for juvenile rearing, especially by chinook and coho salmon during the summer, although coho salmon prefer habitats associated with LWD and few such habitats are present in the gorge. Riffles with coarse bed material also may provide rearing habitat for steelhead. Because shear stresses are extremely high in the gorge during high flows and refuge habitats (e.g., side channel, vegetated floodplain) are nearly absent, winter rearing is likely limited in this reach. In addition, little or no spawning habitat is present in this reach because of high shear stresses and limited availability of depositional areas.

Reach 3, Downstream end of gorge (near Revenue Bridge) to Dodge Park (Bull Run River confluence): Reach 3, which extends from the downstream end of the gorge (near Revenue Bridge) to the Bull Run River confluence at Dodge Park, is about 6 miles in length. This reach widens considerably compared to Reaches 1 and 2 (with an average width of 160 feet), has an average gradient of 0.006 (compared to 0.01 in Reaches 1 and 2), and is characterized by forced pool-riffle morphology with many cobble/boulder bars and a cobble/gravel-dominated channel bed. Because the channel and valley bottom widen and gradient decreases downstream of the gorge, sediment transport capacity is lower than in the gorge and potential for sediment deposition increases. Several wide areas with mid-channel bars are present, both upstream and downstream of Revenue Bridge (RM 24.5), and some side channel features are also present. Shear stresses remain relatively high, however, and although average bed particle sizes in this reach decrease compared to reaches 1 and 2, gravels suitable as spawning substrate are limited, occurring only in scattered patches and pool tail-outs (ODFW 1990, 1997a). The sand content in the bed subsurface is generally high compared to upstream reaches but low compared to downstream reaches. River banks are mostly mudstone bedrock (Troutdale formation), debris fans, and cutbanks of vegetated alluvial features. Active alluvial storage is estimated to be approximately 1,300,000 cubic yards (220,000 cubic yards/mile), based on Stillwater Sciences' assessment of in-channel sediment storage. This is substantially higher than reaches 1 and 2, reflecting the wider active channel and increased depositional potential in Reach 3.

This reach provides suitable habitat for fall chinook salmon and steelhead (spawning, summer rearing, winter rearing) and coho salmon (summer and winter rearing), as well as providing a migration corridor for anadromous salmonids that spawn and rear upstream of Marmot dam. Spawning habitat for chinook salmon and steelhead is available in isolated locations. Stillwater Sciences observed spawning habitat suitable for chinook salmon upstream of Revenue Bridge near the downstream end of the gorge (RM 24.4). PGE surveys documented winter steelhead redds downstream of Revenue Bridge and near the confluence of Cedar Creek in 1998; many of these redds were located in side channels (PGE 1998a). Summer rearing habitat is available for chinook and coho salmon

in the low-velocity pool and glide habitats, and steelhead summer rearing habitat is abundant in pool, riffle and glide habitats. Substrate used by chinook and steelhead during winter rearing is abundant. Winter refuge habitat is available in side channel, overflow channel and vegetated floodplain habitats.

Reach 4, Dodge Park to Dabney Park: Reach 4 extends from the Bull Run confluence (Dodge Park) to Dabney State Park, a length of 12.5 miles. This reach has an average gradient of approximately 0.0025, is bounded by high (mostly alluvial) terraces, and is characterized by pool-riffle morphology with many cobble/gravel bars. The channel bed is a mixture of cobbles, gravel, and sand. Sand content in the bed subsurface is generally high, notably increasing at Oxbow Park. River banks generally consist of mudflow deposits (which include unconsolidated silt, sand and conglomerate deposits), vegetated alluvial bars, and competent bedrock originating from Mt. Hood volcanic material. Banks formed of mudflow deposits, which were deposited by runout from the Old Maid and Timberline volcanic events, are 23–30 feet high along some reaches and may be an important source of fine sediment to the channel under current conditions.

In Reach 4, channel confinement, gradient, and bed particle size decrease further compared to reaches upstream, with these tendencies particularly evident in the reach from Oxbow Park (RM 11.9) to Dabney Park (RM 6.6). Large bars, side channel, overflow channel, and island features are present in larger magnitude and greater frequency. The percent of the active bed and bars covered with sand increases, and in portions of Reach 4 (particularly downstream of Oxbow Park), the active bed is saturated with sand and the potential for additional sand storage in the interstices of coarser sediment is low. Many of the active channel bars are mantled with overbank sand deposits and have side channels. Reach 4 has a large amount of coarse and fine sediment stored in the active and semi-active channels. Stillwater Sciences estimated the volume of sediment stored in active storage sites to be approximately 4,400,000 cubic yards (350,000 cubic yards/mile).

This reach provides suitable habitat for chinook, steelhead, and coho salmon, in particular providing substantial spawning habitat for fall chinook salmon and winter steelhead. This reach contains the majority of fall chinook spawning habitat in the Sandy River and the majority of mainstem spawning habitat used by winter steelhead (PGE 1998a), reflecting the increased availability of spawning-sized gravel in this reach. Most of this spawning habitat is located downstream of Oxbow Park (PGE 1998a). Chinook and steelhead spawning has also been observed in tributaries to the Sandy River within this reach, specifically Buck, Gordon, and Trout creeks (ODFW 1997a). In a 1998 aerial survey of winter steelhead redds in the mainstem Sandy River from Marmot dam to the Interstate-84 bridge, about 70 percent of the redds observed were in this reach (PGE

1998a), although it is unknown what percentage of total winter steelhead spawning in the Sandy River Basin this represents. Summer rearing habitat is available for chinook and coho salmon in low-velocity pools and glides, and steelhead summer rearing habitat is abundant in pool, riffle and glide habitats. Coarse substrates potentially used by chinook and steelhead during winter rearing are abundant. Winter refuge habitat is available in side channel, overflow channel and vegetated floodplain habitats. Side channels in this reach likely provide important spawning and summer and winter rearing habitat for salmonids; these types of habitats are particularly suitable for juvenile coho rearing.

Reach 5, Dabney Park to mouth: Reach 5 is 6 miles long and is characterized by a 0.0007 gradient (compared to 0.0025 in Reach 4), moderate-to-low confinement at bankfull flow, and dune-ripple morphology with large gravel/sand alternate and medial bars. Many of the active channel bars, some spanning 50 percent of the channel area, are mantled with overbank sand deposits and have side channels. The channel bed is a mixture of sand and gravel, is highly mobile, and has a very high sand content in the bed subsurface. (Stillwater Sciences estimated 60–100 percent embeddedness.) The decrease in bed particle size is a function of decreased channel gradient and confinement. Active sediment storage, estimated at approximately 2,200,000 cubic yards (370,000 cubic yards/mile) by Stillwater Sciences, is the highest per unit length of any reach in the Sandy River. This reflects the increased channel width and the decreased sediment transport capacity in this reach compared to upstream reaches.

The Sandy River delta forms the downstream-most portion of Reach 5. In the delta, the channel is sand-bedded and depositional dynamics are strongly influenced by the backwater effect of the Columbia River. Human influences have caused substantial morphologic changes in the Sandy River delta this century. Earlier this century, a channel to the east of what is currently the main channel was the main outlet of the Sandy River to the Columbia River (Craig and Suomela 1940). This channel has been referred to as the Big Sandy Channel and may have become the main channel after a large flood in 1904. At that time, what is now the main channel was a secondary channel that was sealed (aggraded) at its mouth during low flows (Craig and Suomela 1940). Because this resulted in fish passage problems during periods of low flow, a small wooden dam (10 feet high) was constructed across the Big Sandy Channel in 1938 in order to divert water into what is now the main channel of the Sandy River, allowing year-round passage for migratory fishes (Craig and Suomela 1940). Dredging of the main Sandy channel at its mouth has also occurred to facilitate fish passage.

This reach contains spawning and rearing habitat in its upstream end, particularly for fall chinook and winter steelhead, and serves as a migration corridor for all fish entering the Sandy River system. The majority of spawning habitat for fall chinook

salmon occurs upstream of Lewis and Clark State Park, although overall, this reach supports less fall chinook spawning than Reach 4. Steelhead spawning habitat is also present in isolated locations, however, steelhead tend to spawn in smaller channels upstream. The upper portion of this reach provides abundant summer rearing habitat for chinook and coho salmon and steelhead. Winter refuge habitat for all salmonids is also available in side channel, overflow channel and vegetated floodplain habitats, although juvenile coho salmon tend to prefer smaller channels for rearing. In addition, coarse substrate suitable for use by chinook and steelhead during winter is limited. The Sandy River delta is not likely used for extended periods by any salmonid species or lifestage; this area primarily serves as a migration route.

Little Sandy River

The lower Little Sandy River (below the diversion dam) consists of two distinct geomorphic reaches; the reach immediately upstream of the dam would also experience morphologic changes following dam removal. Stream banks and valley walls are composed of Rhododendron Formation bedrock, mantled in some locations with alluvial deposits. The average channel gradient is 0.028, the average active channel width is 47 feet, and about two-thirds of total reach length consists of riffles, cascades, or rapids (the rest consists of pools) (ODFW 1997b). The substrate is composed of boulders, cobbles, and bedrock with few gravels. Previous surveys (ODFW 1997b, Hardin 1998, Craig and Suomela 1940, Stillwater Sciences 2000a) have noted that spawning substrate is severely limited (or nonexistent) downstream of Little Sandy diversion dam. The lower Little Sandy River (below the diversion dam) consists of three distinct geomorphic reaches (Stillwater Sciences 2000a).

Upstream of Little Sandy diversion dam: The sediment accumulation behind Little Sandy diversion extends upstream for a distance of approximately 300 feet and has an average depth of about 4 feet (maximum depth is about 8 feet). Further upstream of Little Sandy diversion, the channel is no longer bedrock constrained, causing a change in morphology and increased frequency of gravels, although boulders and cobbles are dominant substrates (ODFW 1997b). Five bedrock falls that act as barriers to fish migration were noted in ODFW habitat surveys (ODFW 1997b). Additional detail on habitat conditions upstream of Little Sandy diversion is provided in ODFW (1997b).

Little Sandy Reach 1: The reach from Little Sandy diversion to approximately 0.3 mile downstream of the dam is a geomorphically distinct reach. This reach has a step-pool/plane bed morphology, an average gradient of 0.02, and channel bed substrates consisting of cobbles (50 percent by volume) and gravel (40 percent by volume) within an immobile framework of boulders (10 percent by volume). Although gravel is present in

the channel bed, mixed in with cobbles, no gravel patches that are suitable for spawning were observed in Reach 1. Reach 1 has a relatively wide valley (up to 500 feet wide) constrained by bedrock, with 5-foot-high strath terraces within the valley walls constraining the channel on the left bank. The active channel has an average width of about 33 feet, which appears to be less than under unregulated conditions due to encroachment of riparian vegetation onto channel bars. Boulder/cobble bars are densely vegetated with willows and alders. High-water marks from the November 1999 high-flow event were observed on this vegetation 6.6–8.2 feet above the channel bed. This event also appears to have created overbank sand deposits in Reach 1. Large woody debris is infrequent throughout the reach and is mostly deposited on streamside bars; no channel-spanning debris accumulations are present. Removal of LWD that accumulates at Little Sandy diversion by PGE maintenance crews has likely contributed to the low frequency of LWD in Reach 1. Evidence of bank erosion along this reach is provided by exposure of tree roots of Western red cedars growing on 3–5 foot-high terrace banks, perhaps as a result of aggradation caused by reduced sediment transport capacity.

Pools suitable for steelhead resting during migration are spaced at regular intervals throughout Reach 1 (pool frequency in this reach is 4.3 channel widths/pool). Deep pools (> 10 feet) suitable for extended holding, however, are not present. Reach 1 does not currently contain spawning habitat, although increased flows could make some channel-margin areas suitable for steelhead spawning. Reach 1 contains habitat that could be used for summer and winter rearing by steelhead juveniles although under current conditions, summer rearing habitat is limited by low summer instream flows. Interstices within coarse substrate particles, which provide suitable winter rearing habitat for juvenile steelhead (e.g., Everest and Chapman 1972), are abundant in Reach 1.

Little Sandy reach 2: Reach 2 extends from about 0.3 mile below Little Sandy diversion downstream to the confluence of the Little Sandy with the Bull Run River (1.7 miles below the dam). This reach has an average slope of approximately 0.028 and is constrained within a narrow bedrock gorge (mostly Rhododendron Formation mantled with alluvial terraces). The channel is characterized by step-pool morphology, with boulder-dominated riffles/rapids separating pools and cobble bars that have a surface elevation about 5 feet above the current active channel bed. Most of the channel bed is mantled by coarse alluvium, although bedrock protrusions are common, localized bedrock knickpoints are present, and some pools lack an alluvial mantle. Gravel deposits are limited in Reach 2, reflecting the high sediment transport capacity in the reach, and mostly occur as patches formed on channel margins, in pool tails, and in association with momentum defects (e.g., boulders, bank irregularities). Although the bed is dominated by coarse sediments, sand deposits were also observed in the channel bed and on low cobble bar surfaces, which were inundated by the November 1999 flood. Valley width averages

82 feet (ranging from 52–130 feet), active channel width averages 66 feet (ranging from 30–72 feet), and bankfull depth averages approximately 2.6 feet. In addition to sediment supply from upstream and tributary sources, sediment is supplied to this reach by recruitment of boulders from Rhododendron Formation cliffs and banks, which are highly erosive in some locations, and Quaternary alluvial terraces that overlie the Rhododendron bedrock along portions of the reach also contribute cobbles to the channel. There are six small debris jams in this reach, and only two logs that span the channel. The upstream end of Reach 2 (from about 0.3 to 0.6 mile below the dam) represents a transition between reaches 1 and 2, having a lower gradient (approximately 0.025) than the majority of reach 2 and small gravel deposits behind boulders. Further downstream, the Little Sandy River steepens and becomes more confined. Several bedrock knickpoints, which are about 100–500 feet in length and 6.6–13 feet high, create substantial elevation change in the channel bed. The main fish habitat within this reach is provided by 2 large pools and one riffle (0.9–1.0 mile below the dam). These pools are approximately 100 feet in length, have a maximum depth of 6.6–10 feet, and are constricted within bedrock walls.

The basic differences between Reaches 1 and 2 are as follows:

- Reach 1 has a wider valley bottom than Reach 2.
- Reach 1 (0.02) has a lower gradient than Reach 2 (0.028).
- No bedrock scour pools were observed in Reach 1, whereas many are present in Reach 2.
- Sediment stored in the channel bed in Reach 1 appears less mobile in Reach 1 than in Reach 2, possibly reflecting the greater influence of Little Sandy diversion in reducing transport capacity in Reach 1 than in Reach 2, where the channel is steeper and more confined (resulting in greater transport capacity) and tributaries increase discharge magnitudes.
- Large boulders that were likely recruited from channel banks/valley walls are rare in Reach 1 but are frequent in Reach 2.
- Gravel patches (consisting of mobile, well sorted clasts) are not present in Reach 1 but are locally present in Reach 2.
- Sand deposits are less extensive in Reach 1 than Reach 2, occurring in the latter reach in both the channel bed and as overbank deposits while mainly being limited to overbank areas in Reach 1.
- LWD frequency is lower in Reach 1 than Reach 2, although overall both reaches have little LWD

5.3.1.2 Effects of Alternatives

Removal of Marmot Dam

This section compares the potential geomorphic impacts resulting from sediment release and reservoir erosion for each of the three alternatives for removal of Marmot dam. This discussion is based primarily on results of numerical modeling, which, for each of these dam removal alternatives, provides reach-scale predictions of: (1) depth of sediment deposition (differentiated into sand versus gravel components) downstream of the dam, (2) time required for the coarse sediment and sand to pass through the river system, (3) erosion patterns of the sediment stored behind Marmot dam, and (4) suspended sediment concentrations from the reservoir reach downstream to the mouth of the Sandy River.

Stillwater Sciences developed one-dimensional numerical models of fine and coarse sediment transport to quantify the routing of sediment from behind Marmot dam downstream through the Sandy River. The numerical modeling allows comparative assessment of sediment transport characteristics under different dam removal methods and river conditions. This modeling effort applies published sediment transport equations to assess the release of coarse and fine sediment from Marmot reservoir to downstream reaches of the Sandy River following dam removal. Because coarse and fine sediment transport occur over different time scales (years vs. days) and in different modes (bedload vs. suspended load), transport of fine sediment (including sand) was modeled separately from coarse sediment (gravel). Key input data for the model include channel gradients, channel widths, grain size distribution of the sediment stored behind Marmot dam, and water discharge. A technical report describing the numerical modeling, including the governing equations for the models, is provided in Stillwater Sciences (2000b) and Cui and Wilcox (2002). Additional model runs were conducted for the DWG and can be found in Stillwater Sciences (2002).

The numerical modeling results are most applicable on a reach-scale and time-averaged basis. The modeling does not account for certain depositional processes, such as infiltration of fine sediment into the interstices of the channel bed. Modeled deposition thicknesses are on a cross-section averaged basis and do not account for local variations in shear stress caused by features such as deep pools, bedrock outcrops, or large boulders in the channel. Modeling results are particularly well-suited for comparing relative rather than absolute impacts expected under different dam removal alternatives. Figure B-1 (Appendix B) shows the amount of sediment deposition expected under reference (background) conditions, and can be used as a basis for analyzing the effects of each alternative.

Geomorphic and habitat impacts were assessed based on the modeling results combined with field reconnaissance, aerial photograph interpretation, and literature review. Comparison of the impacts of each proposed alternative is summarized in table 4.

Alternative 1 (PGE's Proposal)–Single Season Dam Removal with Minimal Sediment Removal

Under this alternative, only a minimal amount (20,000 to 30,000 cubic yards) of sediment would be excavated from behind the dam (i.e., only as required to facilitate dam removal activities). Approximately 960,000 cubic yards of sediment, consisting of approximately 35 percent sand (and finer) and 65 percent gravel (and coarser) would be delivered downstream following dam removal. As discussed above in Section 3.2, rough estimates of background sediment flux in the Sandy River suggest that the volume of sediment released under Alternative 1 would be on the order of 10–20 years of annual yield; this would be spread out over several years as discussed below.

Numerical modeling results

Modeling of coarse sediment transport: Model results show that under average hydrologic conditions, the depth of the sediment deposit in the reservoir would decrease from about 36 feet at the time of dam removal to about 30 feet after 30 days, 23 feet after 60 days, 20 feet after 1 year, 10 feet after 5 years, and 3 feet after 10 years (figure B-2). Modeling also shows that in a downstream direction following dam removal, aggradation of about 3.3 feet would be expected in Reach 1 (0–1.5 miles downstream of the dam), little or no aggradation would be expected in most of Reach 2 (1.5–5 miles downstream of the dam; some aggradation is predicted in the lowermost 0.6 mile of Reach 2), and aggradation of about 5–6.5 feet would be expected in the upper portion of Reach 3 (6–8 miles downstream of the dam), where the channel widens and decreases in gradient (figure B-2). In Reach 1, the greatest amount of aggradation would be expected in the early years following dam removal, while in Reach 3, aggradation would show gradual increases through the first 10 years of the model run. The model shows small amounts of aggradation (typically <1.6 feet) downstream of the Bull Run River confluence, although this aggradation is similar in magnitude to aggradation predicted in a reference run of the model and is not likely to be distinguishable from natural depositional processes.

Table 4. Summary of General Impacts Associated with Sediment Release from Marmot Dam.*

Reach No.	Reach Location	Potential Geomorphic Impacts	Potential Ecological/Biological Impacts
—	Upstream of Marmot Dam, within reservoir influence (approximately RM 31.6–RM 30)	- increased channel gradient - coarsening of bed substrates - channel instability, bank failure	- loss of low-gradient habitat, including spawning areas - increase in steep, coarse sediment habitat - potential impairment of adult upstream migration
1	Marmot Dam to upstream end of gorge (RM 30–RM 28.5)	- aggradation with coarse sediment - sand deposition at some locations - increased bank erosion - potential increased TSS concentration during construction - increased TSS concentration after dam removal	- impairment of adult upstream migration - loss of pool habitat - loss of low-gradient floodplain and backwater habitat at Beaver Island (RM 29.4) - burial of interstitial rearing habitat and potential burial or scour of organisms due to increased sediment loading - moderate exposure to increased TSS concentration
2	Sandy River gorge (RM 28.5–RM 24.5)	- localized sediment deposition - potential increased TSS concentration during construction - increased TSS concentration after dam removal	- scour of organisms due to increased sediment loading - moderate exposure to increased TSS concentration
3	Downstream end of gorge (near Revenue Bridge) to Bull Run River confluence (RM 24.5–RM 18.5)	- deposition of coarse sediment and sand in the active channel - increased bank erosion - infiltration of sand into the channel bed - potential increased TSS concentration during construction - increased TSS concentration after dam removal	- burial or scour of redds and spawning substrates - infiltration of sand into spawning and rearing substrates - burial of low-velocity rearing habitats - burial or scour of organisms due to increased sediment loading - moderate exposure to increased TSS concentration
4	Bull Run River confluence to Dabney Park (RM 18.5–RM 6)	- deposition of sand into side channels - increased bank erosion - infiltration of sand into the channel bed - potential increased TSS concentration during construction	- loss of low-velocity rearing habitats - infiltration of sand into spawning substrates, resulting in reduced survival-to-emergence
5	Dabney Park to mouth (RM 6–RM 0)	- sand aggradation near the river mouth - potential increased TSS concentration during construction	potential impairment of adult upstream migration

* The likelihood and magnitude of these potential impacts are discussed in more detail in the text.

In addition to the total deposition thickness, the annual change in bed elevation is an important component of channel response that would influence biological effects. In most reaches and years, the model predicts annual changes in bed elevation of less than 1 foot. In Reach 3, where the largest total magnitude of reach-scale aggradation is predicted, the annual change in bed elevation is typically less than 1.6 feet. Further downstream, the model predicts annual changes in bed elevation of less than 1 foot; these changes are indistinguishable from the results of the reference run.

Modeling also indicates that variations in hydrologic conditions and in the assumed grain size distributions for the reservoir deposit result in differences in the rate of erosion of the reservoir deposit and cause only slight changes in the predicted spatial and temporal pattern of downstream sediment deposition. Wet conditions cause sediment to move more quickly out of the reservoir area and slightly reduced the overall aggradation in Reach 1 in the years following removal. Wet conditions would also alter the temporal pattern of aggradation in Reach 3 (with thicker deposition in the first several years after removal compared to Run 1 but with similar magnitude of aggradation over a 10-year scale). In Reach 4, wet conditions slightly increased aggradation compared to average hydrologic conditions. Dry conditions reduce the rate of sediment movement out of the reservoir area but result in similar patterns of downstream aggradation as under average conditions, with aggradation evident in Reach 1 and Reach 3. Stillwater Sciences (2000b) provides additional detail on model runs that incorporate variations in hydrology and assumed grain size distributions of the reservoir sediment.

Modeling of sand transport: After the dam is removed and the channel begins to incise into the reservoir deposit, sand and fine sediment would be mobilized from the reservoir deposit, mostly as suspended load. Modeling of sand transport indicates that sand aggradation is most likely to occur in the lower 6 miles of the Sandy River (Reach 5), and that no aggradation would occur further upstream. Reach 5 has the lowest transport capacity of any reach in the Sandy River, reflecting its width and low gradient, and is currently sand-bedded in the lower portion of the reach. The model predicts deposition thicknesses of up to about 1.3 feet in Reach 5, with the greatest aggradation occurring in the first year following removal of Marmot dam. The deposition thickness could be much greater than this, however, because of the potential backwater effect of the Columbia River. Modeling also indicates that the magnitude of sand aggradation would fluctuate both seasonally and between years.

Sand would be metered out of the reservoir area in the years following dam removal, with the magnitude of sand transport depending on the rate of movement of the gravel surface layer out of the reservoir. The rate of sand transport out of the reservoir varies with flows, as indicated by the wet, average, and dry hydrologic conditions that PGE modeled, and with the assumed grain size distribution of the reservoir deposit (Stillwater Sciences 2000b). In all model runs, the magnitude of sand transport out of the reservoir is largest in the first winter following dam removal, although sand transport out of the reservoir continues for the duration of the model runs.

Sand release from the reservoir would not result in large increases in total suspended sediment (TSS). Modeling indicates that, between Marmot dam and the Bull Run confluence, peak TSS of about 500 ppm would occur in the first winter following

dam removal. TSS would generally remain between 100 and 200 ppm during the first 2 years after removal, with increases above this level associated with high flows during the second winter. Downstream of the Bull Run River, TSS levels would be lower because of the dilution effect of flows from the Bull Run River. TSS levels associated with dam removal are relatively low because of the nature of the sediment deposit, in which fine sediment deposits are armored by a coarser surface layer (figure 3) and are therefore released gradually, rather than as one large pulse. Background TSS levels in the Sandy River are not known; modeled results should be considered indicative of potential increases in TSS above background levels due to sediment release from Marmot reservoir.

Stillwater Sciences also completed a sensitivity analysis of sand release from the reservoir to account for the uncertainty in the modeling of reservoir erosion patterns. This analysis, which is explained in more detail in Stillwater Sciences (2000b), tested the effects of accelerated sediment release (compared to basic model predictions) on downstream deposition patterns and total suspended sediment (TSS) concentrations under Alternative 1. This test involved increasing the rate of sand release from the reservoir by an order of magnitude (10-fold) over that which is predicted by the model based on predicted shear stresses in the reservoir reach. This test models rapid release of sand from the reservoir rather than relatively gradual metering of the sand layer. Although sand release at such a high rate is extremely unlikely, the results of this test may provide an upper bound on downstream sand transport and the potential downstream impacts. Sand release from the reservoir at ten times the expected rate would result in peak TSS of approximately 4,000 ppm in the first winter following dam removal (compared to a maximum of about 500 ppm for basic model runs). Otherwise TSS would generally remain between 100 and 400 ppm with levels approaching background conditions during late summer and fall (July to October). In the second winter following dam removal, TSS would increase above 400 ppm during storms, with a maximum of 2,000 ppm, and decline to near-background conditions during late summer and fall. Increasing the rate of sand release by an order of magnitude would also result in additional deposition downstream, including deposition of about 1 foot in the downstream end of Reach 4 and maximum aggradation of about 3 feet in Reach 5. If sand release occurred faster than predicted by the basic model runs, this would increase the magnitude of potential impacts, as described in this sensitivity test, but would shorten the duration, because sand would be transported out of the Sandy River more rapidly.

Geomorphic assessment

In the following section, the model results presented above are interpreted for each of the geomorphic reaches delineated by Stillwater Sciences, including discussion of the

implications of model results for channel morphology and of how actual transport and deposition patterns may differ from model predictions. Compared to Alternatives 2 and 3, the magnitude of downstream sediment deposition and the resulting geomorphic and ecological impacts would be greatest for this alternative. Comparison between Alternative 1 and Alternatives 2 and 3 is provided in the sections addressing those alternatives.

Upstream impacts and channel adjustment in the reservoir-influenced reach (RM 32-RM 30): Under Alternative 1, the majority of the sediment stored behind Marmot dam would be transported downstream and the reach upstream of the dam would adjust towards its pre-dam channel gradient following removal of the dam. The gradient would increase from about 0.002, which reflects the grade control provided by the dam, to about 0.006, an estimate of the pre-dam gradient based on analysis of a channel profile surveyed by USGS shortly after construction of Marmot dam (USGS 1915) and PGE photogrammetry data. This gradient adjustment would occur over a period of years as a result of downstream transport of reservoir sediment.

During the adjustment period, the channel in the reservoir reach is expected to be highly unstable. As the channel incises to its new gradient, the bed would be highly mobile and mass wasting of banks may occur, especially in the downstream portion where the depth of incision would be greatest and where sand would be a dominant bank component. Chronic ravel may also occur along the banks of the newly incised channel as a result of seepage, which, in combination with gravitational forces (i.e., the relatively low angle of repose of non-cohesive reservoir sediments) would encourage further channel widening (e.g., Crouch and Blong 1989, Howard and McLane 1988, Schumm et al. 1984, Little et al. 1982).

Because the reservoir deposit is composed of non-cohesive sediment (predominantly gravel in the upper layer and sand in the lower layer [Squier Associates 2000]), headcutting and associated knickpoint migration are unlikely to occur. Headcutting and/or knickpoint formation are most likely to develop in cohesive sediments that are difficult to erode and that have a high angle of repose (e.g., Selby 1993, Heede 1976). In the case of a loose gravel deposit, as occurs in Marmot reservoir, a negative feedback would likely act against potential headcutting, whereby initiation of headcutting would increase gradient and shear stresses, resulting in erosion of any headcut and flattening of the gradient.

As discussed in the model results above, most reservoir sediment would be transported downstream in the first several years after dam removal, but some sediment would remain for a decade or more. After the first several years, however, the rate of

erosion would be low and instability would be reduced. Reservoir erosion patterns and the rate of channel adjustment would depend upon flow conditions following dam removal. Higher flows in the first years following dam removal would result in more rapid erosion of sediment from the reservoir reach and more rapid stabilization of the channel in this reach.

Model predictions of reservoir erosion patterns contain uncertainties because one-dimensional modeling does not capture processes such as channel incision and lateral migration. In the model, sediment transport out of the reservoir area is driven by shear stress (i.e., as indicated by the Parker [1982] equation) and is assumed to be laterally uniform. Erosion of reservoir sediment would in fact likely result in incision of a channel within the valley walls. To estimate the effect of this incision process, sensitivity tests were performed by assuming increased sediment transport rates out of the reservoir, as discussed above and in Stillwater Sciences (2000b). Incision could accelerate both the movement of sediment out of the portions of the reservoir that incise and the exposure of the sand layer of the reservoir deposit compared to model predictions, and could also increase the time required for sediment to be eroded from areas along the margin of the reservoir.

Reach 1: Marmot dam to the upstream end of the gorge (RM 30–RM 28.5): Reach 1 would be the most seriously impacted of the reaches for each removal option. As discussed above, modeling indicates that under Alternative 1, the thickness of sediment deposition following removal of Marmot dam would be greatest immediately downstream of the dam, where a debris fan could quickly form in the channel at the former dam location, with thickness of the deposit expected to be reduced as the sediment wave is transported downstream. Model predictions indicate that the debris fan immediately downstream of the dam could have a thickness of approximately 12 feet in the first year following removal, under average hydrologic conditions. Deposition further downstream in Reach 1 is predicted to have a thickness of about 3 feet. This estimate is a reach and cross-section average and local deposition patterns would vary from these predictions. Deposition may also be greater than model predictions in certain portions of this reach where the channel widens and shear stresses are reduced, including: (1) a large alder-vegetated bar and side channel known as Beaver Island (RM 29.4–29.2), where deposition could bury this bar, create braided, unstable conditions, and/or block access to side-channel habitat; and (2) a large alcove/backwater pool at the downstream end of the reach (RM 28.7), where deposition could substantially reduce pool depth.

The model predicts that except for immediately downstream of the dam, most coarse sediment would have passed through this reach in less than 10 years. This reach would likely experience some long-term changes in morphology as a result of dam

removal, sediment release, and the change in gradient of the upstream reach. For example, in the years following dam removal, aggradation would likely result in plane-bed morphology (Montgomery and Buffington 1993) in this reach, filling of pools with sediment, and increased gradients in the upstream end of the reach. Channel banks immediately downstream of the dam, to about 0.4 mile downstream, are dominated by bedrock and, therefore, have low susceptibility to erosion from aggradation (which would be large in this sub-reach due to debris-fan formation below the dam). Further downstream in Reach 1, beginning approximately 0.4 mile downstream of Marmot dam, the left bank is characterized by noncohesive, alluvial terrace material, and bed aggradation in this sub-reach could cause localized flow deflection and increased rates of bank erosion. Increased erosion of alluvial terrace banks would contribute sand, gravel, and minor amounts of cobble to the channel, thereby increasing the supply of coarse and fine sediment to this reach and downstream. The magnitude of this effect has not been quantified, although it is not likely to be large because only about 3 feet of aggradation is predicted in Reach 1. Even if aggradation is greater than this, the volume of increased sediment from bank erosion would likely be very small compared to the amount of sediment released from behind Marmot dam under Alternative 1, according to rough estimates by Stillwater Sciences.

Model results indicate that sand would be transported in suspension through Reach 1, with no deposition predicted. If sand deposition does occur, it would be most likely in the two locations cited above where the channel widens and shear stresses are reduced (the alder bar/side channel at RM 29.4–29.2, and the large alcove/backwater pool located at the downstream end of the reach). Sand infiltration into interstitial spaces may also occur, depending on flow conditions following dam removal.

Reach 2: Sandy River gorge (RM 28.5–RM 24.5): Sediment transport modeling indicates that through most of the gorge reach, no deposition of sand and gravel following dam removal would be expected under Alternative 1 (figure B-2) (or any of the other removal alternatives). This is because the steep gradient and high confinement of this reach create very high shear stresses and high sediment transport capacity. Model results concur with field observations, which suggest that little deposition currently occurs in Reach 2. Modeling indicates that deposition would be restricted to the downstream-most portion of the gorge (RM 25–RM 24.5; figure B-2), where the channel gradient decreases (figure 3) and the channel widens slightly due to the transition between conditions in the gorge and in Reach 3. The model uses simplifying assumptions about channel morphology in this reach, however, and localized deposition could occur in certain locations that are not identified by modeling. Such deposition would be most likely in the following areas, according to field observations: (1) a less-confined channel segment at the upper end of Reach 2 (RM 28.5–27.6); (2) areas with strong momentum defects (e.g.,

downstream of large boulders or upstream of channel constrictions); and (3) at the margin of some bedrock pools, where localized sand deposits may increase in extent and thickness after removal of the dam. High sediment transport and pool-scouring capacity in this reach limit the likelihood of substantial deposition in pools.

Reach 3: Downstream end of the gorge (near Revenue Bridge) to Dodge Park (Bull Run River confluence) (RM 24.5–RM 18.5): Sediment transport modeling suggests that the upstream portion of Reach 3 has the highest potential for coarse sediment deposition downstream of Reach 1 (figure B-2). This is because at the transition from Reach 2 to Reach 3, valley width increases substantially and channel gradient decreases, facilitating deposition of alluvial sediment. As sediment released from Marmot dam travels downstream following dam removal, little attenuation of the coarse sediment wave would have occurred by the time it arrives at Reach 3, because of the high transport capacity of the upstream reach (Reach 2). The greatest amount of deposition is predicted in the upstream end of Reach 3, from approximately RM 24.5 to RM 22 (approximately 5.6–8 miles downstream of the dam) (i.e., from upstream of Revenue Bridge downstream to near the Cedar Creek confluence). Little deposition is predicted in the downstream portion of Reach 3, near the confluence with the Bull Run River.

The magnitude of predicted aggradation, 3–6 feet, is a reach-average for the upstream portion of Reach 3. Deposition patterns would not be expected to be uniform across the channel bed, and most deposition would likely be associated with existing alluvial features, causing swelling of these features both laterally and vertically. Differential deposition patterns could result in localized aggradation of greater than 6 feet in areas such as the large alluvial bar and side-channel area located upstream of Revenue Bridge. Several side-channel areas are located in the upstream end of Reach 3, and gravel deposition in these areas could fill these side-channels and/or close off the upstream or downstream ends of side channels. Gravel deposition could contribute to increased braiding in depositional areas, potentially creating additional side channels. The presence of large woody debris at the heads of side channels may affect sediment deposition dynamics in these areas, by reducing transport capacity and thereby increasing sand deposition in side channels. Alluvial banks along this reach, which largely consist of Troutdale mudstone, are cohesive but may be susceptible to limited aggradation-induced erosion. Banks consisting of vegetated alluvial features, which are present along portions of Reach 3, are more susceptible to erosion than mudstone banks, although erosion of such features is not likely to be distinguishable from natural bank erosion processes.

Modeling indicates that the aggradational wave of coarse sediment would gradually build in Reach 3 in the first 10 years following removal, to a maximum thickness of 6 feet, and would dissipate between 10 and 20 years following removal

(figure B-2). Maximum aggradation, therefore, would not occur for a number of years until after dam removal and would be the result of gradual aggradation rather than resulting from a pulse of sediment depositing in this reach shortly after dam removal. Therefore, the rate of change in bed elevation would be relatively low (<1.5 feet/year). This is important in terms of the ecological impacts of the deposition in this reach, which would be greater if the sediment deposition resulted in rapid and frequent changes in bed elevation (scour and fill).

These results are based on average hydrologic conditions and reflect the hydrologic input data used in the modeling. The actual transport time of the aggradational wave and deposition magnitude would differ from this depending on the hydrologic conditions in the years following dam removal. For example, a model run with wetter hydrologic conditions suggested more rapid arrival of the sediment wave in Reach 3 and subsequent transport downstream, with a similar maximum magnitude of aggradation (Stillwater Sciences 2000b).

Reach 4: Dodge Park to Dabney Park (RM 18.5–RM 6): Numerical modeling predicts only a small amount of coarse sediment deposition in the reach from Dodge Park to Dabney Park (figure B-2). Deposition of less than 1.6 feet is predicted, an amount that is only slightly greater than predicted under reference conditions in Reach 4 (figure B-1). Under natural conditions, the reach downstream of Dodge Park (and particularly downstream of Oxbow Park) has a high potential for deposition of sediment delivered from upstream reaches because channel gradient and confinement are considerably reduced compared to upstream reaches. Sediment transport modeling suggests that most coarse sediment would be deposited upstream of Reach 4 and that sand would travel in suspension through this reach. The timing of sediment transport to this reach and subsequent deposition would vary with flows following removal. Modeling for 20 years with average flows in year 1 indicates very small increases in sediment deposition would occur with increasing time after dam removal, with maximum deposition thickness (about 2 feet) occurring 20 years after removal (figure B-2). This reflects the downstream movement of the sediment wave; as aggradation declines in Reach 3 in years 10 to 20, aggradation slightly increases in Reach 4.

The limited amount of deposition predicted in Reach 4 would be most likely to occur in existing depositional areas, such as at the heads of bars, potentially resulting in swelling of alluvial features. As in Reach 3, such a deposition pattern is more likely than uniform deposition across the channel bed. If sand deposition occurs, it would be most likely further downstream on riffles and bars, particularly on bars that are currently mantled with sand (T. Lisle, pers. comm., 1999). In addition, sediment deposition may be concentrated in side channels and at stream junctions that have substantial debris fans.

(such as Walker Creek).

Because of abrasion, the time required for coarse sediment to travel to this reach, and the large amount of coarse sediment already stored in this reach, it is possible that deposition of coarse sediment released from Marmot dam would not be detectable in this reach. As noted above, predicted deposition in Reach 4 is not substantially greater for Alternative 1 than for a reference run of the model with only background sediment transport conditions. An assessment of alluvial sediment storage estimated that the amount of active sediment (i.e., sediment available for mobilization under moderate flows) stored in Reach 4 is more than 4 times greater than the amount stored behind Marmot dam. This suggests that whatever fraction of sediment released from the dam that is deposited in Reach 4 is not likely to represent a substantial increase over the volume of sediment currently stored in the reach. The likelihood of aggradation that is sufficient to accelerate bank erosion in Reach 4 appears to be extremely low.

Reach 5: Dabney Park to mouth (RM 6–RM 0): Numerical modeling suggests that sand aggradation of up to 1.3 feet would occur in this reach following removal of Marmot dam but that no coarse sediment aggradation is predicted. Sand aggradation may in fact be greater than predicted. The magnitude of sand aggradation in this reach is difficult to predict because of the complex hydraulics created by the backwater effect of the Columbia River and the uncertainty of the combined flow conditions in the Columbia and Sandy Rivers following dam removal. If flows are high in the Columbia River at the same time as sand from Marmot reservoir is being transported downstream in the Sandy River, this would create a backwater effect in Reach 5 (i.e., gradient and velocity would be reduced), and increased deposition (>1.3 feet) could occur. Sand aggradation could be lower than model predictions in Reach 5, however, if deposition occurs in upstream reaches, which is not predicted in basic model runs but is likely to occur locally. No coarse sediment aggradation is predicted by modeling for this reach, which is reasonable given upstream deposition of coarse sediment, abrasion, the long travel time that would be required for gravel to travel to Reach 5, and field observations that most of the channel is currently sand-bedded in Reach 5.

Alternative 2--Removal of Top of Dam in Year 1. Complete Dam Removal in Year 2 with Sand Layer Excavation.

Numerical modeling results

For Alternative 2, PGE used numerical modeling to test the effects of lowering Marmot dam by different amounts in year 1 on sediment transport patterns and to estimate downstream deposition patterns under these scenarios. PGE carried out the following

model runs for Alternative 2:

- (1) Lowering of Marmot dam by about 25 feet in year 1, thereby leaving the lower 22 feet in place until the following year,
- (2) Lowering of Marmot dam by about 30 feet in year 1, thereby leaving the lower 17 feet in place until the following year,
- (3) Lowering of Marmot dam by 35 feet in year 1, thereby leaving the lower 12 feet in place until the following year.

In addition, PGE modeled the effects of wet, dry, and average water years for dam lowering of 30 feet, using techniques identical to those used to model Alternative 1. Basic runs for Alternative 2, including modeling of reservoir erosion and downstream deposition, were only extended for 1 year. After the first year, sediment would be removed up to 2,700 feet upstream of Marmot dam and the rest of the dam would be removed. PGE also completed a model run in which the dam was lowered in the first year, and the lowered dam remained in place for up to 5 years, in order to gain insight into how much sediment would be eroded with a lowered dam left in place and how much of the sand layer would be exposed.

Modeling of Coarse Sediment Transport: Modeling results show that if the top 30 feet of Marmot dam were removed, approximately 25 percent of the reservoir sediment would be transported downstream in year 1, mostly consisting of gravel but including a small sand component. The thickness of the reservoir deposit would decrease from approximately 36 feet at the time of dam removal to about 20 feet after 1 year under average hydrologic conditions. This result is similar to the amount of reservoir erosion predicted in year 1 under Alternative 1, in which the entire dam would have been removed in 1 year. Likewise, there is little difference in the amount of lowering of the sediment between removal of 30 feet and 35 feet of the dam after 1 year. If the dam is lowered only 25 feet, however, less than 20 percent of the total reservoir sediment would be eroded downstream, and the height of the sediment is reduced to 21 feet after 1 year, about 2 feet less than the other scenarios. Hydrologic conditions would also affect the removal of sediment immediately upstream of the dam. After 1 year, the depth of the sediment deposit is predicted to be 22 feet and 14 feet under dry and wet conditions (30 feet lowering), respectively versus 19 feet under average hydrologic conditions.

The greatest amount of aggradation is predicted immediately downstream of the dam (approximately 9 feet), as sediment is eroded from the reservoir and a debris fan forms in the first 0.6 mile below the dam. Further downstream, modeling predicts that under average hydrologic conditions, downstream deposition thickness would generally be less than 2 feet, regardless of the level of dam lowering, with the largest amount of

aggradation in Reach 1 and lesser aggradation in Reach 3. Altering the level of dam removal from 25 to 35 feet would not significantly change the amount of aggradation downstream. Altering the hydrologic regime, however, would affect the amount of downstream aggradation. In a wet water year, maximum aggradation height would be approximately double and much more extensive than normal water year values, whereas under dry conditions in year 1, there would be little or no aggradation after the 0.6 mile downstream of the dam. In general, the amount of sediment carried downstream in year 1 with a lowered dam left in place would not likely be substantially larger than what would occur during a natural flood event, and aggradation patterns may be indistinguishable from background patterns.

The degree to which the sand layer would be exposed in year 1 near the downstream end of the reservoir deposit would depend on the level of dam removal (25, 30, or 35 feet) and hydrologic conditions. There was little difference between lowering the dam 30 feet versus lowering the dam 35 feet during average flow years, but both would expose much more of the sand layer than if the dam was lowered 25 feet. The type of water year would also influence the portion of the sand layer exposed. Approximately 1,310 feet of the sand layer would be exposed during wet water years versus approximately 705 feet during dry water years. Leaving the lowered dam in place for 5 years would increase the length of the exposed sand layer from approximately 740 feet after the end of the first year to approximately 1,440 feet, under average hydrologic conditions.

Modeling of Sand Transport: Under this alternative, the magnitude of downstream sand transport is predicted to be about 45,000 cubic yards for lowering of 30 feet and average hydrologic conditions, which is similar to the amount predicted for year 1 under Alternative 1. This includes both the sand fraction of the gravel layer (Unit 1) and sand from the exposed portion of the sand layer (Unit 2). Downstream deposition and TSS patterns are, therefore, similar to those predicted for year 1 under Alternative 1. Downstream sand transport was not modeled after year 1 for Alternative 2.

Geomorphic assessment

Upstream impacts and channel adjustment in the reservoir-influenced reach: The idea behind development of this dam removal alternative was that during the first year, following removal of the top portion of the dam, a substantial amount of the gravel layer in the reservoir (Unit 1) would be transported downstream, while the sand layer (Unit 2) would be retained in place by the lower portion of the dam. During the following construction season, the sand layer would then be excavated and removed. In year 2, the remaining sediment would be removed up to a point about 2,700 feet upstream.

In this alternative, there would be a trade-off between the amount by which the dam is lowered, the amount of gravel transported downstream in year 1, and the amount of the sand layer that is exposed in year 1. That is, the further the dam is lowered, the more gravel transport from Unit 1 occurs, but more of Unit 2 is also exposed. If the dam is only lowered by a small amount, the sand layer is retained in place, but only a small amount of the overlying gravel is eroded in year 1 and a large amount remains to be excavated in year 2. Based on the modeling scenarios to test varying levels of dam lowering, the optimal level of lowering under this alternative appears to be about 30 feet, in terms of balancing retention of the sand layer versus allowing sufficient downstream transport to facilitate excavation in the summer following dam lowering.

Model runs indicate, however, that a relatively limited portion of the gravel layer in the reservoir (Unit 1) would be transported downstream in year 1 following lowering of the dam, even under the maximum lowering scenario (35 feet) that was modeled. Comparison of model runs for Alternatives 1 and 2 indicates that even if the entire dam were removed in 1 year, the difference in downstream transport after 1 year would not be substantially different. The modeling suggests that a 2-year removal, with sediment excavation in year 2, would not work as originally envisioned, because much of the sediment would remain in the reservoir area. For example, wet conditions would be required in year 1 in order to erode a substantial portion of the gravel layer, thereby facilitating excavation, but substantial sand transport would also occur. Alternative 2 would therefore not be substantially different than Alternative 1, in terms of reservoir erosion in year 1. Discussion of downstream impacts following year 1 is not included because more sediment would need to be excavated in year 2 than PGE engineering analysis indicates is possible.

Downstream sediment deposition: Reaches 1-5: Under this alternative, a portion of the upper gravel layer of the reservoir deposit (Unit 1) would be transported downstream, while most of the sand layer (Unit 2) would be retained behind the dam and mechanically excavated in year 2, along with remaining gravel overlying the sand layer. The volume of gravel and sand transported in year 1 would be dependent on the elevation of the remaining portion of the dam and on the discharge during year 1. Modeling indicates that approximately 260,000 cubic yards of mixed sand and gravel could be transported downstream in year 1 for lowering of 30 or 35 feet, which is similar to reservoir erosion in year 1 for Alternative 1. As described above, the patterns of downstream sediment deposition resulting from erosion of reservoir sediment in year 1 are similar all of the dam lowering scenarios. Compared to Alternative 1, the following sediment delivery and deposition patterns would be expected under Alternative 2:

In Reach 1, the pattern of coarse sediment deposition in year 1 would be similar,

reflecting the similar volume of downstream sediment transport. Substantial aggradation would occur immediately downstream of the lowered portion of Marmot dam, in the form of a debris fan. Sediment deposition immediately downstream of the dam during year 1 could require additional excavation in year 2 to facilitate removal of the lower portion of the dam. Smaller amounts of aggradation are predicted for downstream portions of Reach 1. Although aggradation would be less than for Alternative 1 in subsequent years, the geomorphic disturbance in Reach 1 would be greatest for this alternative. For the other dam removal scenarios, the rate of aggradation just below the dam would be very high during the first year, but would decrease in subsequent years. Under Alternative 2, the rate of aggradation in Reach 1 would also be high in the second year, once the lower portion of the dam is removed. Because there would be rapid aggradation in Reach 1 during 2 years (versus only 1 year for other alternatives), impacts to Reach 1 would be increased relative to Alternative 1.

In Reaches 2 through 5, deposition patterns would be similar in year 1, with only limited deposition because most coarse sediment would remain upstream. In subsequent years, aggradation in downstream reaches, including coarse sediment aggradation in Reach 3 and sand deposition in Reach 5, would be reduced compared to Alternative 1 because of the excavation of reservoir sediment. In addition, because the majority of the sand (and a portion of the gravel) would be removed from the reservoir under Alternative 2, the potential for impacts that are not predicted by the model, including localized deposition resulting in blockage of side channels or infiltration of sand into the channel bed, would be reduced compared to Alternative 1.

Turbidity and suspended sediment concentrations: Construction-related excavation is expected to increase turbidity levels during both construction seasons. During year 1, increases in turbidity are expected to be similar to that described for Alternative 1. During year 2 (while the sand lens is being excavated), increases in turbidity would likely be similar to that described during excavation under Alternative 3. Downstream transport of sand from the reservoir would also result in increased turbidity and suspended sediment concentrations. Modeling indicates that if the top 30–35 feet of the dam is removed, downstream sand transport would be similar as under Alternative 1, resulting in similar patterns of downstream TSS.

Alternative 3--Remove the Dam and the Maximum Amount of Sediment Possible During One in Water Work Period.

PGE engineers estimated that the maximum amount of sediment that could be removed during one in-water work season would be between 125,000 and 300,000 cubic yards. The difference accounts for differences in timing of the first storm, potential work

stoppages due to elevated turbidity, and other unforeseeable construction delays. Numerical modeling of these alternatives was conducted in Spring 2002 and are described in detail in Stillwater Sciences (2002).

Numerical modeling results

In order to assess the upstream extent of excavation of the reservoir deposit, it was assumed that the reservoir had an average width of 50.5 meters and an assumed depth shown in figure 4. Using these assumptions, sediment excavation was estimated to extend to 200 meters and 600 meters upstream of the dam for removal volumes of 125,000 and 300,000 cubic yards, respectively.

Modeling of coarse sediment transport: The modeling results for the removal of 125,000 and 300,000 cubic yards of sediment did not differ significantly from each other, and were similar to Alternative 1 following year 1. Reach 1 would be the most seriously impacted of the reaches for either removal volume. This reach would be very dynamic, with extensive deposition in the first year following dam removal, and erosion in subsequent years (figures B-3 and B-4). Sediment dynamics in Reach 1 are similar to reference conditions starting in year 8. The remainder of the sediment wedge in year 8 may be a permanent deposition that fills in the area where either the spillway caused erosion or sediment was excavated during the construction of the dam.

Generally, the steep slope and narrow width of Reach 2 (the gorge) prevent sediment deposition (and subsequent erosion), rather sediment is delivered to downstream reaches relatively quickly. Some deposition is predicted to occur at the upper and lower ends of Reach 2 for both excavation volumes (figures B-3 and B-4). Both locations have lower slopes and slightly wider channel widths, and therefore, sediment deposition is more likely than in the remainder of the gorge. The annual change in bed elevation at the entrance to the gorge under reference conditions is within 1.3 feet of the current bed elevation. Under Alternative 1 (minimal dredging), the maximum change in bed elevation at this location increases to about 2.6 feet in year 2. The sediment would be eroded in subsequent years. The magnitude of deposition at the top of Reach 2 for the Alternative 3 for both 125,000 and 300,000 cubic yards of sediment removal was similar to the amount of deposition under Alternative 1. The frequency of deposition and erosion would also increase from the reference conditions. The annual change in bed elevation at the exit of the gorge under reference conditions is within 1.3 feet. The maximum change in bed elevation at this location under Alternative 1 is about 4 feet, but is generally less than 2.6 feet/year. The annual change at this site for removal of 125,000 and 300,000 cubic yards of sediment is similar to Alternative 1.

With the exception of over 3.3 feet of deposition at the upstream end of Reach 3, sediment dynamics in Reach 3 are similar to reference conditions for the removal of 125,000 and 300,000 cubic yards. Additionally, there is little difference between the amount of deposition in Reach 3 under Alternative 1 versus removing 125,000 or 300,000 cubic yards of sediment. The magnitude of annual erosion and deposition under Alternative 1, however, is similar to that of the reference condition, both at about 3.3 feet. The upper 3 miles of Reach 3 would be more dynamic following dam removal, with an increased frequency of erosion and deposition for the dam removal alternatives than under reference conditions.

The magnitude and frequency of coarse sediment dynamics in Reaches 4 and 5 are similar to reference conditions, Alternative 1, and removal of 125,000 and 300,000 cubic yards of sediment.

Modeling sand transport: Modeling results indicate that TSS would be similar to Alternative 1 for the first 2 years after the dam removal. The increases of TSS over the assumed reference conditions due to the removal of the dam are relatively low for both excavation volumes modeled. For example, the maximum TSS downstream of Marmot dam during the first year increased from under 200 ppm to about 550 ppm, i.e., an increase of less than 300 ppm.

The extent and magnitude of sand deposition in Reach 5 indicates that none of the alternatives would result in significant sand deposition from the reference conditions.

Geomorphic assessment

Upstream impacts and channel adjustment in the reservoir-influenced reach: The reservoir reach would experience rapid erosion following dam removal regardless of whether 125,000 or 300,000 cubic yards are removed. The amount of sediment in the reservoir reach is essentially the same after year 4 for the 125,000 cubic yard removal volume and Alternative 1. Similarly the deposit morphology is the same after year 6 for the 300,000 cubic yard removal alternative and Alternative 1. After 4 years the difference between these three removal alternatives is less than 1 meter in the Reservoir Reach (PGE 2002e, figure 5.2.1-16).

Downstream sediment deposition: Reaches 1–5: Modeling results indicate that the amount of sediment deposition in Reach 1 is very similar for Alternative 1 and both excavation volumes for Alternative 3 after year 1. During the first year, there would be slightly less deposition for Alternative 3 than Alternative 1, but the amount of sediment deposition immediately downstream of the dam would be high under both alternatives.

The rate of aggradation in the Reach 1 is similar for both excavated volumes and Alternative 1.

Downstream of Reach 1, sediment deposition patterns for Alternative 3 would be very similar to Alternative 1. Sediment would be deposited at the bottom of Reach 2 and top of Reach 3. The magnitude of deposition would be slightly lower than Alternative 1, but is within the range of potential uncertainty.

Turbidity and suspended sediment concentrations: The excavation operation may result in substantial increases in turbidity downstream of the dam during the construction season due to mobilization of fine sediments in the reservoir deposit. The magnitude of this turbidity increase cannot be modeled but would depend on how the excavation is carried out and on flow conditions during the excavation period. This increase in turbidity would be attenuated downstream of the Bull Run River because of the dilution effect of inflows from the Bull Run River, but construction-related turbidity increases could extend downstream to the confluence with the Columbia River and would likely continue at least for the period of construction. In addition, if the excavated material is stored on-site adjacent to the river, erosion of the disposal pile may deliver additional fine sediment to the channel and increase turbidity during storm events.

Following removal of the dam, exposed sand and fine sediment remaining in the channel (i.e., material that was not excavated) would be transported in suspension downstream as flows increase. Modeling results indicate that both modeled excavation volumes for Alternative 3 resulted in similar TSS to Alternative 1 for the first 2 years after the dam removal, and the magnitude of TSS increases is not significantly greater than reference conditions. The increases of TSS over the assumed reference conditions due to the removal of the dam are relatively low. For example, the maximum TSS downstream of Marmot dam during the first year increased from under 200 ppm to about 550 ppm, i.e., an increase of less than 300 ppm.

Removal of Little Sandy Diversion Dam

Approximately 4,500–9,400 cubic yards of sediment are stored behind Little Sandy diversion and would be released downstream into the Little Sandy River following removal. The range of 4,500–9,400 cubic yards represents a small volume of sediment, equivalent to less than 1 percent of the volume of sediment accumulated behind Marmot dam (980,000 cubic yards). The uncertainty surrounding the volume of sediment behind the dam therefore does not affect the analysis of potential effects of removing Little Sandy diversion and releasing sediments downstream. Potential geomorphic impacts of sediment release from Little Sandy diversion are discussed below for the Little Sandy

River ("Reaches 1 and 2") from Little Sandy diversion to the mouth, and for the Bull Run River below the Little Sandy confluence. Effects are not likely to be detectable in the Sandy River below the Bull Run River confluence, which is about 2.7 miles downstream of the Little Sandy River confluence with the Bull Run River. No numerical modeling was performed to assess sediment release from Little Sandy diversion because of the small volume of sediment stored behind the dam.

Geomorphic and ecological assessment

Little Sandy Reach 1 (0-0.3 mile downstream of Little Sandy diversion):

Removal of Little Sandy diversion would result in movement of the sediment currently accumulated behind the dam downstream into Reach 1. Under full-flow conditions, this reach would have a high sediment transport capacity, resulting in relatively rapid downstream movement of accumulated sediments, depending on the magnitude of high flows in the Little Sandy River following dam removal. In the short term, aggradation in Reach 1 is anticipated, with deposition occurring unevenly depending on local shear stress conditions. Coarse sediment aggradation may cause mortality of alders that have encroached into the channel due to reduced flows. Restoration of natural flow regimes (including high flows and winter baseflows) could also cause scour/dieback of riparian vegetation that has established in the active channel. Restoration of high flows would also likely promote mobilization of bed materials that are immobile under the current flow regime, resulting in an overall decrease in median grain size in the channel. Mortality of riparian vegetation (willows and alders) could also contribute to increased mobility of cobble/boulder bars on which willows currently grow, since the stabilizing influence of vegetation roots on substrates would be reduced once the willows die and their roots decay. The small pools in Reach 1 are also likely to infill with coarse sediment. Fine sediment deposits that are currently present in Reach 1 would likely be transported downstream by restored flows.

Little Sandy Reach 2 (0.3-1.7 miles downstream of Little Sandy diversion):

Removal of Little Sandy diversion is expected to have little effect on geomorphic conditions in Reach 2, because the steep gradient and high confinement of this reach create high shear stresses and transport capacity, resulting in channel morphology that appears to be highly resilient to changes in sediment and water supply. Sediments released from behind the dam are expected to travel quickly through this reach and into the Bull Run River, and restored flows are not expected to result in morphologic changes. Some coarse sediment deposition may occur in the pools located 0.9-1.0 mile downstream of the dam (as well as the riffle between the pools), decreasing pool depth and volume. Decreases in habitat area in these pools may be counterbalanced to some extent by increased discharge. In addition, localized aggradation may deposit a coarse

sediment mantle over bedrock bench areas associated with knickpoints in this reach, and some small deposition sites associated with momentum defects (bedrock outcrops, boulders) could swell with gravel in response to the sediment pulse from the dam, although the duration of these effects would likely be short.

Bull Run River: The Bull Run River appears to be sediment-depleted downstream of the City of Portland's dams, which block downstream delivery of coarse sediment, and gravel augmentation in the Bull Run River has previously been proposed to mitigate the loss of upstream supply (R2 Resource Consultants 1998a). Release of sediment from Little Sandy diversion may therefore have a beneficial effect on the Bull Run River, facilitating deposition in locations that currently lack alluvial deposits or are unsaturated. This effect is likely to be small, however, given the small amount of sediment that would be released from behind Little Sandy diversion. No adverse effects of sediment release from Little Sandy diversion on the Bull Run River are anticipated.

Turbidity and suspended sediment impacts: Because sand comprises 35 to 45 percent of the reservoir deposit upstream of Little Sandy diversion, removal of the dam and subsequent mobility of the reservoir sediments could increase turbidity and suspended sediment concentrations in the lower Little Sandy and Bull Run Rivers. Because the amount of sand stored behind Little Sandy diversion is relatively small, however, PGE expects turbidity and suspended sediment impacts to be substantially less than those resulting from any of the alternatives for removal of Marmot dam.

Removal of Canals, Tunnels, Flumes, and Ancillary Structures

The timber box flume that conveys water from the Little Sandy diversion dam to Roslyn Lake parallels the Little Sandy River and is situated on steep hillslopes for most its length. Historically, several tributaries to the Little Sandy have been intercepted and diverted to the timber box flume. The timber box flume traverses existing old landslide terrain, but has not caused increased slide activity in these areas (Cornforth Consultants 1999a). A geologic hazards study (Landslide Technology 1999, as cited in Cornforth Consultants 1999a) identified several issues related to slope stability in the location of the flume. These included erosion, rock-fall, local soil sloughs, and old landslide terrain. Catastrophic landslides and large rock falls have impacted the operation of the flume a few times during its existence. An assessment of these events indicates that they were natural processes. Rock falls originated on the steep slopes above the flume in areas that are not impacted by the flume. The catastrophic landslides occurred in a marginally stable geologic area, and appear to have originated as small slides that took out the foundation of the flume (Cornforth Consultants 1999a).

PGE proposes to remove the flume from within the box, and operate a crane to run within the flume to pickup, bundle and band timbers for transport via the speeder back to the car barn area-located near the project powerhouse. Sidewall sections would be cut and folded in over the floor between the bents, then they would be picked up as a section and transported. Longer columns would be helicopter-lifted from the site. Concrete footings would be left in place, except that the large footings within the Little Sandy River would be removed during the low-flow period. Also, intercepted and diverted streams would be restored to their natural courses.

Since most of the deconstruction work would be accomplished from the flume structure, potential impacts to adjacent slope stability are expected to be minimal. The proposal to leave most concrete footings in-place would help minimize excavation and backfilling; hence, reducing ground disturbing activities that could comprise slope stability.

Project Powerhouse

Removal of the project powerhouse would have no significant impact on geological resources. The removal of the tailrace would be done in the summer under low water conditions, which would avoid impact in the water or downstream. Erosion and sediment control measures would be implemented as necessary.

Removal of Roslyn Lake

Under the Proposed Action Alternative, the 160-acre Roslyn Lake impoundment would be drained and filled. The removal of Roslyn Lake would result in some minor disturbance of soils and surficial deposits. During the removal period, drawdown of the lake would result in short-term impacts to turbidity levels in the Bull Run River.

Also, under this alternative the outlet structure would be removed/demolished and disposed of off-site. The portion of the penstocks under Roslyn Lake, under the adjacent roadway, and under the powerhouse would be sealed with concrete. All exposed sections of the penstocks would be removed. This action would have significant disturbance to the ground surface in this area (i.e. excavation and infilling at the pipe locations). The planned earthwork would need to be evaluated in relation to the landslide conditions that are present in this area.

In addition, as a result of the complete removal of Roslyn Lake, water yields from groundwater wells located adjacent to the lake could potentially be affected by the

elimination of leakage (Cornforth Consultants 1999b). See Section 5.3.2.2 for more discussion on anticipated impacts on groundwater flow from the elimination of leakage as a result of Roslyn Lake removal.

5.3.1.3 Staff Modification of PGE's Proposal

Erosion and Sediment Control Plan

Removal of the project would require disturbance of land areas, the dredging of 20,000 to 30,000 cubic yards of sediment, major, earth-moving activities, construction of cofferdams and fish trap, and sediment/debris disposal. These activities would result in increased sediment load into the Sandy and Little Sandy Rivers.

PGE proposes to implement best management practices and erosion control measures but no specific plan has been developed—except for revegetation of disturbed areas.

The development and implementation of detailed erosion and sediment control measures, based the final design of construction activities, construction staging areas, and access locations, would control the release of sediment and turbid water from construction sites and would help to mitigate the effects of land disturbances during removal of project structures. Therefore, PGE should develop an erosion and sedimentation control plan to control erosion, to control slope instability, and to minimize the quantity of sediment resulting from project removal. The plan should be developed after consultation with appropriate agencies and should include:

- detailed descriptions, functional design drawings, and specific topographic locations of all erosion and sedimentation control measures
- measures to control dust
- detailed descriptions of proposed dredging and dredge disposal methods to remove accumulated sediments
- a specific implementation schedule

5.3.1.4 Cumulative Impacts

The following discusses cumulative impacts with respect to the geologic and geomorphic effects of removing Marmot and Little Sandy diversions in combination with other land uses. Geological resources in the Sandy River Basin have been altered by

forestry practices, agriculture, flood control projects, residential development, roads, and water supply and hydroelectric power development. Approximately 78 percent of the basin is forested, with 75 percent of the forested lands occurring in the Mt. Hood National Forest (Taylor 1998). Land use in the remaining 22 percent of the basin, much of which occurs at lower elevations and is in private ownership, includes agriculture, grazing, and residential uses (ODFW 1997a).

From a cumulative impacts perspective, previous and ongoing land uses in the Sandy River Basin have likely had offsetting effects on sediment yields in the Sandy River. Since 1892, the area of the Bull Run Basin upstream of the City of Portland's Bull Run Project has been protected to maintain a source of high-quality drinking water (Taylor 1998), resulting in sediment yields characteristic of reference (unmanaged) conditions. The City of Portland's dams on the Bull Run River block delivery of coarse, and possibly fine, sediment from the Bull Run River Basin to downstream reaches, including the Sandy River downstream of the Bull Run River. Other land uses have likely increased sediment supply, however. In the upper Sandy River Basin, where land is predominantly in federal ownership, timber harvesting and road construction have likely increased sediment inputs to streams (although under the Northwest Forest Plan, management of federal lands would be designed to minimize anthropogenic sediment inputs in the future). In the lower Sandy River Basin, recreation, residential development, agriculture, and roads have likely increased bank erosion and surface erosion, thereby accelerating coarse and fine sediment inputs to streams. No data are available with which to quantify the effects of these land uses on sediment yield in the Sandy River. It is likely that the overall effect of land uses has been to increase sediment supply above natural conditions, although because sediment yields are naturally high in the Sandy River, this effect may not be large. Sediment release from Marmot dam (under Alternatives 1, 2, and 3) would further increase sediment yields above natural levels for the duration of downstream transport of reservoir sediments, particularly in the first year following dam removal (comparison of the volume of sediment stored in Marmot reservoir with hypothesized background sediment yields is provided in Section 5.3.1.1).

Removal of Marmot dam may also contribute to cumulative impacts in terms of channel morphology in the Sandy River, including impacts to side-channel areas and infiltration of fine sediments in the channel bed. For example, flood control projects following the December 1964 flood resulted in straightening of channels and loss of side channels in the upper Sandy River Basin, where several miles of the Salmon, Zigzag, and Sandy Rivers and Still Creek were channelized. Channels were straightened using heavy equipment; boulders, logs, and other flow obstructions were removed; and side channels were blocked by berms created in the channelization process (ODFW 1997a). Removal of Marmot dam would not affect any of the channelized areas, all of which are upstream

of the dam. Aggradation or cutoff of side channels in the Sandy River downstream of Marmot dam as a result of sediment deposition could, however, create a cumulative impact in combination with this previous loss of side channels from channelization. In addition, anthropogenic sediment inputs related to road erosion or bank erosion may have increased infiltration of fine sediments into the channel bed, a condition that could be exacerbated by dam removal. High substrate embeddedness is currently evident in Reach 4, although this may reflect the naturally high sediment loading in the Sandy River.

In the long term, removal of Little Sandy and Marmot dams, in combination with the Northwest Forest Plan, would have a positive cumulative impact on restoration of natural LWD supply to the Little Sandy and Sandy Rivers, respectively. Removal of Little Sandy and Marmot dams would increase LWD supply to some extent, because LWD is currently removed at the dams by PGE maintenance crews. In riparian and upslope areas along the Sandy and Little Sandy Rivers, historic timber harvesting has reduced occurrence of large, old-growth conifers, which are an important source of LWD, but Riparian Reserves created under the Northwest Forest Plan would increase recruitment of LWD to stream channels in the long term. Increasing LWD supply toward natural conditions would potentially increase channel complexity, pool formation, and retention of gravels suitable for spawning in the Sandy and Little Sandy Rivers.

Overall, decommissioning of the project would help restore natural geomorphic processes to the Sandy and Little Sandy Rivers. This would result in the improved maintenance of aquatic and riparian habitats in previously affected stream reaches by reestablishing natural hydrology, sediment, and large woody debris regimes.

5.3.1.5 Unavoidable Adverse Impacts

Unavoidable adverse impacts of removing Marmot and Little Sandy diversions include temporary increases in turbidity and suspended sediment concentrations downstream of the dams during deconstruction activities. Some turbidity increases would be expected under all removal alternatives, with the magnitude depending on whether sediment excavation occurs (which could cause large turbidity increases during the excavation period) and on the amount of downstream transport of fine sediment following dam removal. In addition, removal of Marmot dam would change the gradient and morphology of the reach immediately upstream of the dam under all removal alternatives, although because this would eventually restore more natural conditions in this reach, this would not represent an adverse impact. As discussed in Section 5.3.1.2, sediment excavation from behind the Marmot dam and/or downstream transport of reservoir sediments would increase the gradient to approximately 0.006 (from about 0.002), increase bed particle sizes, and potentially create unstable conditions in the short term as

the channel adjusts to a new gradient and morphology.

5.3.2 Water Resources

5.3.2.1 Affected Environment

Water Quantity

The Sandy River Basin is bounded by the Columbia River to the north, the Hood and Deschutes Basins to the east, and the Willamette River Basin to the south and east. The Sandy Basin is the smallest of the 18 administrative basins in the state, and lies entirely within Multnomah and Clackamas counties. The basin is 582 square miles, and originates on the upper slopes of Mt. Hood and flows 56 miles to the Columbia River near the City of Troutdale.

The main tributaries to the Sandy River include the Salmon River, the Zigzag River, the Bull Run River, and the Little Sandy River, which is a tributary to the Bull Run; as well as the Still, Cedar, Gordon, and Beaver Creeks. The Sandy River, the Muddy Fork of the Sandy River, and the Zigzag River originate from glaciers on Mt. Hood. The Little Sandy, Bull Run, and Salmon Rivers have no glacial influence. Glacial sediments frequently cause the mainstem Sandy River to remain turbid throughout the summer snowmelt period. The Bull Run River is the primary source for drinking water for the City of Portland. The City of Sandy obtains its water from Alder Creek in the upper Sandy watershed.

Table 5 shows the increase in annual average precipitation with elevation based on station records from 1961 through 1990 in the Sandy River Basin and from the nearby Clackamas Basin. Precipitation at the lower elevations occurs primarily as rain, while the higher elevations receive snow.

Table 5. Average Annual Precipitation at Several Locations in the Sandy and Clackamas River Basins

Location	Elevation (feet)	Basin	Average Annual Precipitation (inches)
Troutdale	30	Sandy	45
Estacada	410	Clackamas	59
Three Lynx	1,120	Clackamas	72
Government Camp	3,980	Sandy	86

Precipitation varies considerably throughout the year in this geographic area. July and August typically have the least precipitation, while November, December, and

January have the most. Two-thirds of the yearly precipitation falls in November through March. Table 6 shows the percent of average annual precipitation that falls in each month, averaged for all stations for the period from 1961 through 1990 (PGE 1998b).

Table 6. Seasonal Variation in Precipitation for Stations in the Sandy and Clackamas River Basins

Month	Percent of Total	Month	Percent of Total
January	15	July	1
February	11	August	2
March	10	September	4
April	8	October	7
May	6	November	14
June	4	December	16

Flows, impoundment levels, and flooding: Hydrologic regimes in the Sandy River Basin are characterized by low flows in August and September and high flow generated by rainfall and rain-on-snow events in winter and snowmelt in spring. The Sandy River discharges approximately 1,954,000 acre-feet of water to the Columbia River annually. The natural discharge patterns of the Sandy River into the Columbia are modified by diversions from the City of Portland municipal water supply reservoirs on the Bull Run River, and to a smaller extent by PGE's Bull Run Hydroelectric Project.

At Marmot dam, up to 600 cfs of water can be diverted from the Sandy River to Roslyn Lake; thus, reducing flows in the mainstem of the Sandy River below the dam. Beginning in 1976, PGE began following the current minimum flows, which are required by the current license: 200 cfs-June 16 through October 15; 400 cfs-October 16 through October 31; and 460 cfs-November 1 through June 15. Annual and monthly 10 percent, 25 percent, median, 75 percent, 90 percent and mean flows were calculated for the USGS streamflow gage at Sandy River located 0.3 mile above Marmot dam (USGS gage No. 14137000) for the period WY 1911-97 (table 7).

The Little Sandy diversion dam diverts all flow up to 800 cfs from the Little Sandy River to Roslyn Lake. Shown in table 8 are annual and monthly 10 percent, 25 percent, median, 75 percent, 90 percent and mean flows for the USGS streamflow gage on the Little Sandy River located 0.25 mile above the diversion dam (USGS gage No. 14141500) for the period WY 1911-13; 1919-97. There is no minimum flow release in the 1.7-mile bypass reach below the diversion dam. Monthly median flows at the mouth of the Little Sandy (just above the Bull Run confluence) range from 2 to 14 cfs (Andrus 1998).

**Table 7. Discharges for Various Exceedance Probabilities for the Sandy River (USGS Gage No. 14137000) Above Marmot Dam Period of Record: Water Year 1911-97.
Drainage Area = 216 square miles**

Sandy River Above Marmot Dam						
	10%	25%	Median	75%	90%	Mean
January	3960	2360	1400	922	690	2023
February	3640	2130	1370	950	720	1891
March	2726	1940	1380	1040	867	1657
April	2810	2250	1740	1330	1030	1890
May	2816	2250	1680	1240	945	1804
June	1970	1450	1010	782	633	1220
July	928	728	585	493	421	644
August	562	475	408	361	316	428
September	571	437	360	313	283	417
October	1295	732	403	313	266	656
November	3470	1930	1050	587	360	1616
December	4110	2312	1420	949	626	2087
Annual	2630	1710	994	510	352	1355

**Table 8. Discharges (cfs) for Various Exceedance Probabilities for the Little Sandy River (USGS Gage No. 14141500) Period of Record: Water Year 1911-13; 1919-97.
Drainage Area = 22.3 square miles**

Little Sandy River Above Little Sandy Diversion Dam						
	10%	25%	Median	75%	90%	Mean
January	500	274	152	94	66	238
February	420	245	146	95	68	211
March	330	220	150	103	77	187
April	306	231	178	130	93	196
May	278	210	147	96	64	163
June	193	126	75	48	35	101
July	66	44	31	24	20	39
August	34	24	19	16	13	23
September	81	37	20	15	12	39
October	207	100	43	22	15	87
November	472	264	132	68	36	212
December	508	278	160	101	65	243
Annual	304	185	97	36	18	144

Flow in the Bull Run River is regulated by Bull Run reservoirs Nos. 1 and 2, which are owned by the City of Portland and operated for municipal water supply. Most of the water stored in the reservoirs is diverted out of the basin for this purpose. Shown in table 9 are annual and monthly 10 percent, 25 percent, median, 75 percent, 90 percent and mean flows for the USGS streamflow gage on the Bull Run River located 1.8 miles downstream of the City of Portland's Bull Run reservoir No. 2 (USGS gage No. 14140000) for the period WY 1959-97.

Table 9. Discharges (cfs) for Various Exceedance Probabilities for the Bull Run River (USGS Gage No. 14140000) Period of Record: Water Year 1959-97. Drainage Area = 107 square miles

Bull Run River Below Bull Run Reservoir No. 2						
	10%	25%	Median	75%	90%	Mean
January	2684	1370	629	214	40	1124
February	2176	1190	611	216	59	611
March	1572	986	538	228	55	538
April	1500	1020	657	375	150	657
May	1230	832	445	172	15	551
June	722	372	106	13	7	270
July	198	25	8	6	4	65
August	20	8	5	4	3	18
September	23	9	5	3	2	34
October	573	50	7	4	3	191
November	2240	1250	520	37	5	893
December	2722	1405	690	293	79	1159
Annual	1450	745	211	9	4	564

Flow in the lower Bull Run River and lower Sandy River is regulated by PGE powerhouse operations at the Bull Run Hydroelectric Project. With a maximum generation capacity of 900 cfs, operation of the Bull Run powerhouse substantially increases flows in the lower Bull Run River. Shown in table 10 are annual and monthly 10 percent, 25 percent, median, 75 percent, 90 percent and mean flows for the USGS streamflow gage on the Sandy River located 0.1 mile downstream of the Bull Run River confluence (USGS gage No. 14142500) for the period WY 1910-14; 1929-66; and 1984-97.

Large floods in the basin tend to occur as a result of rain-on-snow events during the winter. Two such events in the past 40 years have contributed to maximum flow events in the vicinity of the project. The maximum daily flow recorded for the Sandy River occurred on December 22, 1964. Flows of 61,400 cfs were recorded just above Marmot dam, compared to the annual mean of 1,355 cfs, and 84,400 cfs recorded just below the Bull Run River, compared to the annual mean of 2,311 cfs. The maximum daily discharge event for the Little Sandy River was 5,320 cfs on November 20, 1921, compared to the annual average of 144 cfs. The different timing of the maximum event in the Little Sandy River reflects its lower elevation and relative lack of snow. In February 1996, record rainfall on an unusually heavy snow pack resulted in severe flooding throughout much of western Oregon. The recurrence interval for the resulting flood in the Sandy River at Marmot dam was 100 years. Table 11 provides specific information about the Bull Run Hydroelectric Project impoundments

Table 10. Discharges for Various Exceedance Probabilities for the Sandy River (USGS Gage No. 14142500) Below the Confluence of the Bull Run River Period of Record: Water Year 1910-14; 1929-66; and 1984-97.
Drainage Area = 436 square miles

Sandy River Below the Confluence of the Bull Run River						
	10%	25%	Median	75%	90%	Mean
January	6940	4200	2480	1580	1132	3501
February	6576	3810	2320	1610	1200	3354
March	5284	3700	2530	1740	1370	3041
April	4570	3580	2640	1837	1240	2825
May	5040	4010	3100	2320	1730	3398
June	3210	2220	1420	1000	757	1804
July	1267	941	714	575	461	816
August	688	575	482	406	342	499
September	810	600	443	353	299	543
October	2688	1290	586	375	293	1176
November	7260	4120	2080	1060	514	3204
December	7500	4210	2440	1610	1080	3756
Annual	4740	3000	1620	671	419	2311

Table 11. Bull Run Project Impoundment Data.

Item/Impoundment	Above Marmot	Above Little Sandy	Roslyn Lake
Normal Maximum Water Surface Area	18 acres	3 acres	160 acres
Normal Maximum Water Surface Elevation	742 feet [PGE datum]	710 feet [PGE datum]	655.0 feet [PGE datum]
Gross Storage Capacity	None	None	2,000 acre-feet
Usable Storage Capacity	None	None	928 acre-feet

Water rights and use: Irrigation withdrawals occur along the Sandy River downstream from the City of Sandy. An estimated 3,000-acres in the basin are irrigated, requiring approximately 6,900 acre-feet of water annually. The City of Sandy obtains its municipal water from Brownwell Springs and Alder Creek in the upper Sandy River watershed. Also, the City of Sandy has a water right permit for 25 cfs on the upper Salmon River.

The Bull Run watershed has been the main source of water for Portland and the surrounding communities since 1895. Over the years, the City has constructed two reservoirs and dammed the outlet of Bull Run Lake to provide storage to meet the demands of a growing population of approximately 750,000 people. Current useable storage capacity in the Bull Run watershed is approximately 10.2 billion gallons (RWSP 1996). PGE diverts up to 800 cfs from the Little Sandy and Sandy Rivers through Roslyn Lake to the Bull Run River to generate power at the 22-MW Bull Run Hydroelectric

Project. Both PGE (1992) and the City of Portland (1992) have filed surface water registration claims on the Little Sandy River based on pre-1909 water appropriation.

Groundwater flow and water well withdrawals: Leakage from the 160-acre Roslyn Lake, which has been estimated at 5 to 7 cfs, contributes to the local near-surface groundwater regime (Cornforth Consultants 1999b). A portion of the Roslyn Lake leakage is likely transmitted as groundwater flow in the Quaternary-age terrace deposits and the upper layers of the Troutdale formation, which lie directly beneath Roslyn Lake. In addition, a drainage ditch, located on the west side of Roslyn Lake, collects seepage from the lake and feeds several ponds located to the north of the lake. Flow in the ditch accounts for approximately 10-40 percent of the total leakage from Roslyn Lake. Several domestic water wells have been constructed near Roslyn Lake since 1967. Completion depths typically range from 40 to 250 feet, with some as shallow as 28 feet and as deep as 860 feet. Well yields most commonly range from 7 to 25 gallons per minute.

Water Quality

Water quality standards applicable to the Sandy River Basin are found in Oregon Administrative Rules (OAR) 340-41-0485. These water quality standards are designed to protect the designated Beneficial Uses for the Sandy River Basin as outlined in table 12. River impoundment, flow diversion, and powerhouse discharges can all potentially affect water quality characteristics within a riverine system, with the potential to threaten some or all of the designated Beneficial Uses. Of particular concern, is the sensitivity of rivers and streams designated for salmonid spawning and rearing habitat. Temperature, dissolved oxygen, turbidity, total dissolved solids, pH, and bacterial and toxic pollution

have all been identified as parameters of concern for protecting the designated beneficial uses of the Sandy River Basin.

Historic water quality monitoring data indicate that, with the exception of temperature, water quality falls within the limits of the standards set out in the Oregon Administrative Rules (PGE 1998b). The ODEQ has listed two stream segments in the Sandy River Basin as water quality limited, including them in the 1998 Draft 303(d) list (ODEQ 1998). The Bull Run River exceeded the temperature standard applied to waters designated as salmonid rearing from its mouth to the City of Portland's Bull Run reservoir No. 2. The Sandy River exceeded the temperature standard for salmonid rearing from its mouth up to Marmot dam.

Table 12. Beneficial Uses Designated in OAR 340-41-482 for the Sandy River Basin.

Beneficial Use	Sandy River	Bull Run River and all Tributaries	All Other Tributaries to the Sandy River
Public domestic water supply	X	X	X
Private domestic water supply	X		X
Industrial water supply	X		X
Irrigation	X		X
Livestock watering	X		X
Anadromous fish passage	X	X	X
Salmonid fish rearing	X	X	X
Salmonid fish spawning	X	X	
Resident fish/aquatic life	X	X	X
Wildlife and hunting	X		X
Fishing	X		X
Boating	X		X
Water contact recreation	X		X
Aesthetic recreation	X	X	X
Hydropower	X	X	X

Historically, the Sandy River exhibits higher turbidity levels than many streams in the region due to the influence of glacial runoff. Especially during the summer months, glacial melt water can contribute significantly to the suspended sediment load of Sandy River. These elevated turbidity levels do not, however, impinge upon OAR water quality standards as they reflect natural conditions. OAR standards indicate that “no more than a ten percent cumulative increase in natural stream turbidities shall be allowed....” (OAR 340-41-0485). The diversion of Sandy River water at the Marmot dam and into the Bull Run River may introduce higher than normal levels of turbidity from the Bull Run powerhouse to the mouth of the Bull Run under existing conditions.

Although historic conditions indicate that water temperature in the Sandy River Basin is problematic, and natural levels of turbidity within the Sandy River are high, overall, the USFS (1993) has defined water quality in the basin as “outstandingly remarkable” and several segments of the Sandy River and its tributaries have been designated as ‘Wild and Scenic Rivers’.

In order to assess present water quality conditions, samples were collected during the months of May and August, 1999, according to the Oregon Plan for Salmon and Watersheds Water Quality Monitoring Guide Book and protocols in EPA 40 CFR 136. The May sampling was chosen to reflect snowmelt conditions, while the August sampling was chosen to reflect low flow, high temperature conditions. The May and August water quality data collection was performed every 10 hours during a 72 hour period. Sampling sites were selected on the Sandy, Little Sandy and Bull Run Rivers, and were situated in the vicinity of the project. Additional sites were within Roslyn Lake and in the flume just

prior to entering Roslyn Lake for a total of 16 sites. Table 13 includes site descriptions, identification codes, and approximate river mile location. Water temperature data were collected as described in table 13 below.

Water temperature: The Sandy River Basin experiences flow diversions from both the Little Sandy and Sandy Rivers. Flows are diverted into Roslyn Lake and discharged into the Bull Run River at the powerhouse. Flow diversion can be expected to increase water temperature in the downstream reaches experiencing reduced flow. Impoundment of water may result in warming, while hypolimnetic releases may contribute cooler than normal water when released to streams. Powerhouse discharges may increase or decrease downstream water temperature.

A seven-day moving mean of daily maximum (SDMMDM) temperature was calculated for water temperatures collected every 30 minutes from late June through early October, 1999, at a total of 9 sites in the Sandy River Basin. The SDMMDM smoothes out some of the fluctuations in the temperature profile and provides a picture of the average temperature affecting fish over a longer period of time. The SDMMDM is the basis of the ODEQ water quality standard for stream temperature. Of the nine sites sampled, all, with the exception of the two upstream sites (SR01 and SR02) on the Sandy River, exceeded the ODEQ stream temperature standard for salmonid rearing of 64°F at some point during the sampling period.¹⁵

Daily fluctuations (difference between daily maximum and daily minimum temperatures at a site) in water temperature were calculated and are summarized in table 14. In general, daily temperature fluctuations were larger within the Sandy River than within the Little Sandy or Bull Run Rivers (although data for only a single upstream site is available for the Little Sandy). The mean daily temperature fluctuation across all months and all sites for the Sandy River averaged 5.7°F and ranged from a low of 3.1°F at site SR02 in August to a high of 8.3°F in September at site SR03. A maximum daily temperature fluctuation of 11.7°F was recorded in August at site SR04. This compares with the Bull Run River that averaged a mean daily temperature fluctuation across all sites and months of 2.9°F and ranged between a low of 2.4°F at site BR03 in August and September to a high of 3.8°F at site BR02 in August. A maximum daily temperature fluctuation of 7.5°F was recorded in August at site BR03. Mean daily temperature

¹⁵ Graphs of the SDMMDM for each site can be found in PGE 2002e, figures 5.2.2-2 through 5.2.2-10.

Table 13. Sampling Site Description, Approximate River Mile Location and Sampling Site Identification Codes for the 16 Sites Included in the Water Quality Study.

Site Description	Site ID	River Mile (approximate)	Sampling Dates	Sampling Interval
Sandy River above Marmot Dam	SR01	30	June to October	30 min.
Sandy River at Revenue Bridge	SR02	23.9	June to October	30 min.
Sandy River above Bull Run River	SR03	18.4	June to October	30 min.
Sandy River below Bull Run River	SR04	18.3	June to October	30 min.
Sandy River at Dabney Park	SR05	6	May 11,12,13 Aug 18,19,20	Once per day
Little Sandy River above Tunnel from Sandy River	LS01	1.7	June to October	30 min.
Little Sandy River below Tunnel from Sandy River	LS02	1.8	May 11,12,13 Aug 18,19,20	10 Hours
Flume just prior to Roslyn Lake	LS03 ^a	n/a	June to October	30 min
Little Sandy River at the mouth	LS04	0	May 11 to 14	Hourly
Roslyn Lake, shallow west side	RL01	n/a	May 12 Aug. 18	Once
Roslyn Lake, east side in channel	RL02	n/a	May 12 Aug. 18	Once
Roslyn Lake near outlet	RL03	n/a	May 12 Aug. 18	Once
Tailrace of Bull Run Powerhouse	TR01	1.5	June to October	30 min.
Bull Run River above Little Sandy	BR01	4.6	May 11 to 14 Aug. 17 to 20	Hourly
Bull Run River above Bull Run Powerhouse	BR02 ^b	1.7	Aug. 14 to Oct. 6	30 min.
Bull Run River upstream of the mouth	BR03 ^c	0	June to October	30 min.

a - Water temperature data collected between early July and early August and again in mid September were not valid as they reflect measurement of air temperatures during low flow periods

b - Due to vandalism, data collected at site BR02 is limited to a period from August 14 to October 6, 1999. Data recorded on August 16, 17 and 19 reflects measurement of air temperatures during low flow periods.

c - Water temperature data collected at site BR03 between late July and early August and again in mid September were not valid as they reflect measurement of air temperatures during low flow periods.

n/a - not applicable

fluctuations were small within the tailrace of the Bull Run powerhouse and were 2.1 °F, 1.5 °F and 1.6 °F for the months of July, August and September. No significant trend in mean daily temperature fluctuations was noted between sites above and below Marmot dam. For the months of July, August and September, mean daily temperature fluctuations were smaller at site SR02, below Marmot dam, than at site SR01, above Marmot dam. Mean daily temperature fluctuations at site SR03 averaged 6.37 °F from July to September compared with 6.43 °F at site SR01. Although the average across these 3 months was similar between these two sites, the mean daily temperature fluctuation increased from July to September at site SR03 while it decreased at site SR01.

Table 14. Monthly Mean, Maximum, Minimum and Standard Deviations of Daily Temperature (°F) Fluctuations for the Months of July, August, and September, 1999, recorded for Nine Instream Sites in the Sandy River Basin.

Site	Month	Mean Daily Temperature Fluctuation	Max. Daily Temperature Fluctuation	Min. Daily Temperature Fluctuation	Standard Deviation
SR01	July	7.7	11.5	1.9	2.5
	August	6.5	9.3	1.7	1.9
	September	5.1	7.5	2.2	1.3
SR02	July	4.0	7.5	1.4	1.6
	August	3.1	4.8	1.1	1.0
	September	3.6	5.8	1.9	0.9
SR03	July	3.9	6.4	0.8	1.3
	August	6.9	11.6	1.9	2.8
	September	8.3	11.4	3.9	2.1
SR04	July*	5.2	7.4	2.2	1.4
	August	7.2	11.7	2.2	2.9
	September	7.2	10.4	3.1	2.2
LS01	July	5.8	8.7	1.7	2.4
	August	5.2	7.9	1.1	1.9
	September	4.5	6.4	2.2	1.3
LS03	July	4.4	8.1	2.5	2.6
	August	5.6	8.5	1.7	1.7
	September	5.6	9.5	2.8	2.1
BR02	July**	NA	NA	NA	NA
	August**	3.8	6.8	1.4	1.4
	September	2.7	4.8	1.4	0.9
BR03	July	3.1	5.5	1.1	1.4
	August	2.4	7.5	0.9	1.5
	September	2.4	6.2	1.1	0.9
TR01	July	2.1	7.2	0.6	1.4
	August	1.5	4.8	0.3	0.9
	September	1.6	5.1	0.6	0.9

* - Includes data beginning on July 10, 1999.

** - July data were not collected and August data begins Aug. 14, 1999 due to theft of original data recorder.

Flow diversion at the Marmot dam may be expected to affect downstream water temperature by reducing in-stream flow on the Sandy River. The Sandy River from its mouth to the Marmot dam has been identified by the ODEQ 303(d) program as 'Water Quality Limited' due to elevated summer water temperature (ODEQ 1998). This listing is based on ODEQ temperature data from the lower Sandy River (RM 3.1) for 1986-1995, which indicated that 12 of 34 summer water temperature measurements exceeded the ODEQ standard for rearing salmonids of 64 °F. No violations of the ODEQ water temperature standard for rearing salmonids occurred between July 6 and October 6, 1999, either above Marmot dam (site SR01: RM 30) or below Marmot dam at site SR02 (RM 23.9). In addition,

despite reductions in flow below Marmot dam, the downstream change in temperature between these two sites was modest. The monthly average downstream increase in water temperature between sites SR01 and SR02 was -0.1°F in July, 0.4°F in August and 1.1°F in September. This translates to a rate of change of -0.02°F per mile in July, 0.07°F per mile in August, and 0.2°F per mile in September. Water temperatures exceeded the ODEQ water temperature standard for rearing salmonids on 15 days at site SR03 (RM 18.4) between July 6 and October 4, 1999. The monthly average downstream increase in water temperature between sites SR01 and SR03 was 0.2°F in July, 3.6°F in August and 4.7°F in September. This translates to a rate of change of 0.02°F per mile in July, 0.3°F per mile in August, and 0.4°F per mile in September.

The Little Sandy diversion dam diverts all flow up to 800 cfs from the Little Sandy River to Roslyn Lake. There is no minimum flow release in the 1.7 mile reach below the diversion dam and monthly median flows at the mouth of the Little Sandy range between 2 and 14 cfs (Andrus 1998). The SDMMDM temperature calculated for water temperatures above the Little Sandy diversion dam indicate that from July 6 through October 6, 1999, only a single value exceeded the ODEQ water temperature standard and this value was recorded on August 4, 1999.

Limited data exist for either a comparison of in-stream temperatures above and below the Little Sandy diversion dam, or above and below the tunnel which delivers diverted water from the Sandy to the Little Sandy River. Hourly temperature data collected across a 72 hour period between May 11 and May 13, 1999, shows an average downstream increase of 2.5°F between sites LS01 and LS04 during this period. Data collected at site LS02 includes six water temperature readings between August 17 and August 20, 1999. A comparison of these readings with those collected at site LS01 show an average increase in water temperature of less than 1°F suggesting only modest impacts of the diverted waters from the Sandy River on the Little Sandy River. This conclusion is supported with a comparison of the SDMMDM temperatures from above Marmot dam (SR01) with those from above the Little Sandy River dam (LS01). The average temperature difference between these two sites from late June through early October was only 0.9°F , with a maximum difference of only 2.5°F .

Sites BR01 and BR02 are situated on the Bull Run River immediately above and immediately below the confluence with the Little Sandy River. A comparison of water temperatures at these two sites measured hourly from August 18 through August 20, 1999, reveals a significant difference in mean water temperature. Temperatures averaged 60.5°F above the confluence with the Little Sandy and 68.0°F below the confluence. This difference in mean water temperatures suggest that the Little Sandy River has a significant warming influence on the Bull Run from the confluence with the Little Sandy (RM 4.1) to the Bull Run powerhouse. Water temperatures at site LS01 averaged 59.4°F during the

period from August 18 to August 20, suggesting that in-stream temperatures rose significantly below the Little Sandy diversion dam prior to entering the Bull Run River.

Water temperatures recorded between August 17 and 20 at the mouth of the flume just prior to entering Roslyn Lake (site LS03) indicated a moderate increase compared with temperatures recorded behind Little Sandy diversion dam (site LS02) for the same period. Temperatures increased from 59.6 °F at site LS02 to 62.7 °F at site LS03. This increase reflects a change in temperature of approximately 1.1 °F per mile.

Flow diverted from both the Marmot dam and the Little Sandy diversion dam is collected within Roslyn Lake and discharged through the Bull Run powerhouse into the Bull Run River at RM 1.5. Water temperature in the lower Bull Run River, below the powerhouse, and in the Sandy River, below the confluence with the Bull Run, may be affected by powerhouse discharges. The Bull Run River from its mouth to the City of Portland's reservoir No. 2 is identified by the ODEQ 303(d) program as 'Water Quality Limited' due to elevated summer water temperature (ODEQ 1998).

Water temperature measurements were recorded in the tailrace of the Bull Run powerhouse between July 8 and October 6, 1999. SDMMMDM temperatures were within the ODEQ standard for salmonid rearing on all but four days in August. A maximum SDMMMDM temperature of 64.5 °F was reached on August 6, 1999. Water temperatures measured between August 18 and August 20 at site BR01 on the Bull Run River, above the confluence with the Little Sandy River, were only moderately cooler than water temperatures in the tailrace. Temperatures averaged 61.7 °F in the tailrace compared with an average of 60.5 °F at site BR01. During the 72 hour sampling period, a maximum temperature of 66.8 °F was recorded at site BR01 on August 19.

The average daily maximum temperature for July 2 through October 6 differs very little between site BR03 and site TR01. Site BR03 had a daily maximum average of 59.9 °F compared with 59.6 °F at site TR01. With the SDMMMDM temperatures recalculated for site BR03 - minus the twelve extreme values - site BR03 exceeded the ODEQ standard of 64 °F on 4 days in early August.

The ODFW (1997a) has stated concerns that warmer water entering from the mainstem Sandy River may act as a thermal barrier that may cause upstream migrating salmonids to be attracted into the cooler water of the Bull Run River. The average SDMMMDM temperature from July 8 through October 6 at site SR03 was 61.8 °F compared with 60.5 °F at site BR03. The most pronounced difference in SDMMMDM temperatures between site SR03 and BR03 occurred between August 19 to August 31 where the temperature was an average of 4.1 °F higher at site SR03.

Roslyn Lake did not exhibit a temperature profile that would suggest it is a thermally stratified lake. In May, water temperatures decreased little with depth, going from 44.8^o F at the surface to 44.4 °F near the bottom (16 feet). Although a more significant decrease in temperature with depth was noted in August, no distinct thermocline was found. Temperatures decreased from 66.6^o F at the surface to 58.3 °F near the bottom. Surface water temperatures within Roslyn Lake on August 19 were an average 6.0 °F and 6.1 °F warmer than behind Marmot dam or Little Sandy diversion dam respectively. At the depth from which the penstocks withdraw water from Roslyn Lake, however, water temperatures were moderately cooler than those from behind Marmot and Little Sandy diversion dams, with an average decrease of 1.6 °F and 1.5 °F, respectively.

Other water quality: In general, the water quality indicators¹⁶ reflect good water quality conditions. In both May and August, and across all sites, biological oxygen demand (BOD) was low and frequently below the method detection limit of 2.0 mg/l. The highest measured value for BOD was recorded in May on the Sandy River above Marmot dam and was 2.7 mg/l. In addition to low BOD levels, measured levels of both dissolved organic carbon (DOC) and total organic carbon (TOC) do not suggest that high levels of organic matter are present in the Sandy River Basin waters.

Alkalinity was highest in Sandy River, and overall, values were higher in August than in May. Alkalinity ranged from a low of 8.0 mg/l in the Bull Run and Little Sandy Rivers in May to a high of 24 mg/l in the Sandy River in August. System wide, alkalinity averaged 14 mg/l and is indicative of a system only moderately sensitive to potential acid inputs. Across all sites, at no time did the measured values for pH fall outside the ODEQ water quality standard range of 6.5 to 8.5. Minimum and maximum recorded values were 7.1 and 8.1 respectively.

Throughout the basin, nutrient levels (phosphorus and nitrogen species) were typically low during the measured period in May. Ammonia, ortho-phosphate (PO₄), and total phosphorus were consistently below method detection limits (0.05, 0.01 and 0.01 mg/l respectively). Total Kjeldahl nitrogen, as well as the combined concentrations of nitrate and nitrite ions were well within acceptable levels to support the designated beneficial uses for the Sandy River Basin. The August nutrient data showed significant increases in nutrient concentrations with respect to ortho-phosphate (PO₄), and total phosphorus, and to a lesser extent the nitrogen compounds. This increase is most pronounced on the Bull Run and Sandy Rivers where total phosphorus levels averaged 0.04 mg/l on both rivers, and reached a

¹⁶ For detailed water quality data, see table A-1 through A-14 of the draft environmental assessment (PGE 2002e).

maximum of 0.11 mg/l at site SR04 and 0.12 mg/l at site BR03. These levels are indicative of a mesotrophic to eutrophic system. The planktonic chlorophyll a measurements for the month of August do not reflect a nutrient rich system. In general, sites at higher elevations have lower chlorophyll a concentrations and reflect oligotrophic conditions. Sites lower in the basin reflect mesotrophic conditions. Periphyton chlorophyll a concentrations, however, were not measured. In August, Roslyn Lake exhibited total phosphorus concentrations typical of eutrophic waterbodies (mean TP = 0.05 mg/l), yet, the August chlorophyll a concentrations reflect a low mesotrophic waterbody (mean chlorophyll a = 3.6 ug/l). Although a rigorous analysis is not possible given the number of measurements below the method detection limit, it is possible that nitrogen and not phosphorus is the limiting nutrient in this system. In general, total nitrogen levels (estimated as TKN + NO₂ + NO₃) appear to be in short supply relative to total phosphorus.

Turbidity levels were measured over a 72 hour period in mid May and again in mid August. Across the 15 sites sampled, mean turbidity levels ranged from 0.5 NTU to 1.6 NTU in May and 0.4 NTU to 17.5 NTU in August. In general, levels measured in August were significantly higher than those measured in May. This trend did not hold true at all sites, however, and may reflect the influence of summertime glacial melt water contributing to the turbidity of Sandy River, and to those sites influenced by water diverted from the Sandy River. For example, sites BR01 and BR02 exhibited little difference in mean turbidity levels between the May and August sampling.

Site BR01 is not influenced by project waters diverted from the Sandy River. Site BR02 is below the confluence with the Little Sandy, but the data did not show any increase in turbidity levels suggesting that contributions of turbidity from the Little Sandy are minimal. Site BR03, however, exhibited a significant increase in turbidity from May to August, with mean turbidity levels rising from 0.8 NTU to 5.1 NTU. This increase at site BR03, may reflect the inputs of the discharge waters from the Bull Run powerhouse (site TR01) which, in part, are contributed by diversion water from the Sandy River through Roslyn Lake. Site TR01 saw an increase in turbidity from May to August from 0.9 NTU to 6.2 NTU. Sites LS01 and LS02 are situated in close proximity to one another. Site LS01 is immediately above the tunnel which empties diverted water from the Sandy River into the Little Sandy River and site LS02 is immediately below the tunnel and reflects the inputs from the Sandy River. The mean August turbidity level at site LS02 was 9.1 NTU compared with only 0.7 NTU at site LS01. This result indicates that the water diverted from the Sandy River to the Little Sandy resulted in a 13 fold increase in turbidity levels. This increase violates the ODEQ standard of greater than a 10 percent increase above natural levels. A comparison of sites above and below Marmot dam indicate that the dam acts to reduce downstream turbidity levels within the Sandy River. In August, turbidity levels were 10.3 NTU at site SR01 behind Marmot dam and 7.6 and 6.3 at sites SR02 and SR03 below Marmot dam.

Roslyn Lake showed significant increases from May to August with as much as a 17 fold increase recorded at site RL02. Increased turbidity levels within Roslyn Lake and the powerhouse tailrace may, in part, reflect production of planktonic algae within Roslyn Lake and discharged through the Roslyn Lake penstock. The 1.7-mile-long stretch of the Bull Run River from the powerhouse to the confluence with the Sandy River may reflect artificially elevated turbidity due to diversion from the Sandy River. The values recorded at site BR03 indicate that an increase of greater than 10 percent of natural levels (the ODEQ water quality standard) may have occurred between May and August at this site. This conclusion is based on the fact that turbidity levels at sites BR01 and BR02 - both above the Bull Run powerhouse discharge - are not influenced by Sandy River inputs and their turbidity levels decreased from May to August.

The ODEQ water quality standard for dissolved oxygen for "waterbodies identified by the Department as providing salmonid spawning, during the periods from spawning until fry emergence from the gravels" shall not be less than 11.0 mg/l. For waterbodies identified by the Department as "providing cold-water aquatic life, the dissolved oxygen shall not be less than 8.0 mg/l as an absolute minimum." During the May (11th and 14th) sampling, the in-stream dissolved oxygen levels measured at 15 sites in the Sandy River Basin ranged from 9.1 mg/l to 12.4 mg/l. None of the sites fell below the 8.0 mg/l standard, while three sites, BR01, BR03, and SR05, were below the 11.0 mg/l standard. While steelhead spawning does occur during this time, spawning is not likely to occur within the lower reaches of the Sandy (site SR05) and is limited within the Bull Run. In August, values ranged from 8.6 mg/l to 10.6 mg/l. Again, no sites fell below the 8.0 mg/l ODEQ standard, while all were below the 11.0 mg/l standard. During this period, fall chinook spawning is restricted to the lower reaches of the Sandy River and most would spawn later than the mid-August sampling period. Roslyn Lake waters appear well oxygenated and do not exhibit significant oxygen depletion with depth. This is likely a consequence of the lake not exhibiting a distinct thermocline and remaining well mixed throughout the summer. Dissolved oxygen levels measured within the bottom waters of Roslyn Lake (approximately 5 meters) were 8.4 mg/l in May and 10.9 mg/l in August. The only significant trend with respect to project structures/operations and dissolved oxygen was observed at site SR01. Site SR01 recorded the lowest DO levels of all sites measured in August with a mean DO of 8.6 mg/l compared with a mean of 9.6 mg/l for sites downstream on the Sandy River.

A chemical analysis of the sediments trapped behind Marmot and Little Sandy diversions was completed to determine metals and toxics concentrations (Squier Associates 2000). The sampling was completed in accordance with the Corps' *Dredged Material Evaluation Framework Guidelines Manual*. Maximum detected concentrations for each chemical parameter sampled at Marmot and Little Sandy diversions were well below the Corps' screening levels.

5.3.2.2 Effects of Alternatives

Removal of Marmot Dam

Alternative 1 (PGE's Proposal)--Single Season Dam Removal with Minimal Sediment Removal

Water Quantity

The removal of Marmot dam, as part of the Proposed Action, would restore natural flows to approximately 10 miles of the Sandy River between Marmot dam and the confluence of the Bull Run River. Shown in table 15 is a comparison of estimated annual and monthly median and 90 percent exceedance flows (i.e., median and relatively dry hydrologic

Table 15. Comparison of Annual and Monthly Median and 90% Exceedance Flows (cfs) at Marmot Dam on the Sandy River under the No-action and Proposed Action Alternatives.

Month	Annual and Monthly Median and 90% Exceedance Flows (cfs) at Marmot Dam on the Sandy River			
	No-action Alternative		Proposed Action Alternative	
	Median Flow	90% Exceedance Flow	Median Flow	90% Exceedance Flow
January	750	460	1370	690
February	840	460	1480	720
March	800	460	1430	867
April	1060	460	1610	1030
May	830	460	1390	945
June	460	200	936	633
July	200	200	557	421
August	200	200	394	316
September	200	200	336	283
October	241	200	334	266
November	550	344	1240	360
December	880	460	1420	626
Annual	460	200	992	352

conditions) in the Sandy River at Marmot dam under the No-action and Proposed Action Alternatives.

For the no-action alternative, flow at Marmot dam was estimated by accounting for all the water from the Little Sandy River (up to 800 cfs) and then diverting up to 600 cfs of the available Sandy River flow (while still meeting minimum flow requirements) to total a diversion flow of 800 cfs to Roslyn Lake. Under the Proposed Action Alternative, flows in this reach were estimated using the USGS streamflow gage at Sandy River located 0.3 mile above Marmot dam (USGS gage No. 14137000). The period of record for these analyses was WY 1976-97, which is coincident with the implementation of

PGE's current minimum flow schedule below Marmot dam.

Median flows would increase from a range of 200 cfs (July-September) to 1060 cfs (April) under the no-action alternative to a range of 334 cfs (October) to 1610 cfs (April) under the Proposed Action Alternative. Under relatively dry hydrologic conditions (90 percent flow exceedance), flows would increase from a range of 200 cfs (June-October) to 460 cfs (December-May) under the no-action alternative to a range of 266 cfs (October) to 1,030 cfs (April) under the Proposed Action Alternative.

The gross storage capacity in the Marmot dam impoundment is negligible; dam removal, therefore, is expected to have no effect on downstream flooding.

PGE's Sandy and Little Sandy River water rights would be returned to instream use no later than 5 years after project removal, subject to the terms of the Instream Conversion Agreement.

Water Quality

It is anticipated that this action would have long-term benefits for water quality within this river reach. Table 15 shows the anticipated increase in flow rates below Marmot dam following its removal. With increased flows, and concomitant increase in water depth and decrease in time of exposure to sunlight, it is anticipated that water temperatures would be reduced within the Sandy River. In addition, the increased flows may also reduce the magnitude of daily fluctuations in temperature as larger volumes of water are more resistant to daily fluctuations in air temperature. Coincident with the decrease in water temperatures, it is anticipated that levels of dissolved oxygen would increase. The capacity of water to hold dissolved oxygen is related, in part, to water temperature. As instream water temperatures decrease, the solubility of oxygen increases. Further, fast moving water dissolves more oxygen than still water, as the churning motion mixes the air into the water.

It can be expected that high suspended sediments loads would occur during dam removal and the limited dredging under this alternative. Because this alternative requires less dredging than Alternatives 2 and 3, the impacts associated with dredging would likely be lower for this alternative than for Alternatives 2 and 3. It is anticipated that the impacts would be short in duration and largely restricted to the period during decommissioning.

Chemical sampling data indicates that the sediments impounded by Marmot dam do not contain levels of contaminants that would adversely impact the environment.

(Squier Associates 2000). All identified compounds of concern are below the current Corps' screening levels.

Alternative 2--Removal of Top of Dam in Year 1, Complete Dam Removal in Year 2 with Sand Layer Excavation

Water Quantity

Anticipated impacts from project decommissioning for Alternative 2 are the same as Alternative 1.

Water Quality

Long-term impacts associated with alternative would be the same as Alternative 1. This alternative would prolong the duration of increased sediment loads within the reach below Marmot dam. This approach may, however, reduce the degree to which the streambed below Marmot dam is impacted by deposited sediments. Modeled TSS concentrations are discussed in Section 5.3.1.2.

Alternative 3--Remove the Maximum Amount of Sediment Possible During One In-water Construction Period

Water Quantity

Anticipated impacts from project decommissioning for Alternative 3 are the same as Alternative 1.

Water Quality

Alternative 3 should have similar long and short-term impacts as Alternative 1. decommissioning. Modeled TSS concentrations were similar to Alternative 1, and are discussed in Section 5.3.1.2.

Removal of Little Sandy Diversion Dam

Water Quantity

Under the Proposed Action Alternative, the removal of the Little Sandy diversion dam would allow streamflows in the Little Sandy River to revert back to natural conditions. Current flows in the 1.7-mile Little Sandy River bypassed reach were

estimated by prorating flows measured at the USGS streamflow gage located 0.25 mile above the diversion dam (USGS gage No. 14141500, Drainage Area = 22.3 square miles) based on the incremental drainage area between the diversion dam and mouth of the Little Sandy River ($[1.64 \text{ square miles} / 22.3 \text{ square miles}] * \text{Little Sandy USGS streamflow}$).

This method for estimating natural flow in the Little Sandy River bypass reach does not account for spillage events at the dam, as these events are negligible. In general, PGE has tried to avoid spillage at Little Sandy diversion dam to prevent salmonids from being falsely attracted to dam. This effort has resulted in spillage occurring less than 1 percent of the time (PGE 1998b).

To estimate potential natural flow conditions at the mouth of the Little Sandy, USGS streamflows above the diversion dam were prorated based on the increase in incremental drainage area between the USGS gage and mouth of the Little Sandy River ($[24.13 \text{ square miles} / 22.3 \text{ square miles}] * \text{Little Sandy USGS streamflow}$).

Shown in table 16 are Little Sandy River annual and monthly median and 90 percent exceedance flows (i.e., median and relatively dry hydrologic conditions) for the No-action and Proposed Action Alternatives. Median flows would increase from a range of 1.3 cfs (August) to 12.1 cfs (April) under the no-action alternative to a range of 21 cfs (August) to 193 cfs (April) under the Proposed Action Alternative. Under relatively dry hydrologic conditions (90 percent flow exceedance), flows would increase from a range of 0.8 cfs (September) to 6.3 cfs (April) under the no-action alternative to a range of 13 cfs (August) to 101 cfs (April) under the Proposed Action Alternative.

In addition, removal of the Little Sandy diversion dam would increase flows in the Bull Run River from the mouth of the Little Sandy River (RM 2.9) downstream to the location of the Bull Run powerhouse (RM 1.5). For the No-action and Proposed Action Alternatives, flows in this section of the Bull Run were estimated by combining USGS streamflow gage data from the Bull Run River (see table 9) and estimated flows from the Little Sandy River (see table 16). Any water yield from the incremental drainage area between the Bull Run River USGS gage and the mouth of the Little Sandy River was considered to be negligible, as no appreciable tributaries enter this reach of the river.

Table 16. Comparison of Estimated Annual and Monthly Median and 90% Exceedance Flows at the mouth of the Little Sandy River under the No-action and Proposed Action Alternatives.

Month	Annual and Monthly Median and 90% Exceedance Flows (cfs) at the Mouth of the Little Sandy River			
	No-action Alternative		Proposed Action Alternative	
	Median Flow	90% Exceedance Flow	Median Flow	90% Exceedance Flow
January	11.2	4.9	165	71
February	10.7	5.0	158	74
March	11.0	5.7	162	83
April	13.1	6.8	193	101
May	10.8	4.7	159	69
June	5.5	2.6	81	38
July	2.3	1.5	34	22
August	1.4	1.0	21	14
September	1.5	0.9	22	13
October	3.2	1.1	47	16
November	9.7	2.6	143	39
December	11.8	4.8	173	70
Annual	7.1	1.3	105	19

Shown in table 17 are Bull Run River (between the mouth of the Little Sandy River and the Bull Run powerhouse) annual and monthly median and 90 percent exceedance flows (i.e., median and relatively dry hydrologic conditions) for the No-action and Proposed Action Alternatives. Median flows would increase from a range of 6 cfs (September) to 669 cfs (April) under the no-action alternative to a range of 26 cfs (August) to 850 cfs (April) under the Proposed Action Alternative. Under relatively dry hydrologic conditions (90 percent flow exceedance), flows would increase from a range of 3 cfs (September) to 156 cfs (April) under the no-action alternative to a range of 15 cfs (September) to 251 cfs (April) under the Proposed Action Alternative.

With the discontinuation of flow diversions to Roslyn Lake as a result of Little Sandy and Marmot dam removal, powerhouse generation discharges in the Bull Run River (from the Bull Run powerhouse (RM 1.5) to the confluence of the Sandy River (RM 0)) would cease; thus, resulting in a general flow reduction in this section of the Bull Run River under the Proposed Action Alternative.

Monthly median and 90 percent exceedance flows in this section of the Bull Run River were estimated for existing conditions (R2 Resource Consultants 1998b). For the Proposed Action Alternative, the following methodology was used to estimate flows in this reach of the Bull Run River.

Table 17. Comparison of Estimated Annual and Monthly Median and 90% Exceedance Flows in the Bull Run River (between the mouth of the Little Sandy River and the Bull Run Powerhouse) under the No-action and Proposed Action Alternatives.

Month	Annual and Monthly Median and 90% Exceedance Flows (cfs) in the Bull Run River (between the mouth of the Little Sandy River and the Bull Run Powerhouse)			
	No-action Alternative		Proposed Action Alternative	
	Median Flow	90% Exceedance Flow	Median Flow	90% Exceedance Flow
January	639	44	794	111
February	621	64	769	133
March	548	60	700	138
April	669	156	850	251
May	455	19	604	84
June	111	10	187	45
July	10	6	42	26
August	7	4	26	17
September	6	3	27	15
October	10	4	54	19
November	529	8	663	44
December	701	83	863	149
Annual	218	5	316	23

Three small tributaries (Devil's Backbone, Laughing Water, and Deer Creeks) enter this reach of the river. As a consequence, there was a need to estimate water yields for this incremental drainage area. The incremental drainage area (7.16 square miles) between the Bull Run River USGS gage and the confluence with the Sandy River was accounted for with flows from the Fir Creek USGS gage located upstream of the City of Portland's Bull Run reservoirs (USGS Gage No. 14138870, Period of Record 1975-97, Drainage Area = 5.46 square miles).

The Fir Creek USGS gage flows were prorated ($[7.16 \text{ square miles} / 5.46 \text{ square miles}] * \text{Fir Creek USGS streamflow}$) and combined with flows from the Bull Run River USGS streamflow gage (see table 9) and estimated flows from the Little Sandy River (see table 16) to yield the estimated streamflow for this reach.

Shown in table 18 are Bull Run River (from the Bull Run powerhouse to the confluence of the Sandy River) annual and monthly median and 90 percent exceedance flows (i.e., median and relatively dry hydrologic conditions) for the No-action and Proposed Action Alternatives. Median flows would decrease from a range of 100 cfs (October) to 1,525 cfs (April) under the no-action alternative to a range of 29 cfs (August) to 901 cfs (December) under the Proposed Action Alternative. Under relatively dry hydrologic conditions (90 percent flow exceedance), flows would range from 16 cfs (September) to 1,040 cfs (April) under the no-action alternative and 17 cfs (September) to 269 cfs (April) under the Proposed Action Alternative.

Table 18. Comparison of Estimated Annual and Monthly Median and 90% Exceedance Flows in the Bull Run River (from the Bull Run Powerhouse to the confluence of the Sandy River) under the No-action and Proposed Action Alternatives.

Month	Annual and Monthly Median and 90% Exceedance Flows (cfs) in the Bull Run River (from the Bull Run Powerhouse to the confluence of the Sandy River)			
	No-action Alternative		Proposed Action Alternative	
	Median Flow	90% Exceedance Flow	Median Flow	90% Exceedance Flow
January	1370	380	824	122
February	1390	480	804	141
March	1475	620	735	156
April	1525	1040	890	269
May	1175	500	629	99
June	800	280	202	51
July	370	180	48	29
August	200	80	29	20
September	150	16	31	17
October	100	21	59	21
November	1525	35	703	53
December	1250	440	901	162
Annual	--	--	337	27

The gross storage capacity in the Little Sandy impoundment is negligible; thus, dam removal is expected to have no effect on downstream flooding in the mainstem Sandy River.

Water Quality

The removal of the Little Sandy River dam can be expected to have significant impacts on both the 1.7-mile-long bypass reach below the dam and in the Bull Run River from the mouth of the Little Sandy to the Bull Run powerhouse. Table 16 indicates that significant increases in flow are anticipated in the Little Sandy River bypass reach following removal of the diversion dam. Water temperature and dissolved oxygen should both exhibit notable improvement because there is very little fine sediment stored behind Little Sandy diversion dam, removal of the dam is not expected to result in increased suspended sediment concentrations downstream of the dam (Also see discussion on sediment impacts/turbidity in Section 5.3.1.2).

Chemical sampling of sediments impounded by the Little Sandy diversion shows that for the compounds of concern, the reported concentrations are also all below the Corps' screening levels (Squier Associates 2000).

Removal of Canals, Tunnels, Flumes, and Ancillary Structures

Water Quantity

There are no anticipated impacts to water quantity associated with removal of canals, tunnels, flumes and ancillary structures.

Water Quality

It can be expected that construction activity performed in conjunction with the removal of the canals, tunnels, flumes, powerhouse, and ancillary structures would have short-term impacts resulting in increased in-stream turbidity levels. Impacts can be minimized through the use of siltation barriers during construction, and through stabilization of disturbed areas following construction. All work should be completed as quickly as possible to minimize the duration of exposure. The removal of these structures would restore natural flows to both the Sandy and Little Sandy Rivers. Although heating of water flowing across the flume does occur, water released from Roslyn Lake does not reflect this impact.

Project Powerhouse

Water Quantity

There are no anticipated impacts to water quantity associated with removal of the project powerhouse.

Water Quality

There are no anticipated impacts to water quality associated with removal of the project powerhouse.

Removal of Roslyn Lake

Water Quantity

Under the Proposed Action Alternative, the 160-acre Roslyn Lake impoundment would be drained and filled, resulting in the discontinuance of its use for energy generating purposes.

The gross storage capacity of Roslyn Lake is 2,000 acre-feet; however under

normal conditions the impoundment is kept near full pond and as a result provides little storage for flood events. Therefore, removal of Roslyn Lake is expected to have no effect on downstream flooding in the mainstem Sandy River.

The removal of Roslyn Lake could affect residential water wells located in the vicinity of the lake. Leakage from the lake, about 5 to 7 cfs, has contributed to local groundwater resources. Most of the wells were drilled after 1967. Cornforth Consultants (1999) evaluated 259 water well records in Clackamas County. Cornforth Consultants applied three screening criteria to judge potential effects:

- hydrologic boundaries—wells must be located within the hydrologic boundaries formed by the Sandy and Bull Run Rivers
- hydrogeology—the wells have to pump groundwater from the same aquifer that is receiving leakage from Roslyn Lake based on subsurface materials
- depth—wells located significantly deeper than the original bottom of Roslyn Lake, with some exceptions, were eliminated from the evaluation

Based on the above criteria, Cornforth Consultants concluded that removal of Roslyn Lake could potentially affect, to some degree, 58 wells¹⁷ located within approximately 1 mile of the lake (table C-1, Appendix C) by the elimination of existing leakage from the lake. Of the 58 wells, 26 wells were likely to be affected while the effects of the remaining 32 wells were uncertain based on insufficient information; some of these wells may not be affected.

The extent of the effects is unknown and would likely decrease with distance from the lake. Shallow, low-yield wells, less than 50 feet in depth and producing less than 15 gallons per minutes, that draw water from the Quaternary-age terrace gravels are likely to be impacted the greatest. Effects would likely to be seen within 2 to 4 weeks after the lake is drained (Cornforth Consultants 1999). In the very worst case, all 58 wells would go dry.

Many of the affected wells would have to be redrilled if they no longer provided adequate flows for household use. Deepening the existing wells instead of drilling new wells is also a possibility but may be more expensive and difficult based on the regulatory

¹⁷ This total does not include any hand-dug wells, new wells drilled since 1999, and wells without well logs filed with the Oregon Water Resources Department.

restrictions for improving existing wells and geologic conditions (Cornforth Consultants 2002).

Without leakage from Roslyn Lake into the near-surface Quaternary terrace deposits or the upper layers of the Troutdale formation, the new source of water would have to be from the fractured bedrock layer that underlies the lower impermeable unit of the Troutdale formation (Cornforth Consultants 2002). The depth of existing wells in this aquifer ranges between 300 and 700 feet. The deeper wells were typically located near Roslyn Lake, while the shallower wells were typically at lower elevations. If all the wells needed to be redrilled, the estimated depth of the 58 new wells is:

Section Number	Number of Wells	Average Depth per Well (feet)
36	7	700
31	12	700
1	4	700
6	8	700
12	3	700
7	12	600
5	4	500
8	8	300

The costs associated with redrilling would be based on the depth and size of the wells and the nature of the geologic materials. Cornforth Consultants (2002), based on interviews with well drillers with experience with well drilling in northeast Clackamas County, developed a preliminary estimates of the cost of redrilling all 58 wells—the worst case—as between \$1.3 and \$1.7 million, with each well costing between \$14,000 and \$31,000.¹⁸

Other options that could be considered include having water supplied by the City Portland's Water Bureau.

¹⁸ Cost estimates are based on drilling costs of between \$25 to \$33.50 per foot, new submersible pump, wiring, and piping costs of between \$5,000 and \$6,000, and costs of abandoning old wells at between \$1,500 and \$2,000 (if necessary) (Cornforth Consultants 2002).

The Bull Run Community Association recommends that the Commission require mitigation of any effects on wells. As noted above, the loss of Roslyn Lake is likely to have an adverse affect on shallow residential wells in its immediate vicinity; however, the magnitude and degree of such effects is currently unknown. Homeowners installed these wells long after Roslyn Lake was constructed and have benefitted from the increased groundwater supply and reliability that Roslyn Lake has provided over the years. The Bull Run Hydroelectric Project is operated by PGE under a 50-year FERC license with a current expiration date of November 16, 2004. As a project feature, Roslyn Lake is subject to the requirements of the project license may be modified at any time during the license period. Further, pursuant to the Commission's regulations, there is no guarantee that the project would be relicensed in the future and/or continue to operate in the same manner in the future.

Given this information, the homeowners have no reasonable expectation to believe that Roslyn Lake, exclusively a project facility, would remain in its present form and provide benefits to their wells indefinitely. PGE should not be required to compensate the homeowners for the loss of Roslyn Lake, a body of water it created for another purpose and from which the homeowners merely got a collateral benefit. We, however, recommend that PGE give homeowners sufficient advance notice of its specific plans and schedule to drain Roslyn Lake in order to give these homeowners adequate time to implement necessary measures, such as redrilling, to meet their water supply needs.

In addition, the elimination of leakage would cause a small creek and several ponds located to the north of Roslyn Lake to dewater immediately. Springs and seeps located on the west and south of the lake would probably cease to exist. In total 19 surface ponds, 4 streams, and 17 potential wetlands or springs could likely be affected, to some degree, by the complete removal of Roslyn Lake. In general, the springs, ponds, and creeks closest to the lake would likely be impacted most.

Water Quality

Currently, water released from Roslyn Lake through the Bull Run powerhouse is generally cooler than that immediately upstream of the powerhouse and is well oxygenated. Turbidity levels are higher in water from the powerhouse than upstream. Removal of Roslyn Lake, and a return of natural flows to the Little Sandy, should generally improve water quality conditions of the lower Bull Run River. Water temperatures can be expected to be lower, oxygen levels raised and turbidity lowered.

5.3.2.3 Staff Modifications of PGE's Proposal

As discussed in Section 5.3.2.2, we recommend that PGE give homeowners sufficient advance notice of its specific plans and schedule to drain Roslyn Lake in order to give these homeowners adequate time to implement necessary measures, such as redrilling, to meet their water supply needs.

5.3.2.4 Cumulative Impacts

Water Quantity and Quality

The long term impacts of the Proposed Action Alternatives would be to restore natural flows to both the Sandy and Little Sandy Rivers with a concomitant improvement in water quality. In general, both water temperature and levels of dissolved oxygen should show improvement in the Sandy, Little Sandy, and Bull Run Rivers. In addition, turbidity levels within the Little Sandy and Bull Run Rivers should be reduced once Sandy River flow is no longer diverted at Marmot dam. The Proposed Action Alternatives would allow the Sandy River Basin waters to better assimilate impacts from non-project related activities. (Also see discussion in Section 5.3.1.3.)

5.3.2.4 Unavoidable Adverse Impacts

Water Quantity

Removal of Roslyn Lake would result in unavoidable adverse impacts to water yields from wells located adjacent to the lake. Shallow, low yield wells, less than 50 feet in depth and producing less than 15 gallons per minutes, that draw water from the Quaternary-age terrace gravels are likely to be impacted the greatest. Also, removal of Roslyn Lake would result in unavoidable adverse impacts to a small creek and several ponds located to the north of Roslyn Lake, as well as springs and seeps located on the west and south of the lake.

Water Quality

Short-term unavoidable adverse impacts are a consequence of the Proposed Action Alternatives. In all cases, increased sediment loads to project waters are expected as a result of construction during decommissioning of project structures. This adverse impact can be minimized through the use of siltation barriers during construction. ODEQ water quality standards allow for increased turbidity resulting from "limited duration activities necessary to address an emergency or to accommodate essential dredging, construction or

other legitimate activities....” (Also see discussion in Section 5.3.1.3.)

5.3.3 Fishery Resources

5.3.3.1 *Affected Environment*

As shown in table 19, the composition of the fish community in the Sandy River Basin is dominated by resident cold water and anadromous species. Several warm water species that are common in adjacent Columbia River habitats are present in the very lowest reaches of the main stem of the river. The Sandy River Basin is heavily fished for both the anadromous and cold water resident species, with the exception of the Bull Run River portion of the basin which is not fished since access is restricted to protect the City of Portland municipal water supply. The ODFW annually stocks approximately 20,000 catchable size rainbow trout into Roslyn Lake, a man-made waterbody which was constructed in 1911 to act as the forebay for the Bull Run powerhouse. At maximum operating level, the lake is 160 acres and averages less than 10 feet deep. The lake is open to angling year-round with the intent to maximize recreational opportunity.

The Sandy River Hatchery, operated by ODFW, is located on Cedar Creek, a tributary of the Sandy. The Sandy River Hatchery has raised various salmon species in the past, but currently produces only coho salmon. Under the current FERC license, hatchery compensation is provided by PGE for lost anadromous fish production in the Little Sandy River instead of providing minimum flow and fish passage at Little Sandy diversion dam. The method used to estimate potential smolt production uses total available habitat at summer low flow and a multiplier determined from known production per square foot of habitat from coastal streams. The final calculation includes 14 miles of stream encompassing several impassable falls above the Little Sandy diversion dam. The estimated smolt production potential of this habitat is 35,300 steelhead smolts and 35,500 coho smolts. Based on the hatchery return rates at the time, it was agreed that two-and-a-half times the number of hatchery coho smolts would replace the lost wild production, so the final agreement was for 35,298 steelhead and 94,890 coho smolts. Compensation funds from PGE are used by ODFW in its spring chinook program. Funds were first used to expand the Clackamas hatchery to accommodate increased smolt production and then to pay annual operation and maintenance costs associated with the expansion. Currently, spring chinook smolts from the Clackamas hatchery are the only mitigation fish stocked in the Sandy River. Acclimation ponds downstream of the Marmot dam are used to hold these fish while they acclimate and imprint on Sandy River water.

Table 19. Species Present in the Bull Run Hydroelectric Project Area.

Common Name	Scientific Name	Origin
Pacific lamprey	<i>Entosphenus tridenatus</i>	Native
Western brook lamprey	<i>Lumpetra richardsoni</i>	Native
Summer steelhead	<i>Oncorhynchus mykiss</i>	Introduced
Winter steelhead	<i>Oncorhynchus mykiss</i>	Native
Rainbow trout	<i>Oncorhynchus mykiss</i>	Native
Coho salmon	<i>Oncorhynchus kisutch</i>	Native
Spring chinook salmon	<i>Oncorhynchus tshawytscha</i>	Native
Fall chinook salmon	<i>Oncorhynchus tshawytscha</i>	Native
Cutthroat trout	<i>Oncorhynchus clarki</i>	Native
Mountain whitefish	<i>Prosopium williamsoni</i>	Native
Brook trout	<i>Salvelinus fontinalis</i>	Introduced
Brown bullhead	<i>Ameiurus nebulosus</i>	Introduced
Sculpin	<i>Cottus sp.</i>	Native
Dace	<i>Rhinichthys sp.</i>	Native
Largescale sucker	<i>Catostomus macrocheilus</i>	Native
Mountain sucker	<i>Catostomus platyrhynchus</i>	Native
Redside shiner	<i>Richardsonius balteatus</i>	Native
Three-spine stickleback	<i>Gasterosteus aculeatus</i>	Native
Largemouth bass	<i>Micropterus salmoides</i>	Introduced ¹
Smallmouth bass	<i>Micropterus dolomieu</i>	Introduced ¹
Black crappie	<i>Pomoxis nigromaculatus</i>	Introduced ¹
White crappie	<i>Pomoxis annularis</i>	Introduced ¹
Bluegill	<i>Lepomis macrochirus</i>	Introduced ¹
Warmouth	<i>Lepomis gulosus</i>	Introduced ¹
Goldfish	<i>Carassius auratus</i>	Introduced ¹
Carp	<i>Cyprinus carpio</i>	Introduced ¹
Peamouth	<i>Mylocheilus caurinus</i>	Native ¹
Chiselmouth	<i>Acrocheilus alutaceus</i>	Native ¹
Sockeye salmon	<i>Oncorhynchus nerka</i>	Native ¹
Northern pike-minnow	<i>Ptychocheilus oregonensis</i>	Native ¹
White sturgeon	<i>Acipenser transmontanus</i>	Native ¹
Bull trout	<i>Salvelinus confluentis</i>	Native ¹
Inland/reddband rainbow trout	<i>Oncorhynchus mykiss gairdneri</i>	Native ¹

¹ Fish found in the lower Columbia River that also may be present in the lower reaches of the Sandy River due to unimpeded access and similar habitat characteristics

Several species of special concern occur in the Sandy River system (see table 1). Naturally produced fall and spring chinook salmon are present, and they were listed as a threatened species in April 1999. Winter steelhead were listed by NMFS in March 1998 as a threatened species. Winter steelhead habitat is located throughout the accessible portions of the Sandy River Basin. Coho salmon as well as migratory cutthroat trout and Pacific lamprey are also of concern because of declining populations throughout their range.

Current management objectives and priorities are addressed in the *Sandy River Subbasin Fish Management Plan*, adopted by the Oregon Fish and Wildlife Commission (ODFC) in 1997 (Murtagh et al. 1996) and the Revised Sandy River Fish Management Plan, adopted by OFWC in September 2003. The revised plan considers Marmot dam removal and modifies ODFW's fish management and hatchery program to limit the impact of hatchery fish on the basin's protected wild fish populations. For federally listed threatened or endangered species, jurisdiction falls to either NMFS for anadromous species or the USFWS for resident species. Much of the land in the upper Sandy Basin is under the jurisdiction of the USFS, which is responsible for habitat management. Anadromous and resident fish species are described in more detail in the following sections. Much of the information presented below on anadromous salmonids and cutthroat trout is drawn from Stillwater Sciences (1999).

Anadromous Species

The Sandy River Basin supports populations of the following anadromous salmonid species: chinook salmon (spring and fall), steelhead (winter and summer), coho salmon, coastal cutthroat trout and bull trout.¹⁹ Bull trout have recently been found in low numbers in the last 3 years, but it is unlikely that a viable population occurs there. Except for summer steelhead, all of these salmonid populations have special status under the Endangered Species Act, as summarized in table 1. In addition, all of these populations, except for coastal cutthroat trout (which have an uncertain stocking history), have been augmented with hatchery stocks (table 20). Coho, winter steelhead and spring chinook continue to be augmented. Detailed discussion of each of these stocks, including life history, current status under the Endangered Species Act, habitat preferences, and hatchery influences, is provided in *A Review of Special Status Salmonid Issues for PGE's Sandy River Basin Projects* (Stillwater Sciences 1999).

¹⁹ Maps showing the distribution of these species (excluding bull trout) in the Sandy River Basin are found in the draft environmental assessment (PGE 2002e).

Table 20. Period of Hatchery Supplementation and Origin of Hatchery Stocks used to Supplement Anadromous Salmonid Populations in the Sandy River Basin.

Species and Run	Period of Supplementation	Hatchery Stock Origin
spring chinook salmon	early 1900s to 1969	primarily Sandy River stock
	1977-1978	Carson stock, Washington
	1973 to present	Willamette River stock
fall chinook salmon	early 1950s to 1977	lower Columbia River tule stock
	early 1950s to 1977	intermittent releases of both Sandy River Basin and out-of-basin stocks
	1978 to present	no hatchery supplementation
coho salmon	1951 to present	primarily Sandy River stock
winter steelhead	late 1800s	hatchery supplementation began (unknown origin)
	1950s (?) to present	Two primary hatchery stocks used: • Big Creek Hatchery stock from lower Columbia River near Astoria, Oregon • Eagle Creek National Fish Hatchery stock from Clackamas River Basin
summer steelhead	1968 to 1975	probably primarily Skamania Hatchery stock
	1975 to 1996	Skamania Hatchery stock from Washougal River in southwest Washington
coastal cutthroat trout		no information on hatchery supplementation has been identified

Distribution, habitat preferences, and locations of key habitat of each anadromous salmonid species present in the Sandy River Basin are discussed in the following section. Distribution and key habitat locations for many anadromous salmonid species in the Sandy River Basin is poorly understood, especially with regard to juvenile rearing distributions. Where information is lacking, potential spawning and rearing distribution is described based on availability of suitable habitat.

In general, spring chinook salmon, coho salmon, and steelhead tend to spawn upstream of Marmot dam, while fall chinook salmon spawn primarily downstream of the dam. Some coho salmon and winter steelhead spawning, however, occurs downstream of the dam, and some fall chinook salmon spawning occurs upstream of the dam. Very little information describing juvenile distribution in the watershed is available. Coho salmon, steelhead, and spring chinook salmon originating from upstream of the dam would be expected to rear primarily in the upper watershed, but may also rear in suitable habitats downstream. Fall chinook salmon would be expected to rear almost exclusively downstream of the dam, as would coho, winter steelhead, and sea-run cutthroat trout that

originated downstream of the dam. Species distributions and habitat requirements are discussed in more detail below and are summarized in table 21.

The life history timing of anadromous salmonid species occurring in the Sandy River Basin is shown in tables 22 and 23. Many aspects of the life history timing of salmonid life history stages in the Sandy River remain uncertain. Table 24 shows the total run size for the salmon and steelhead runs counted at Marmot dam.

Spring chinook: Spring chinook salmon in the Sandy River Basin spawn and rear primarily in the larger tributaries upstream of Marmot dam, with most spawning occurring in the Salmon River and in lower Still Creek (ODFW 1997a). Mainstem and side-channel habitats in the Sandy River upstream of Marmot dam (in particular, upstream of the Salmon River) may also be used for spawning (ODFW 1997a). In addition, spawning has been observed immediately below Marmot dam, including 30-40 pairs in 1999, and in the reach immediately upstream of the dam (D. Cramer, pers. comm., 2000). Spawning has also been documented in the lower Bull Run and Little Sandy Rivers (R2 Resource Consultants 1998a).

Naturally reproducing spring chinook salmon return to the Sandy River from late winter through summer and pass over Marmot dam from May through October, with peak passage occurring in June and a second smaller peak occurring in September (tables 22 and 23). Adult spring chinook salmon require large, deep pools with flowing water and suitable temperatures as summer holding habitat during the upstream migration. In many years, about 20 percent of the spring chinook salmon run that pass over the dam hold in the lower basin for most of the summer (before passing over the dam in September).

Little information is available on rearing habitats utilized by spring chinook salmon in the Sandy River Basin. Extensive use of mainstem reaches and estuaries as rearing habitat typically distinguishes juvenile chinook salmon from coho salmon, steelhead, and sea-run cutthroat trout. Following emergence, chinook fry occupy low velocity, shallow water areas near stream margins, including backwater eddies and areas associated with bank cover such as large woody debris (Lister and Genoe 1970, Everest and Chapman 1972, McCain 1992). As fry increase in size, they move to higher velocity, deeper areas further from banks (Hillman et al. 1987, Everest and Chapman 1972, Lister and Genoe 1970). Rearing patterns of spring chinook are variable. They may disperse downstream soon after emergence, as fry; early in their first summer, as fingerlings; in the fall as flows increase; or after overwintering in freshwater, as yearlings (Healey 1991). Information about the life history strategy of spring chinook salmon in the Sandy River Basin suggests that downstream migrations occur from the fall of their first year through the spring of the following year, with the majority of outmigration occurring prior to the onset of winter (Cramer et al. 1989; Cramer and Clark 1988; PGE, unpublished data).

Table 21. Anadromous Salmonid Primary Spawning and Rearing Locations and Habitats in the Sandy River Basin.

Reach	Species and Run	Primary Spawning Locations	Key Rearing Habitats¹	Years Rearing
Upstream of Marmot Dam	Spring Chinook	Salmon River up to Final Falls, lower 3 miles of Still Creek, Zig Zag River, mainstem upper Sandy River	Pools	<1 to 1+
	Fall Chinook	limited spawning observation in 1.6-mi (2.6-km) reach upstream of Marmot dam and near mouth of Salmon River	margin habitats, pools	<1
	Coho Salmon	Salmon River and tributaries below Final Falls, Still Creek, mainstem Sandy River	LWD formed pools	1+
	Winter Steelhead	Salmon River below Final Falls, Still Creek, other upper basin tributaries	large substrates	1+ to 3+
	Summer Steelhead	Mainstem Sandy River and its tributaries	large substrates	1+ to 3+
	Sea-run Coastal Cutthroat Trout	N/A	N/A	
Downstream of Marmot Dam	Spring Chinook	Immediately below Marmot dam (Reach 1)	Pools	<1 to 1+
	Fall Chinook	Mainstem Sandy River from Lewis and Clark State Park to upstream boundary of Oxbow Park; lower tributaries, such as Gordon and Trout Creeks.	margin habitats, pools	<1
	Coho Salmon	Lower basin tributaries, such as Gordon and Trout Creeks (most likely hatchery fish)	LWD formed pools	1+
	Winter Steelhead	Mainstem Sandy River (limited data)	large substrates	1+ to 3+
	Summer Steelhead	N/A	large substrates	1+ to 3+
	Sea-run Coastal Cutthroat Trout ²	Small tributaries	side channels, pools	2 to 4

1 Limited data are available describing salmonid rearing distribution in the Sandy River Basin; potential presence is assumed based on availability of suitable habitat.

2 Limited data are available describing spawning locations of sea-run coastal cutthroat trout in the Sandy River Basin. Based on availability of suitable habitat, it is assumed that small tributaries downstream of Marmot dam offer likely spawning locations.

Juvenile spring chinook salmon may, however, be present in the Sandy River throughout the year (ODFW 1997a).

Table 22. Timing of Life History Stages of Anadromous Salmonids in the Sandy River Downstream of Marmot Dam.

LIFE STAGE	SPECIES	MONTH											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Adult Migration &	Spring Chinook Salmon												
	Fall Chinook Salmon												
	Summer Steelhead												
	Winter Steelhead												
	Coho Salmon												
Spawning	Spring Chinook Salmon ¹												
	Fall Chinook Salmon												
	Summer Steelhead ¹												
	Winter Steelhead												
	Coho Salmon ¹												
Rearing	Spring Chinook Salmon ²												
	Fall Chinook Salmon												
	Summer Steelhead ²												
	Winter Steelhead												
	Coho Salmon ²												
Outmigration	Spring Chinook Salmon												
	Fall Chinook Salmon												
	Summer Steelhead ³												
	Winter Steelhead												
	Coho Salmon												

1 Since spring chinook salmon, summer steelhead and coho salmon are not believed to spawn downstream of Marmot Dam, timing of this life history stage is not well documented for the Sandy River Basin.

2 Juvenile rearing patterns are poorly understood. Although spring chinook salmon, summer steelhead, and coho salmon are not believed to spawn in the mainstem Sandy River downstream of Marmot dam, it is possible that juveniles migrate to the mainstem to rear prior to outmigration as smolts.

3 Outmigration of summer steelhead is not well documented in the Sandy River Basin.

	Span of Moderate to Light Activity
	Span of Peak Activity
	Span of Possible Activity

Table 23. Timing of Life History Stages of Anadromous Salmonids in the Sandy River Basin Upstream of Marmot Dam.

LIFE STAGE	SPECIES	MONTH											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Adult Migration	Spring Chinook Salmon ^{1,2}												
	Fall Chinook Salmon												
	Summer Steelhead												
	Winter Steelhead												
	Coho Salmon												
Spawning	Spring Chinook Salmon												
	Fall Chinook Salmon ³												
	Summer Steelhead												
	Winter Steelhead												
	Coho Salmon ⁴												
Rearing	Spring Chinook Salmon												
	Fall Chinook Salmon												
	Summer Steelhead												
	Winter Steelhead												
	Coho Salmon												
Outmigration	Spring Chinook Salmon												
	Fall Chinook Salmon												
	Summer Steelhead												
	Winter Steelhead												
	Coho Salmon												

- 1 Chinook counted at Marmot Dam in late October and early November may actually be late-maturing fall chinook attracted into the upper basin when flows permit (ODFW 1997a).
- 2 Passage of spring chinook over Marmot dam decreases in July and August, probably in response to decreases in flow and increases in water temperature. A second smaller peak of movement over the dam often occurs in September as water temperatures decrease again (ODFW 1997a).
- 3 Fall chinook salmon runs include an early (hatchery) run, with peak spawning activity September to November, and a late (native) run, with peak spawning activity in November.
- 4 Coho salmon runs include an early (hatchery) run, with peak spawning activity September to November, and a late (native) run, with peak spawning activity late November through early January.
- 5 Outmigration of summer steelhead is not well documented in the Sandy River Basin.

	Span of Moderate to Light Activity
	Span of Peak Activity
	Span of Possible Activity

Table 24. Anadromous fish counts at the Marmot Dam, 1954-1998.

Year	Spring Chinook	Coho Salmon	Summer Steelhead	Winter Steelhead
1954	400	No Data	No Data	2200
1955	5	No Data	No Data	1581
1956	0	No Data	No Data	2240
1957	10	No Data	No Data	2054
1958	78	No Data	No Data	3166
1959	304	No Data	No Data	2359
1960	23	No Data	No Data	1612
1961	37	No Data	No Data	3124
1962	65	No Data	No Data	4046
1963	124	No Data	No Data	3326
1964	660	No Data	No Data	3893
1965	13	No Data	No Data	5531
1966	63	No Data	No Data	5390
1967	51	No Data	No Data	4076
1968	61	No Data	No Data	2949
1969	81	No Data	No Data	3181
1970	137	No Data	No Data	2390
1971-1976	No Data	No Data	No Data	No Data
1977	349	283	1086	Incomplete Data
1978	607	426	948	3879
1979	267	681	1755	2000
1980	553	645	3471	3015
1981	1090	634	2992	4078
1982	525	742	2673	2600
1983	561	60	1323	2449
1984	1212	806	7598	2232
1985	566	1472	4640	2787
1986	714	1606	5201	2752
1987	1421	1403	5469	3675
1988	1947	1591	6109	3440
1989	1413	2295	2625	2993
1990	1614	456	4293	3065
1991	1904	1492	2127	1995
1992	5726	845	3662	2916
1993	3435	220	2053	1636
1994	2319	648	2097	1567
1995	1503	716	1351	1680
1996	2572	181	1164	537
1997	3047	116	1700	1425
1998	2527	47	Incomplete Data	883
Average 1977-1998	1630	789	3064	2457

Source: Stillwater Sciences, 1999

Juvenile chinook often disperse downstream in the fall from tributaries into mainstem reaches and take up residence in deep pools with large woody debris, interstitial habitat provided by boulders and rubble substrate, and/or along river margins for the

present in Reaches 1, 3 and 4 (figure 3) would likely provide the best habitat for older age classes of juvenile steelhead. The large substrates present in these reaches would provide flow obstructions and feeding opportunities for steelhead during the summer and refuge from high velocity in winter. Side-channel and off-channel habitats would offer refuge during extreme flow events.

Summer steelhead: Summer steelhead in the Sandy River Basin are currently managed for hatchery production only (ODFW 1997a), although summer steelhead may have historically occurred in the basin. Stocking of hatchery summer steelhead above Marmot dam has been discontinued and marked hatchery fish are now prevented from ascending the fish ladder to spawn upstream of the dam, but the unmarked progeny of naturally spawning hatchery fish continue to pass upstream of the dam and spawn in the upper Sandy River Basin. Little is known about natural production of summer steelhead downstream of Marmot dam, although given the habitat preferences of these fish, it is unlikely that they spawn in the mainstem Sandy River downstream of Marmot dam. Summer steelhead migrate into the Sandy River from early winter through spring and pass over Marmot dam from March through November, with peak passage occurring in June and July (tables 22 and 23). Adults hold in the river during summer and fall until reaching sexual maturity around mid-winter. Adult summer steelhead require large, deep pools with flowing water and suitable temperatures as holding habitat during the summer and fall (Roelofs 1983).

Summer steelhead, like winter steelhead, typically rear for 2 to 3 years before migrating downstream to the ocean. Steelhead likely remain in their natal streams for the first summer after which they may disperse downstream. In the mainstem Sandy River, steelhead rearing habitat would be similar to that described above for winter steelhead.

Cutthroat trout: Anadromous (sea-run), freshwater migratory, and resident coastal cutthroat trout are native to the Sandy River Basin. Cutthroat trout exhibiting a freshwater migratory life history strategy migrate to larger mainstem river reaches in the spring, summer, and fall growing season and migrate upstream into tributaries for overwintering and spawning. Migratory forms (both sea-run and freshwater migratory forms) are believed to occur primarily in tributaries downstream of Marmot dam (PGE 1998a), although little or no data are available on the abundance, population trends, and distribution of migratory cutthroat trout in the Sandy River Basin (PGE 2002e, figure 5.2.3-5). At least two to three dozen sea-run cutthroat trout historically returned each fall to the lower Sandy River hatchery; however, there have been no verified observations of sea-run cutthroat trout in the Sandy River in recent years. Hooton, as cited in Johnson et al. 1999; ODFW 1997a). Anecdotal information from anglers suggests that, in the past, sea-run cutthroat trout supported a significant sport fishery in the lower Sandy River

Basin (Taylor 1998). Resident coastal cutthroat trout are well-distributed in the Sandy River Basin, and occur both upstream and downstream of the Marmot and Little Sandy diversions.

Cutthroat trout generally spawn and rear in tributary streams (Trotter 1989), typically between late winter and early spring (ODFW 1997a). In the Sandy River, migratory adult coastal cutthroat trout are present from September through December (PGE 1997). Generally, juvenile cutthroat outmigration occurs primarily from March through May. Tributary reaches used by sea-run cutthroat trout are generally considered to be located upstream of areas used for spawning by coho salmon and steelhead. Like other anadromous salmonids, after emerging from the gravel, cutthroat fry move to low-velocity channel margins, backwaters, and side channels (Moore and Gregory 1988). As they age and grow, juvenile cutthroat generally move to deeper habitats. Where cutthroat are not spatially or temporally segregated from other salmonid species, they are often displaced from their preferred habitats by larger, more aggressive species, especially steelhead and coho. Juvenile cutthroat prefer to overwinter in low-velocity habitats such as pools and side channels that provide cover such as those having large woody debris (LWD) or undercut banks (Bustard and Narver 1975, Sullivan 1986, Bisson et al. 1988, Heggenes et al. 1991). Older cutthroat tend to prefer habitats with water velocities intermediate between the higher-velocity habitats chosen by juvenile steelhead and the low-velocity habitats used by juvenile coho salmon. Fausch and Northcote (1992) found that pools formed by LWD provided critical habitat for age 2+ and older cutthroat during summer low flows.

Although information on migratory cutthroat trout distribution and habitat utilization in the Sandy River is poorly understood, juvenile cutthroat likely prefer to rear in smaller tributary reaches containing deep pools and adequate cover. Based on information from Willamette River Basin tributaries, migratory cutthroat trout in the Sandy River Basin likely remain in fresh water for 2 to 4 years before first outmigrating to the ocean (Moring and Youker 1979, Nicholas 1978; both as cited in ODFW 1997a). In large streams such as the mainstem Sandy River, cutthroat likely prefer side channels and channel margins as rearing habitat. During the winter months, cutthroat have been observed using tributaries with pools and side channels that contain velocity refuge and cover, where they may hide in the interstices of coarse substrates (Lewynsky 1986). In the winter in large rivers, cutthroat may aggregate in large schools and have been observed to be more wary than in summer (Lewynsky 1986). In the mainstem Sandy River downstream of Marmot dam, Reach 4 is likely to provide the greatest amount of rearing habitat for cutthroat trout.

Pacific lamprey: Pacific lamprey, a primitive eel-like fish is native to the Sandy

Basin. They are listed as a sensitive species by the State of Oregon and are considered a species of special concern by the Oregon Natural Heritage database (USFS 1996, 1997). The distribution of lampreys in the lower Columbia River is likely reduced due to passage barriers on the Sandy and Clackamas Rivers. No systematic survey of lamprey distribution has been conducted in this area, nor is the historic distribution known (ODFW 1997a).

Resident Fish Species

Bull trout: The Columbia River DPS of bull trout is listed as threatened, and includes all populations occurring throughout the entire Columbia River Basin, and all tributaries, excluding bull trout found in Jarbridge River, Nevada. The Sandy River was not identified in this listing as historically having supported a bull trout population. Bull trout are rarely observed in the Sandy River, and it is unlikely that a viable population occurs there. Bull trout (*Salvelinus confluentus*), members of the family Salmonidae, are a char that historically occurred in major river drainages from about 41°N to 60°N latitude. Bull trout and Dolly Varden (*Salvelinus malma*) had been previously considered a single species but were formally recognized as separate species by the American Fisheries Society in 1980 (USFWS 1998). USFWS did not designate critical habitat for the Columbia River DPS at the time of listing (USFWS 1998).

The USFWS (1998) has identified the following factors as contributing to declines of bull trout in the Columbia River DPS:

- dams and diversions
- forestry
- agriculture
- mining
- overharvest

The Columbia River DPS of bull trout has been adversely affected by dams in almost every major river in the basin except for the Salmon River in Idaho (USFWS 1998). Impassable dams have caused declines primarily by preventing access to historically accessible spawning and rearing areas in headwaters and by precluding recolonization of areas where bull trout have been extirpated (Rieman and McIntyre 1993, as cited in USFWS 1998). Logging and associated roads and their legacy effects have altered habitat by increasing sedimentation, reducing habitat complexity, increasing water temperature, and destabilizing channels (USFWS 1998).

Bull trout historically occurred in the Clackamas River Basin and are currently

found in the Hood River Basin, but it is unknown whether they ever occurred in the Sandy River (USFS 1996). A 1960 report (Leonards 1960, as cited in USFS 1996) refers to the species' presence in the Sandy River Basin, but apparently there is no documentation of the bull trout's historical occurrence there (USFS 1996). However, an 18-inch adult bull trout was found in the Marmot trap in May 2000 (D. Domina, PGE, pers. comm., 2000) and two other suspected adult bull trout were caught by sport anglers in the lower Sandy River since 2000 (J. Muck and D. Caldwell, ODFW, pers. comm., 2001 and 2002), indicating that bull trout may occasionally stray into the Sandy River Basin.

Rainbow trout: Resident rainbow trout are indigenous to the Sandy River Basin and are found throughout the watershed. No historical information on abundance of the species is available. For years, hatchery rainbow trout were stocked in the upper Sandy River to provide angling opportunities. This practice was discontinued in 1995.

Mountain whitefish: Whitefish are indigenous to the Sandy Basin and are found in the mainstem and larger tributaries, including upstream of the Marmot dam and upstream of the Little Sandy diversion dam. Populations of this species appear healthy from information obtained from surveys and angler incidental catches. Whitefish spawn in the fall and reaching lengths of up to 12 inches. Whitefish have been observed passing upstream through the Marmot fish ladder.

Other species: Various warmwater and other resident fish species are known to or can be expected to inhabit Sandy Basin waters. The most common include several species of sculpin, dace, and shiners, which inhabit both the lentic and lotic waters of the entire watershed. largescale suckers and sticklebacks are common in Roslyn Lake, and anglers have also caught brown bullhead and largemouth bass at the lake.

Fish common to the Columbia River are also present in the lower reaches of the Sandy River since there are no barriers to movement and the habitats in the lower Sandy River have characteristics similar to adjacent areas of the Columbia River. Some of these fish species are present in the lower river seasonally (e.g., American shad), or may be locally abundant (e.g., smallmouth bass). The species of fish that may be found in the lower Sandy River include six introduced centrarchids, five cyprinids (two introduced and three native), American shad and white sturgeon. American shad may reproduce successfully in the lower Sandy River, and juveniles have been occasionally observed downstream of Oxbow Park. In addition, sockeye salmon migrating to upstream Columbia River tributaries may occasionally stray into the Sandy River.

With the proposed removal of Marmot and Little Sandy diversions, Oregon

Department of Fish and Wildlife in 1999 completed an amendment to their 1997 Sandy River Basin Fish Management Plan. The amendment incorporated the concept that both dams would be removed and the associated changes in fish management policy and logistics.

Forest Service Sensitive Species List—Aquatics

The Upper Little Sandy River possibly contains a population of pure rainbow trout that are suspected to be sensitive (Region 6) inland/redband rainbow trout. This sub-basin drains into the middle Sandy River, well below the mouth of the Salmon River. Extensive fish sampling within the Upper Sandy Basin (outside the Little Sandy) over the last 20 years has not recovered any inland/redband rainbows and are they are not believed to inhabit any other parts or sub-basins within the Sandy River. Other basins bordering the Sandy have also been sampled. Several fish sampled in the Hood River watershed (to the east) were found to have similar characteristics and genetics to inland/redband trout. These fish have not been documented in the Clackamas River watershed.

Inland/redband rainbow trout have been referred to as 'desert trout' mainly because they inhabit streams of the Columbia Basin, east of the Cascade crest (Behnke 1992). They persist well in warm water temperatures and have been documented to be actively feeding in streams with temperatures exceeding 28 degrees Celsius (Behnke 1992). Habitat requirements are similar of that of coastal rainbows in that they need adequate water quality, food and cover. Inland/redband rainbow trout prefer water temperatures from 10 to 14 degrees Celsius (Currans 1990). Food can be provided by either terrestrial or aquatic macroinvertebrates or smaller fishes that inhabit the stream. They need small, loose gravel for successful spawning in the spring of the year. Fry emerge from the gravel in early summer. Rearing habitat is provided by boulders, large woody debris, overhanging vegetation or along stream margins (Behnke 1992). Inland/redband rainbow trout within the White River watershed are genetically distinct from those in the Deschutes River and are unique among other inland redband trout populations east of the Cascades (Currans et. al. 1990). White River inland/redband rainbow trout are more closely related to those found in the Fort Rock Basin of central Oregon (Currans et al. 1990). Inland/redbands found in the Little Sandy may be remnants from this population, data collected to date is inconclusive (ODFW 1994).

Removal of Marmot and Little Sandy diversions would have little to no direct adverse affects to inland/redband rainbow trout. However, indirect affects from competition from anadromous fish (both wild and hatchery) being reintroduced into the Little Sandy would most likely cause some competition for food and habitat. Also, there may be an opportunity for genetic introgression. The extent or timeframe of these

situations is unknown at this time.

Nutrient Cycling

An assessment was completed to estimate the loss of annual nutrient inputs to the upper Sandy River Basin due to the reduction of anadromous fish runs over time throughout the project operation period. As stated previously, Mattson (1955 as cited in Taylor 1998), reported that historical runs in the Sandy River Basin approximated 15,000 coho, 20,000 winter steelhead, and 8-10,000 spring chinook. From the period 1978-97, run counts at Marmot dam have average approximately 859 coho, 2,536 winter steelhead, and 1,529 spring chinook per year.

Based on comparisons of past hatchery records and recent spawning surveys, current returns to the Salmon River watershed (Sandy River tributary above Marmot dam) are estimated to be only 10-25 percent of 1890 levels (USFS 1996). By extension, it is possible that a similar reduction has also occurred in the rest of the upper Sandy River watershed for the area above Marmot dam. In the present context, this relationship was used to back-calculate historic escapement figures in the upper basin from current escapement estimates for spring chinook, coho, and winter steelhead passing Marmot dam. These estimates were then used to calculate estimates of nitrogen and phosphorus inputs for each of these species (table 25). Nutrient input was based on N (nitrogen) body content of 3.0 percent (Mathisen et al. 1988), and P (phosphorus) body content of 0.364 percent (Donaldson 1967). The average body mass for spring chinook (6.4 kg), coho (4.5 kg), and steelhead (5 kg) were estimated from adult catch records from the Clackamas River Basin. It appears that current runs import about half the nitrogen and phosphorus to the Upper Sandy watershed compared to historical runs (table 25).

5.3.3.2 Effects of Alternatives

With regard to fisheries resources, project decommissioning would eliminate the effects the project has had upon fish passage and fish habitat. The upstream movement of Sandy River fish would no longer be affected by the attraction of fish into the Bull Run River during generation periods (i.e., the "false attraction" issue identified during the initial relicensing scoping). This was probably most significant for summer steelhead and spring chinook. Flow conditions generally prevented visual observations of winter steelhead. Observations of spring chinook and summer steelhead may not have been indicative of delays since these runs move frequently during their protracted upstream migrations.

Table 25. Estimates of Nutrient Inputs from Salmon Carcasses above Marmot Dam.

Species	Historic (Pre 1900)				Period of record, 1978-1997				% nutrient input decline
	Average number of fish	Fish mass (kg)	Estimated nutrient input (kg)		Average number of fish*	Fish mass (kg)	Estimated nutrient input (kg)		
			N	P			N	P	
Spring chinook	2000	12800	384	47	1529	9786	294	36	23
Coho	3125	14062	422	51	859	3866	116	14	73
Winter steelhead**	5000	17500	525	64	2536	8876	266	32	49
Total		39662	1331	162		22528	676	82	49

* Based on run counts from the Marmot dam counting facility.

** The estimated fish mass for steelhead was multiplied by 0.70 to reflect approximately 70 percent of the fish that do not return to the ocean after spawning.

Upstream and downstream fishways would no longer be present in the Sandy River Basin. Wild fish originating from the headwaters of the Sandy River would no longer have to negotiate the Marmot dam fishway. Thus any upstream passage inefficiencies would no longer affect the numbers of spawners reaching the headwaters. Similarly, downstream passage would no longer be an issue. Although the Marmot fish screens work very well for smolt size fish, there were some losses for fry – decommissioning the project would eliminate mortality caused by the juvenile bypass facility.

Temporary fish passage measures would be in place during dam removal. The dam removal alternative would also affect the downstream transport of sediments that have accumulated behind the dam, which has ramifications for downstream habitats. The specific effects of project removal are discussed below in relation to each of the project structures with particular attention to the Marmot dam removal alternatives.

Removal of Marmot Dam

Fishery issues related to the removal of Marmot dam are described in the following sections. The discussion is organized around the three Marmot dam removal alternatives described in Section 3.3--Proposed Action, and includes, for each of these alternatives, discussion of fish passage facilities, impacts of channel adjustment in the reservoir reach, impacts of downstream sediment deposition, and impacts of downstream suspended sediment increases. With regard to fishery resources, the three removal alternatives share several common objectives; achieving unrestricted passage of anadromous species as soon as possible, maintaining passage during the removal process, and minimizing potential impacts from the sediments currently impounded behind Marmot dam. While

sediment-related impacts to fisheries would depend on the dam removal alternative that is selected, effects of removing Marmot dam on restoring natural flows and unrestricted upstream and downstream fish passage in the long term would be the same for all removal methods. These effects are described below, followed by discussion of the effects of each removal alternative with respect to passage (during construction) and sediment-related impacts.

All of the Marmot dam removal alternatives would restore a natural flow regime to the downstream reaches of the river. Restoration of a river's natural flow regime, including the natural magnitude, frequency, duration, and timing of discharges, promotes biotic interactions, water quality, and physical habitat conditions that contribute to ecosystem integrity (Poff et al. 1997). These types of ecosystem benefits, including benefits to fish and other aquatic organisms, would be expected to occur in the Sandy River with cessation of flow diversions at Marmot dam.

Detailed discussion of the hydrologic effects of removing Marmot dam is provided in section 5.3.2 Water Resources, and these effects are summarized here. Restoring the natural hydrology at Marmot dam would increase the frequency of certain discharge rates from the dam to the confluence with the Bull Run River. There would be no change in the discharge of high flows since high flows are currently spilled over Marmot dam (i.e., during high flow events, generating flows are diverted entirely from the Little Sandy River). The distribution of flows below the current minimum flows also would not change since no water is diverted when the Sandy River discharge falls below the minimum flow requirement. Ending water diversions would have the most prominent effect at intermediate flows – river flows above the current minimum flows. This would have the most effect from the end of the annual spring runoff until the beginning of the fall rains – periods when a significant proportion of the flow is currently diverted. No detailed analysis of the effects of flow increases on habitat area has been conducted, but restoring full flows throughout the year would be expected to increase habitat availability by increasing the amount of wetted channel area. It would also change the quality of the habitat by increasing water velocity and depth. Changes in habitat would likely include increases in water depth in pools and in side-channel habitats, potentially increasing the suitability of these key habitat types for fish and other aquatic species during certain times of year.

In addition to changes in water velocity and depth, water temperatures downstream of Marmot dam may decrease after the dam is removed since increased flows would move water through this reach more quickly with less time for exposure to solar radiation and consequent heating. (Note: The absence of flow through Roslyn Lake would also tend to decrease water temperatures.) This temperature reduction could reduce the habitat for

introduced warm water fishes found in the lower Sandy River. These include largemouth bass, smallmouth bass, black crappie, white crappie, bluegill, warmouth, goldfish, and carp. These warm water species are also present in adjacent reaches of the Columbia River. With regard to cold water species of fish found in the lower river, sculpins and longnose dace were the most abundant non-salmonid cold water species while steelhead were the most abundant salmonid found in the lower Sandy River during fish sampling conducted in 1983 (Beak 1985). These species would be favored by reduced temperatures. In addition, adult holding and juvenile rearing habitat for fall chinook, and other anadromous salmonids downstream of the dam site, would also be improved by reduced temperatures.

All of the removal alternatives for Marmot dam would result in free passage to headwater areas of the Sandy River, including hatchery fish. ODFW will continue to release hatchery reared fish at Marmot dam or in the lower Sandy River Basin to imprint them to return to those areas (ODFW 2001, 2003). However, while dam removal activities are taking place in the river, and possibly for a period of time thereafter, there would be a temporary impact on upstream movement. The timing and duration of these fish passage impacts depends on the methods chosen to remove Marmot dam and the downstream transport of the sediments that have accumulated behind the dam. Potential effects of each dam removal alternative on fish passage are discussed further below. Adult chinook salmon require depths greater than 9 inches and steelhead need depths of at least 7 inches for successful upstream migration (Thompson 1972, as cited in Bjornn and Reiser 1991).

In the long term, removal of Marmot dam would improve both upstream and downstream passage for anadromous salmonids and other migratory species (e.g., lamprey) occurring in the Sandy River. Upstream passage would be especially improved for those species or individuals that currently are not likely to use the ladder. Little information is available on the propensity of certain fish species (particularly species other than anadromous salmonids) to use the ladder. Upstream passage would also be improved for species that are delayed while negotiating the ladder during upstream passage. Migration delays associated with shutdowns of the fish ladder due to bedload deposition in the ladder, as currently occurs following high flows, would also be eliminated. Dam removal would also eliminate handling stress associated with sorting migrating adult salmonids (e.g., Fagerlund et al. 1995) at the upstream passage facility.

Mortality, stress, or injury associated with downstream passage would be eliminated with the removal of Marmot dam, resulting in increased survival of juvenile and adult (steelhead) downstream migrants and possibly contributing to increases in populations of species that currently migrate past Marmot dam (primarily coho salmon,

winter steelhead, and spring chinook salmon). The downstream bypass facility at Marmot dam has been shown to cause high mortality of salmonid fry and currently does not meet ODFW criteria (ODFW 1997a). The average mortality of wild chinook salmon fry at the bypass facility has been estimated at 27.5 percent (Ward and Friesen 1998). In addition, stress and/or injury associated with downstream passage at the dam by adult salmonids would be eliminated. Adult steelhead migrating downstream subsequent to spawning currently pass over the dam or through the downstream bypass system (Doug Cramer pers. comm. 2000). Dam removal would also eliminate any migration delay that may be associated with avoidance of the downstream bypass facility. In addition to benefits realized by salmonids, species such as Pacific lamprey would likely benefit from the elimination of the downstream bypass facility. Downstream fish passage facilities designed for salmonids are frequently ineffective at bypassing other species. At Columbia River dams, only 10 percent of lamprey outmigrants are believed to use the downstream bypass systems (B. Muir, NMFS, pers. comm., as cited in Close et al. 1995).

The following sections provide discussion, for each of the three removal alternatives, of fish passage facilities during dam removal activities and of potential sediment-related impacts to anadromous fish. The discussion of sediment-related impacts is based on the description of anadromous salmonid habitat preferences and distribution in the Sandy River Basin under existing conditions (Section 5.3.3.1) and on the analysis of sediment transport and geomorphic effects of each removal alternative (Section 5.3.1.2).

Alternative 1 (PGE's Proposal)--Single Season Dam Removal with Minimal Sediment Removal

Passage facilities: Under this alternative, most of the sediments would be transported downstream during high-flow periods. Marmot dam and the old timber crib dam would be removed, but sediments would be removed only from approximately 400 feet of river channel upstream of the dam. This would include the area of the old timber crib dam. Construction methods are described in more detail in Section 3.3 but would include placing cofferdams above and below the dam, diverting the stream flow through the approach canal, and installing a temporary fish trap barrier below Marmot dam in the vicinity of the evaluator structure.

The temporary barrier and fish trap would be installed 600 to 800 feet downstream of the existing dam. The barrier would consist of a series of "tripod" structures, most likely constructed of wood and weighted with rocks, connected by three horizontal facing beams. The beams would have 1-inch diameter conduit spaced 1-inch apart attached vertically to create a barrier for fish. A Denil ladder near the right bank would provide

access for fish into the trap. The wooden trap would sit on a foundation at the end of the Denil ladder and would be lifted by a jib crane onto a truck for transport. Attraction water would be piped into the box via a PVC line from the bypass canal and would cascade down the ladder to the stream.

The fish trap is required since construction activities would preclude fish passage through the river channel. The trap would be used to collect and sort upstream migrant chinook, coho, and steelhead. Summer steelhead, marked hatchery chinook, and marked hatchery coho would be returned downstream. Unmarked chinook and coho, as well as all winter steelhead – stocks that are protected under the ESA – would be transported upstream of the construction area and released. Preventing hatchery fish from entering the upper basin is in accordance with the Oregon "Wild Fish Policy" as well as ESA provisions administered by NMFS. The trap would be left in place until the cofferdam is breached during the first flow of about 2,500 cfs.

See Section 5.3.1.2 for a discussion of anticipated effects of sediment transport on downstream aquatic habitats.

Impacts of channel adjustment in the reservoir reach: Under this alternative, the majority of sediment stored behind Marmot dam would be released downstream and the reach upstream of the dam would adjust to its pre-dam gradient over a period of years.

This adjustment would result in the conversion of what are currently low-gradient habitats to higher-gradient habitats. As a result, the quality and/or quantity of currently existing spawning habitats would be reduced. This would affect primarily fall chinook salmon. Also, rearing habitat suitability for spring chinook, coho and summer steelhead would be reduced, but suitability for winter rearing of chinook salmon and steelhead, which utilize interstitial spaces in coarse substrates, may increase in the long-term (after the channel adjusts to the new gradient and cobbles and boulders become more abundant).

The channel in the reservoir would continue to adjust to the removal of the dam over a period of several years, but some sediment would remain for a decade or more. During this period (especially the first few years following dam removal), channel instability and input of sand from bank erosion and mass wasting would likely make this reach unsuitable for salmonid spawning or rearing. Redds constructed in this reach would be highly vulnerable to burial and scour, resulting in low survival-to-emergence. Considering the short length of this reach and that most salmonid spawning occurs upstream or downstream of this reach, the impact of this temporary loss of habitat and permanent habitat conversion is expected to be relatively minor.

During the channel adjustment period, sediment deposits in the channel that are formed by bank slumping may pose barriers to upstream migration of adult salmonids, especially under low flow conditions. The likelihood that barriers to migration would form in this reach is uncertain and cannot be determined by the numerical modeling completed for this assessment. Short-term or long-term barriers to migration, however, could be reasonably expected to occur. The occurrence of a significant barrier could have substantial adverse impacts to salmonids that spawn in the upper watershed and must pass through this reach to arrive at their spawning grounds. Species and runs that would be most affected by impairment of passage include spring chinook, winter and summer steelhead, and coho. Fall chinook spawn primarily downstream of the dam and, therefore, would not be as severely affected by migration barriers through the reservoir reach. Large sediment deposits in the channel could also adversely affect downstream passage of juvenile salmonids during low flows, which typically occur from July through October. Blockage or impairment of downstream passage could affect downstream dispersal and outmigration of spring chinook, summer and winter steelhead, and coho.

Impacts of downstream sediment deposition: Downstream of the dam, sediment deposition would be most severe in Reaches 1 and 3 and at the downstream end of Reach 2. For several years following dam removal (expected to be less than a decade), sediment deposition and resulting channel instability in Reach 1 would result in the loss of nearly all salmonid habitat values. This reach is not known to be heavily used for spawning by any salmonid species and, based on field work completed for this assessment, does not appear to provide a substantial amount of spawning habitat, although some spring chinook spawning does occur here. The importance of this reach for juvenile rearing is unknown. Habitat suitable for juvenile rearing of coho, spring chinook, and steelhead is present, although the majority of rearing habitat for these species is believed to occur in the upper watershed.

Channel braiding and channel instability during the adjustment period following dam removal may hinder upstream migration of adult salmonids and downstream movement of juveniles, especially during low flow conditions. The likelihood of the formation of a barrier to passage of adult salmon cannot be determined; however, such a barrier could be reasonably expected to occur, especially at the sediment debris fan expected to form immediately downstream of the dam site. As discussed above, impairment of upstream migration would primarily affect spring chinook, coho, and steelhead. Impairment of downstream migration during low flow periods would primarily affect spring chinook salmon (which may be more likely to pass through this reach during early fall when flows are typically low).

Sediment deposition in this reach may also result in long-term changes to habitat

characteristics. While these changes are not predictable, increase in channel gradient, loss of pool habitat, and loss of side-channel habitat (especially at Beaver Island) would likely occur. These changes in habitat may reduce habitat suitability for winter rearing of coho and spring/summer rearing of coho and spring chinook.

In Reach 2, changes in habitat conditions following dam removal are expected to be minimal. Pools suitable for adult holding habitat are not likely to substantially fill with sediments, and pools are of sufficient depth that, even if some sediment deposition occurs, they would remain usable by salmonids. Gravel-sized material suitable for spawning that enters the gorge is likely to be transported through the gorge quickly and deposited downstream. Sand would be expected to travel through the gorge in suspension.

In Reach 3, sediment deposition is expected to be most severe in the upstream end of the reach (i.e., at the outlet of the gorge). Little deposition is predicted to occur in the downstream portion of Reach 3. Spawning in this reach is limited, but fall chinook spawning has been observed upstream of Revenue Bridge and winter steelhead spawning has been observed in side channels near Cedar Creek. This reach also provides suitable summer and winter rearing habitat for fall chinook salmon and steelhead, and suitable summer rearing habitat for chinook, coho, and steelhead. Sediment deposition in this reach may reduce or degrade spawning habitat by: (1) burying spawning riffles, (2) reducing flow depth, (3) burying redds, (4) increasing the frequency and depth of scour, and/or (5) reducing substrate permeability. Loss of spawning habitat, destruction of redds, or reduced survival-to-emergence in this reach would primarily affect fall chinook and winter steelhead. Other anadromous salmonid species are not expected to spawn in this reach. The magnitude of this impact is expected to be small because little spawning is thought to occur in this reach under current conditions. Filling of pools and side channels and deposition of sand into the channel bed would reduce rearing habitat quality for coho, winter and summer steelhead, and spring chinook from the upper watershed, and fall chinook and winter steelhead produced in this reach. The majority of juvenile coho, winter and summer steelhead, and spring chinook, however, are believed to rear upstream of Marmot dam, and the majority of juvenile fall chinook and winter steelhead produced in the mainstem are expected to rear in Reaches 4 and 5.

In Reach 4, the depth of coarse sediment deposition is expected to be minor and concentrated at the heads of bars, in side channels, and at the mouths of streams where substantial debris fans occur. Reach 4 contains the primary spawning and rearing area for fall chinook salmon (in the mainstem Sandy River) and important spawning and rearing habitat for winter steelhead; coho and winter chinook spawn and rear in tributaries to this reach. Juveniles produced upstream of the dam may also rear in this reach. Deposition of

sand and coarse sediment in this reach may affect salmonid spawning and incubation by burying redds, reducing substrate permeability (if large amounts of sand accumulate in the channel bed), increasing the depth and frequency of scour, and blocking access to spawning tributaries. Deposition may affect rearing habitat by eliminating access to side channels, blocking access to non-natal tributaries that may be suitable for rearing, and impairing juvenile dispersal or emigration from tributaries to the mainstem. Based on the model results, effects on spawning substrates and interstitial spaces used for rearing are expected to be minor (especially given the high sand content of the bed subsurface under current conditions) and the potential for elimination of side channel habitats or blockage of access to tributary habitats is considered to be small (due to the amount of time required for sediment to arrive to this reach, abrasion of sediment prior to its arrival, and the volume of sediment currently stored in this reach). If the model predictions are incorrect and deposition in this reach exceeds predicted levels, important fall chinook salmon and winter steelhead spawning and rearing habitat may be lost or degraded in the short or long term. Effects to other species and runs would still be expected to be small.

Little coarse sediment deposition is predicted to occur in Reach 5, but substantial sand deposition can be expected. This reach is used primarily as a migration corridor by most anadromous salmonids in the Sandy River, but it is also used by fall chinook and winter steelhead for spawning and presumably rearing. Substantial aggradation in this reach could result in creation of barriers to adult salmonid migration, especially under low flow conditions, which could affect all anadromous salmonids entering the river. Aggradation could also impair juvenile outmigration. In addition, deposition of sand may adversely impact fall chinook spawning and incubation by: (1) burying redds, (2) increasing the frequency and depth of scour, and (3) reducing substrate permeability.

Impacts of downstream suspended sediment: Construction activity in the reservoir is expected to increase TSS concentration downstream of the dam during the excavation period. The length of the excavation period would be much shorter for Alternative 1 than Alternatives 2 and 3. The magnitude of the increase in TSS concentration has not been determined but could be substantial, depending on measures implemented to control downstream release of sediment and turbid water. Increased TSS concentration downstream of Marmot dam during the summer and early fall construction period could adversely affect adult and juvenile salmonids present in the lower river. Species, runs, and life stages potentially present downstream of the dam during this period include; spring chinook (adult and juvenile), fall chinook (adult and juvenile), coho (adult and juvenile), winter steelhead (adult [potential] and juvenile), and cutthroat (adult and juvenile). Adult spring chinook, fall chinook, summer steelhead, coho (early hatchery run) and potentially winter steelhead could be particularly vulnerable to increases in TSS concentration downstream of the dam during excavation because

significant portions of these populations could be expected to be holding or migrating through the lower river. In addition, fall chinook salmon spawning and incubation, which could begin as early as September and occurs primarily downstream of the dam, could be impacted by increased TSS concentration downstream. Fall run chinook salmon juveniles, which rear almost exclusively downstream of the dam, and winter steelhead juveniles, originating from spawning downstream of the dam, would be most vulnerable to increases in TSS concentration during the construction season. Juvenile coho, spring chinook, and summer steelhead rearing in the lower river may also be affected, but the majority of juveniles of these species would be expected to occur upstream of the dam.

Potential downstream increase in TSS concentration following dam removal was assessed using the numerical model. For Alternative 1, release of sand and finer sediment from the reservoir would result in increased TSS concentration (relative to reference conditions) during high flow conditions occurring from November through June. Predicted TSS concentration does not change relative to the assumed reference condition during the summer and early fall (July through October). Increases in TSS concentration are predicted to be restricted to the Sandy River upstream of the Bull Run River confluence. Downstream of the Bull Run River, increases in TSS concentration are predicted to be minor due to dilution by inflow from the Bull Run River.

It is difficult to assess the potential impacts of the predicted increase in TSS concentration to adult and juvenile salmonids using information available in the literature. Numerous studies have evaluated the effects of acute and chronic exposure to elevated TSS concentrations for a variety of salmonid species. The results of these studies, however, are often contradictory, making it difficult to predict salmonid response to the range of TSS concentrations predicted by the Sandy River sediment model. The most commonly observed effects of exposure to elevated TSS concentrations on salmonids include the following: (1) avoidance of turbid waters in homing adult anadromous salmonids, (2) avoidance or alarm reactions by juvenile salmonids, (3) displacement of juvenile salmonids, (4) reduced feeding and growth, (5) physiological stress and respiratory impairment, (6) damage to gills, (7) reduced tolerance to disease and toxicants, (8) reduced survival, and (9) direct mortality. The severity of these effects depends on both the magnitude and the duration of the exposure. Many species can withstand extremely high TSS concentrations for short periods but may suffer harmful effects when the exposure is prolonged (Herbert and Merkens 1961).

Newcombe and Jensen (1996) conducted a comprehensive review of the scientific literature on the effects of suspended sediments on numerous fish species. Based on their review, the authors developed an approach to evaluating and describing the severity of ill effects associated with exposure to a range of TSS concentrations. Based on this

information, the predicted magnitude of the increase in TSS concentration could result in mortality of adult salmonids if exposure exceeded approximately 100 days. Exposure for less than 100 days would not be expected to result in mortality but could result in physiological stress and impaired homing. Elevated TSS concentration is expected to occur from November through June. Most adult salmon present in the river during this period would be expected to pass through the affected reaches in a matter of weeks. Spring chinook, however, may hold in the lower river for several months, but the majority of their holding period occurs when increased TSS concentration is not predicted (July through October). For juvenile salmonids, the predicted increase in TSS concentration could result in short-duration physiological stress, reduced feeding rate and reduced growth rate during extreme TSS peaks associated with high flow events. If increased TSS concentration persist longer than anticipated, these effects may increase in both magnitude and duration. Based on the model results, adverse effects on juveniles would be observed primarily upstream of the Bull Run River confluence. Salmonid species and life stages expected to be present in this reach during periods of elevated TSS concentration include spring chinook (adult and juvenile), fall chinook (adult and juvenile), coho (adult and juvenile), winter steelhead (adult and juvenile), summer steelhead (juvenile [potential]), and cutthroat (adult and juvenile). Adult fall chinook would be expected to be found primarily downstream of the Bull Run River confluence, whereas upstream migrating adult spring chinook, coho, and summer winter steelhead would be expected to pass through the affected reaches during periods of elevated TSS concentration. Juveniles of all species and runs could be present in these reaches during the affected period, but steelhead, coho, and spring chinook would be expected to be found primarily in the upper watershed and juvenile fall chinook would be found primarily downstream of the Bull Run River confluence.

The sensitivity analysis conducted for the sand model provides bounds for interpreting the upper limit of impacts to salmonids potentially resulting from exposure to increased TSS concentration resulting from dam removal. The predicted increase in TSS concentration resulting from the 10-fold increase in the rate of delivery of sand and finer sediment from the reservoir could result in more severe impacts to adult salmonids, with some mortality expected to occur at exposure of approximately three weeks (during winter high flow periods). Effects on juveniles would be expected to be similar in nature but potentially more severe in magnitude. It should be noted that the conclusions for both of these scenarios are uncertain due to uncertainty in predicted TSS concentrations, lack of baseline TSS data in the Sandy River, and the variability in observed responses to exposure reported in the literature.

Alternative 2--Removal of Top of Dam in Year 1, Complete Dam Removal in Year 2 with Sand Layer Excavation

Passage facilities: This alternative is similar to Alternative 1 in that sediments would be allowed to move downstream during periods of high flow. However, Alternative 2 stages the removal of Marmot dam sediments over 2 years. In the first year, the crest of the dam would be lowered to an elevation based on geomorphology studies. The intent is to leave the sand layer behind the dam undisturbed while allowing much of the coarser sediment above this elevation to move downstream during high flows. In the second year, the sand layer behind the dam would be excavated. This would prevent fine sediments from being transported downstream with the possibility of affecting important habitats.

Since 2 years of construction work are anticipated, alternative fish passage would have to be in place for two construction seasons. One year prior to the removal of Marmot dam a fish barrier dam, capable of surviving high flows, would be installed about 800 to 1,500 feet downstream of Marmot dam. This effort would require partial cofferdams, built on each side of the stream, above and below the new fish passage facility site. An RCC surface would be installed across the river channel, of minimal height, but level for installation of either a rubber dam (Obermeyer) or a "Chiwawa River" type barrier structure. Either structure could be lowered to accommodate high flows. Concrete abutments would be built to accommodate flow up to 10,000 cfs, after which they would be overtopped. On the north bank a concrete fish ladder structure would allow fish to climb to a trap, a 10-foot by 20-foot by 6-foot deep holding/sorting tank and a recovery tank. Attraction would come from an intake located upstream of the new barrier dam. It would have to be pumped to the upper tanks from which it would flow down to the river through the ladder.

See Section 5.3.1.2 for a discussion of anticipated effects of sediment transport on downstream aquatic habitats.

Impacts of channel adjustment in the reservoir reach: Under this alternative, sediment would be eroded from the reservoir reach during the first year following dam removal, and the remaining sediment would be excavated during the second year following removal. Since a portion of the dam would be left in place during the intervening season, fish passage would need to be provided over the dam. During the first year following removal, the channel upstream of the dam would be unstable in response to adjustment to the new channel gradient, although the instability may be less severe than expected under Alternative 1. Barriers to adult salmonid passage within the reservoir, therefore, would not be expected to occur. Deposition of sediment downstream of the dam, however, would likely block the entrance to the fish ladder, thereby eliminating passage over the dam structure. In addition, any redds constructed in the reservoir reach during the first year would be vulnerable to deposition and scour, although

the magnitude of deposition would be less severe than under Alternative 1. After sediment is excavated from the reservoir (during year 2), removal of the remaining sediment would alter the habitat characteristics in the reservoir reach. Under current conditions, this reach is low gradient and provides suitable habitat for fall and spring chinook spawning, and rearing of juvenile anadromous salmonids of all species spawning upstream of the dam. After excavation, this reach would be steeper and likely would no longer provide suitable spawning habitat, although juveniles of some species would still be expected to rear in this reach. Because this reach is short in length and is not considered to provide primary spawning habitat for anadromous salmonids, impacts to salmonid populations resulting from the changes to this reach are expected to be minor.

Following excavation of the reservoir sediment, morphologic adjustments in the reservoir reach would be expected, including deposition of coarse sediment from upstream areas. Depending on the excavation design and the composition and slope of the channel and bank, some instability would still be anticipated as the channel adjusts to the restored gradient. Because most of the sediment would be mechanically removed, the risk of impairment to fish passage in the reservoir reach is considered to be minimal. The risk of passage impairment would likely be greatest during the first year following construction. Species and runs that spawn primarily upstream of the dam and pass through this reach in fall and winter (mostly coho and winter steelhead) would be most vulnerable to barriers during the first fall and winter following removal.

Impacts of downstream sediment deposition: Under this alternative, approximately 260,000 cubic yards of mixed sand, gravel, and cobbles would be transported downstream in year 1. In year 2, the sediment remaining in the reservoir would be excavated, and little additional sediment from the reservoir reach would be delivered downstream. As described above, the initial deposition of sediment in Reach 1 is expected to be similar as for Alternative 1, but the reach would return to equilibrium sooner. Anticipated impacts to salmonids and salmonid habitats, therefore, would be similar in nature and magnitude but would extend over a shorter duration under Alternative 2 compared to Alternative 1. Downstream, both the magnitude and duration of sediment deposition and resulting impacts to salmonids and salmonid habitats would be less than Alternative 1. Because most sand would be removed from the reservoir by excavation, sand deposition in Reach 5 is expected to be less than Alternative 1, and the risk of sediment accumulation sufficient to block fish passage would likely be minimal.

Impacts of downstream suspended sediment: Under this alternative, total suspended sediment concentration downstream of the dam may increase during the construction period, including during dam removal in year 1 and during excavation of the sediment remaining behind the dam in year 2. Increases in TSS concentration occurring

in year 1 would be similar to those described for Alternative 1.

Following partial removal of the dam, increases in downstream suspended sediment concentration resulting from release of sediment for the reservoir are expected to be similar to those predicted for year 1 under Alternative 1. Impacts to salmonids during the first year following removal, therefore, would be similar to those described for Alternative 1.

Alternative 3--Remove the Maximum Amount of Sediment Possible During One In-water Construction Period

Passage facilities: This alternative includes a temporary trapping facility identical to the trapping facility described in Alternative 1. The same considerations apply with regard to the disposition of hatchery fish after the completion of Marmot dam removal.

See Section 5.3.1.2 for a discussion of anticipated effects of sediment transport on downstream aquatic habitats.

Impacts of channel adjustment in the reservoir reach: Under this alternative, sediment would be excavated between 600 and 2,000 feet upstream of the dam. The remainder of the sediment would be left in place. Following dam removal, the channel would adjust to the restored gradient. Compared to Alternative 1, the magnitude of channel and bank instability expected during the adjustment period is less severe, and the risk of impairment of fish passage during this adjustment period (e.g., through channel instability) is considered to be reduced due to the relatively small volume of sediment remaining after excavation. As described under Alternative 1, habitat characteristics in the reservoir reach would change as the channel adjusts to the restored grade, and redds constructed in the reservoir during the adjustment period would be vulnerable to burial and scour.

Impacts of downstream sediment deposition: Under this alternative, much of the sediment remaining in the reservoir would initially be deposited in the downstream portion of the reservoir reach rather than in Reach 1. The magnitude of impacts to salmonids and salmonid habitats in Reach 1, therefore, is expected to be somewhat less than Alternative 1. However, it is likely that sediment deposition in this reach would result in the loss or degradation of salmonid habitats and that instability in this reach in the first years following dam removal would make this reach less suitable for salmonid rearing.

As with the other alternatives, no deposition of sediment in Reach 2 is anticipated.

Downstream of Reach 2, deposition and resulting impacts to salmonids and salmonid habitats are expected to be similar to Alternative 1.

Impacts of downstream suspended sediment: Under this alternative, total suspended sediment concentration downstream of the dam may increase during the construction period. Construction-related increase in TSS concentration would be greater than for Alternative 1, because the construction would extend for a longer period of time.

Following dam removal, predicted increase in suspended sediment concentration is similar to that described for Alternative 1 during the first year. During the second year, only slight increases relative to reference conditions are predicted.

Measures to Minimize Impacts to Listed Fish Species in the Sandy River

As discussed above, removal of Marmot dam has the potential to affect listed, proposed, and candidate species. Fish passage, tributary and side channel blockage, and sediment deposition are the primary effects. The following is a discussion of the measures proposed by PGE to minimize these effects.

General Protection Measures

PGE proposes numerous measures to minimize impacts. These include single season Marmot dam removal; coffer dam removal at the end of the first in-water construction season prior to high winter flows; maximizing discharge to breach the coffer dam and cause rapid sediment scour; shaping sediment banks to minimize dry season bank sloughing; providing fish passage during in-water dam removal activities; and providing minimum downstream flows into the Sandy River.

Endangered Species Act Fish Monitoring and Contingencies Plan

To address these adverse impacts, PGE convened an ESA Subgroup to develop a monitoring and contingency plan. A team of experts from the USFWS/NMFS and PGE carefully reviewed and discussed potential effects on threatened, endangered, or candidate species under the ESA from dam decommissioning and project removal. From these meetings, measures were identified to address effects of the dam decommissioning and project removal. PGE developed a Fish Monitoring and Contingencies Plan (Section 4.6 of the Decommissioning Plan—Appendix A of this EIS) to implement measures to minimize incidental take to listed species and provide for the conservation of these species during and following the dam decommissioning and project removal until 2017.

An ESA Monitoring and Implementation Team (MIT), comprised of representatives of PGE, ODFW, NMFS, and USFWS, would be established to oversee the ESA Fish Plan. The MIT would meet annually (approximately in May), and MIT members would review the previous winter's hydrologic data and, as the Sandy River flows recede, the current habitat conditions and areas of greatest concern for fish passage and habitat impact for the upcoming low-flow season. As allowed for in the ESA Fish Plan, the MIT may modify the monitoring periodicity after the first full year following Marmot dam removal. The MIT also would meet more regularly, as Sandy River conditions deem necessary or Monitoring/Contingency Response data indicate.

Endpoint Determination Monitoring

PGE would measure channel complexity as an indicator of potential fish barriers following the removal of Marmot dam and to enable the MIT to determine when post-Marmot dam conditions in the Sandy River have returned to baseline-type conditions. Channel complexity at four monitoring sites would be measured by PGE using the standard deviation of channel bed elevation, which would be surveyed annually for at least 3 years prior to dam removal (Interim Measure), and continue annually after the dam removal until the risks of potential passage barrier formation becomes sufficiently small, as described in section 4.7 of the Decommissioning Plan (PGE 2002c).

The monitoring plan includes one site in the Reservoir Reach, two sites in Reach 1, and one site at the top of Reach 3. In the Reservoir Reach and Reach 1, the monitoring duration would be 1 year plus 2 consecutive years with: (1) no barriers to fish passage, and (2) either improved channel complexity or channel complexity within the range of values prior to dam removal (*i.e.*, monitoring would be conducted for at least 3 years in these reaches). Reach 3 would be monitored for the duration of monitoring in Reach 1 plus 2 consecutive years with: (1) no barriers to fish passage, and (2) either improved channel complexity or channel complexity within the range of values prior to dam removal (*i.e.*, monitoring would be conducted for at least 5 years in this reach). Post-Marmot dam channel bed surveys would be supplemented by the ESA Fish Monitoring and Contingencies Plan's fish passage blockage monitoring to assess actual passage conditions in the Sandy River.

Falls Chinook Conservation Program

PGE proposes to contribute \$25,000 toward development of a fall chinook conservation program designed to reduce the risk of adverse effects to fall chinook in the Sandy River (PGE 2002c, Appendix B). The program would include collection and fertilization of adult fish; rearing and disease control of adult fish and their progeny held

in the hatchery; monitoring impacts to fall chinook salmon redds and subsequent emergence; and release and monitoring of hatchery-reared progeny.

Implementation of the proposed mitigative measures would help mitigate short-term adverse impacts of the removal of Marmot dam.

Removal of Little Sandy Diversion Dam

Little Sandy diversion dam would be removed during a single low water season through a combination of blasting, excavation and air hammers. Neither cofferdams nor temporary fish passage would be required during dam removal.

Potential impacts to Little Sandy Reach 1 (0-0.3 mile downstream of Little Sandy diversion): Removal of Little Sandy diversion would result in movement of the sediment currently accumulated behind the dam downstream into Reach 1. Under full-flow conditions, this reach would have a high sediment transport capacity, resulting in relatively rapid downstream movement of this sediment, depending on the magnitude of high flows in the Little Sandy River following dam removal. In the short term, aggradation in Reach 1 is anticipated, with deposition occurring unevenly depending on local shear stress conditions. Coarse sediment aggradation may cause mortality of alders that have encroached into the channel due to reduced flows. Restoration of natural flow regimes (including high flows and winter baseflows) could also cause scour/dieback of riparian vegetation that has become established in the formerly active channel. Restoration of high flows would also likely promote more frequent mobilization of bed materials that are immobile under the current flow regime, resulting in an overall decrease in median grain size in the channel. Mortality of riparian vegetation (willows and alders) could also contribute to increased mobility of cobble/boulder bars on which willows currently grow, since the stabilizing influence of vegetation roots on substrates would be reduced once the willows die and their roots decay. The small pools in Reach 1 are also likely to infill with coarse sediment. Fine sediment deposits that are currently present in Reach 1 would likely be transported downstream by restored flows.

Potential impacts to Little Sandy Reach 2 (0.3-1.7 miles downstream of Little Sandy diversion): Removal of Little Sandy diversion is expected to have little effect on geomorphic conditions in Reach 2, because the steep gradient and high confinement of this reach create high shear stresses and sediment transport capacity, resulting in channel morphology that appears highly resilient to changes in sediment and water supply. Sediments released from behind the dam are expected to travel quickly through this reach and into the Bull Run River, and restored flows are not expected to result in morphologic changes. Some coarse sediment deposition may occur in the pools located 0.9-1.0 mile

downstream of the dam (as well as in the riffle between the pools), decreasing pool depth and volume. Decreases in habitat area in these pools may be counterbalanced to some extent by increased discharge. In addition, localized aggradation may deposit a coarse sediment mantle over bedrock bench areas associated with knickpoints in this reach, and some small deposition sites associated with momentum defects (bedrock outcrops, boulders) could swell with gravel in response to the sediment pulse from the dam, although the duration of these effects would likely be short.

Potential impacts to Bull Run River: The Bull Run River appears to be sediment-depleted downstream of the City of Portland's dams, which block downstream delivery of coarse sediment, and gravel augmentation in the Bull Run River has previously been proposed to mitigate the loss of upstream supply (R2 Resource Consultants 1998b). Release of sediment from Little Sandy diversion may therefore have a beneficial effect on the Bull Run River, facilitating deposition in locations that currently lack alluvial deposits or are unsaturated. This effect is likely to be small, however, given the small amount of sediment that would be released from behind Little Sandy diversion. No adverse effects of sediment release from Little Sandy diversion on the Bull Run River are anticipated.

Impacts of turbidity and suspended sediment: Because sand comprises 35 to 45 percent of the reservoir deposit upstream of Little Sandy diversion, removal of the dam and subsequent mobility of the reservoir sediments could increase turbidity and suspended sediment concentrations in the lower Little Sandy and Bull Run Rivers. Because the amount of sand stored behind Little Sandy diversion is relatively small, however, turbidity and suspended sediment impacts are expected to be substantially less than under any of the alternatives for removal of Marmot dam, including Alternative 3.

Potential impacts to aquatic organisms: Assessment of potential impacts to aquatic habitat in the Little Sandy River differs from assessment of impacts in the Sandy River because of the substantial differences in habitat suitability and access under current conditions. The lower Little Sandy River currently provides poor habitat for salmonids and other aquatic organisms because over 90 percent of baseflows are diverted, and access to the upper Little Sandy River from downstream of the dam is currently blocked because Little Sandy diversion does not have fish passage facilities. In contrast, the Sandy River currently supports good habitat for anadromous salmonids both upstream and downstream of Marmot dam, and facilities for upstream and downstream passage for these species are provided at Marmot dam. Although sediment release from Little Sandy diversion may result in some changes to habitat conditions, dam removal would substantially improve conditions for anadromous salmonids and other native aquatic organisms in the Little Sandy River by increasing flows and restoring connectivity with

the upper basin. The analysis presented below focuses on potential sediment-related impacts of removing Little Sandy diversion and does not discuss the habitat benefits of restoring flows and access in the Little Sandy River, which, as noted above, are expected to far outweigh any adverse sediment-related effects.

Anadromous salmonids: Juvenile steelhead are currently found in the lower Little Sandy River (O'Neal and Cramer 1999), and surveys for this study suggest that steelhead are the anadromous salmonid species most likely to use this reach under full-flow conditions, particularly winter steelhead, given the lack of deep pools suitable for holding by adult summer steelhead. Coho salmon, spring chinook salmon, and cutthroat trout could also use this reach (mainly for rearing) with restored flows.

Migration (which is currently blocked by Little Sandy diversion) is not expected to be adversely affected by sediment release. Because of the relatively low volume of sediment stored behind Little Sandy diversion, it is unlikely that the sediment deposit (or downstream aggradation resulting from sediment release) would create a physical barrier to fish passage following removal of the dam.

Aggradation in Reach 1 may limit its suitability for salmonid spawning in the short term, although as noted above, such habitat is currently limited in this reach. Gravels deposited downstream of the dam would likely initially be highly mobile, potentially causing egg mortality if these gravels are used for spawning. The high sediment transport capacity in this reach would likely transport most substrates suitable for salmonid spawning downstream (and out of the Little Sandy River) within a short period of time following dam removal. Spawning habitat may increase near the downstream end of Reach 1 following dam removal, where deposition of sediments released from the dam (as well as increased flows) may increase the suitability of existing alluvial deposits for spawning. Sediment released from Little Sandy diversion also would not likely substantially affect summer or winter rearing habitat for salmonids in Reach 1. Infilling of pools with coarse sediments may slightly reduce the suitability of these sites as adult holding and juvenile rearing habitat, but the riffle areas that predominate in this reach would likely remain suitable for rearing, even if short-term aggradation occurs.

Sediments released from the dam would not likely affect spawning or rearing habitat for salmonids in Little Sandy Reach 2 in the long term. No suitable spawning habitat currently occurs in the reach, and increases in gravel deposition as a result of the sediment pulse following dam removal would likely be short in duration because of the reach's high gradient. Riffles that are suitable for juvenile steelhead rearing (including coarse substrate interstices used for winter refuge) would not be expected to be susceptible to sediment deposition impacts. In the long term, restoration of LWD

transport and supply from the upper basin could increase the potential for gravel deposition and improve habitat conditions in this reach.

Resident salmonids: With the removal of Little Sandy diversion dam, there will be some short-term impact of the presence of wild salmon and hatchery strays on resident fish upstream of the dam, including on the resident rainbow trout population. Over the long-term, however, with unobstructed upstream and downstream passage, the fish assemblage would return to a more natural condition.

Removal of Canals, Tunnels, Flumes, and Ancillary Structures

The removal of the canals, tunnels, flumes, and ancillary structures would occur during the same 2- to 3-year construction period as removal of the two dams. At the Little Sandy diversion dam site, equipment would be mobilized once to remove the dam and plug the tunnel. Removing these structures should not affect fisheries resources.

Project Powerhouse

Removal of the powerhouse and appurtenant structures should not affect fisheries resources.

Removal of Roslyn Lake

The only flow through Roslyn Lake is water supplied for hydroelectric generation. When the project is decommissioned, Roslyn Lake cannot function as a lake without an alternate supply of water. For this reason, the proposed action is to drain the lake, regrade the area, and turn it into public space that would be donated to, and administered by, an organization to be determined.

Roslyn Lake currently provides a popular put-grow-and-take angling area. The ODFW stocks rainbow trout annually and this provides a popular fishery. Recently, ODFW has also taken summer steelhead that were trapped at the Marmot dam and stocked them in Roslyn Lake to provide a fishery.

Removing the lake would eliminate the lentic habitat and associated biota. However, the lake is an artificial structure that creates warm-water habitat that is common regionally. The summer steelhead and put-grow-and-take rainbow trout fisheries would cease. With regard to the summer steelhead, this is a hatchery supported run which has the potential to compete with ESA listed stocks. Many anglers would move to other fishing areas in the region, increasing angler pressure at these areas.

Interim Fish Protection Measures

PGE proposes two interim measures to be implemented during the period prior to dam removal.

Diversion Canal Water Levels

PGE proposes to lower Marmot dam diversion canal water elevations to 4.7 feet from February 15 to March 1. Additionally, PGE would lower the canal water elevations to 4.2 feet for 8 hours per day, beginning daily at sunset, between March 15 and May 15, and no greater than 4.7 feet for the remaining periods of these days.

Lowering the Marmot dam canal elevation to 4.7 feet from February 15 to March 1, and lowering canal levels to 4.2 feet at sunset for 8 hours each day, and no more than 4.7 feet for the remainder of the day, from March 15 to May 15, in concert with a minimal fry migration timing monitoring effort (to allow modification of the March 15 start date), would minimize impacts to listed salmon species. For the lower canal elevation of 4.2 feet, it is estimated that 80 percent of the fry would use the bypass ports and not become impinged, a 10 to 45 percent improvement over impingement levels at higher canal elevations. Additionally, only 10 percent of outmigration occurs during daylight hours (ODFW 1999), so reducing canal levels during the night will reduce impingement for 90 percent of the fry during peak outmigration.

This measure should benefit threatened Lower Columbia River chinook salmon and steelhead ESUs, and the Lower Columbia River/Southwest Washington Coast coho salmon ESU. Conditions for the Southwestern Washington/Columbia River coastal cutthroat trout DPS that occur above the Marmot Dam and migrate downstream would also improve.

Fish Ladder Operation and Maintenance

PGE proposes to maintain the same effort on operations and maintenance of the fish ladder, as described in the current agreement between ODFW and PGE, during the period between expiration of the current FERC license and dam removal.

Passage conditions for anadromous salmonids would continue to benefit from maintenance of the fish ladder. This trap is used for sorting out hatchery fish and allowing only unmarked fish to pass upstream to the upper Sandy River watershed. The use of the trap should facilitate protection of native fish runs and greater harvest of hatchery fish. To avoid delays to migration, PGE is currently clearing the trap and

transporting the fish daily. At the time at which the dam and fish ladder are removed all hatchery introductions and progeny will be from wild brood stock, and no sorting will be needed.

This measure should benefit threatened Lower Columbia River chinook salmon and steelhead ESUs, and the Lower Columbia River/Southwest Washington Coast coho salmon ESU. Conditions for the Southwestern Washington/Columbia River coastal cutthroat trout DPS that occur above the Marmot Dam and migrate downstream would also continue to benefit from maintenance.

Summary of Effects to Listed Fish Species

Adverse impacts to salmonids would result primarily from removal of Marmot dam. These impacts include: (1) increases in total suspended sediment concentration downstream of the dam during construction, (2) short-term impairment of adult upstream passage during dam removal and potentially following dam removal, and (3) potential short-term impairment of juvenile downstream passage during and following removal, (4) elimination of the opportunity to use the fish ladder at Marmot Dam as a fish sorting facility; and (5) unobstructed access for hatchery salmonids and other fish species to areas above Marmot and Little Sandy dams. However, the selection of 2007 for Marmot Dam Removal is designed to reduce wild-hatchery fish interactions (ODFW 2001, 2003). These adverse sediment effects are all expected to be short-term in nature, and would be minimized through the ESA monitoring and contingencies plan and endpoint monitoring plan described above. Based on sediment transport modeling, it appears that within 10 years following dam removal the sediment in the channel will be transported at natural rates. In addition, modeling also indicates fish passage barriers from sediment deposition are unlikely and, if they do occur, will be addressed, via the ESA monitoring and contingencies program. In the long-term, therefore, residual detrimental effects to fish and aquatic habitat from Marmot dam removal are expected to be insignificant and discountable, and beneficial effects, including restored flows and passage, will be significant.

Total suspended sediment concentration downstream of Marmot dam is expected to increase during construction for all dam removal. The magnitude of construction-related increases to total suspended sediment concentration could be reduced through implementation of measures to control the release of sediment and turbid water from the construction site. The magnitude of increased concentration resulting from delivery of sediment downstream following dam removal, however, likely could not be reduced through available measures.

Detailed information on the effects of removal of the project is found in the biological evaluation prepared for the surrender application (PGE 2002d).

Implementation of the measures outlined in the BOs issued by USFWS and NOAA Fisheries (see Section 4.5.4) would further protect listed fish species.

5.3.3.3 Staff Modifications to PGE's Proposal

PGE proposes to construct a temporary fish barrier, Denil fish ladder, and fish trap to be operated during the period of time when marmot dam is being removed. PGE should file detailed design drawings of these facilities and an operation plan, prepared after consultation with appropriate agencies. PGE should also develop a plan to implement the measures included in the BOs issued by USFWS and NOAA Fisheries (see Section 4.5.4) .

5.3.3.4 Effects of Alternatives on Essential Fish Habitat

Public law 104-267, the Sustainable Fisheries Act of 1996, amended the Magnuson-Stevens Fishery Conservation and Management Act (MSA) to establish new requirements for Essential Fish Habitat (EFH) in Federal fishery management plans and actions and to require agencies to consult with NMFS on activities that may affect EFH. The MSA defined essential fish habitat as those waters and substrate necessary for fish use in spawning, breeding, feeding or growth to maturity. The Pacific Fisheries Management Council (PFMC) has designated EFH for the Pacific Salmon fishery that includes those waters and substrate necessary to ensure the production needed to support a long-term sustainable fishery.

EFH includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to coho and chinook salmon in Oregon, Washington, Idaho and California, except above the impassable barriers identified by PFMC. EFH excludes areas above natural barriers, such as waterfalls. Proposed actions on the Sandy River include removal of Marmot dam and Little Sandy diversion and allowing the associated sediment that has accumulated behind these structures to flush downstream. Analysis completed by Stillwater Sciences, displayed in the biological evaluation prepared for this project (PGE 2002d) discusses the possible short-term negative effects associated with project removal (section 6.2 of the biological evaluation). These short-term impacts may adversely effect EFH. Considering these impacts with the returned volitional passage to the river system for chinook and coho salmon, and the return to a natural stream channel alignment and sediment movement, adverse effects are greatly diluted. In the long-term, the effects of dam removal and project decommissioning would

be beneficial for EFH. In summary, neither short-term effects nor long-term, residual effects of the proposed actions would result in substantial adverse effects to EFH.

5.3.3.5 Cumulative Impacts

Anadromous salmonid populations in the basin have been affected by past actions both within and outside of the Sandy River watershed. For the chinook and coho salmon, and steelhead ESUs occurring in the Sandy River Basin, NMFS (1995, 1996, 1998) identifies the following as factors contributing to declines of the ESUs: loss of access to habitat; habitat degradation resulting from flow diversion, stream channelization, forestry, mining, urbanization, and agriculture; hatchery practices; water withdrawal and unscreened diversions; commercial and sportfish harvest; drought; predation; eruption of Mt. St. Helens; and adverse ocean conditions. Within the Sandy River watershed, salmonid habitat and population abundance have been altered by forestry management practices in the upper watershed, past flood control projects, flow diversion at Marmot and Little Sandy diversions (including entrainment and injury or mortality of juvenile salmon and steelhead at Marmot dam), and flow regulation and diversion at the City of Portland's Bull Run project. In addition, hatchery practices in the basin have affected salmonid population structure and dynamics. As discussed in Section 5.3.3.1, spring and fall chinook salmon and winter and summer steelhead have been introduced to the Sandy River Basin from other watersheds in Washington and Oregon. Spring chinook and winter and summer steelhead continue to be introduced from outside the basin. PGE currently funds a portion of the spring chinook hatchery program as mitigation required by ODFW for elimination of access to habitat upstream of the Little Sandy diversion. ODFW also operates a coho hatchery in the Sandy River Basin. The City of Portland funds ODFW for producing hatchery fish as mitigation for its Bull Run Project (Taylor 1998). Since 1998, PGE and ODFW have sorted hatchery steelhead and coho at Marmot dam to prevent hatchery-origin fish of these species from spawning in the upper basin.

Removal of Marmot dam would result in a range of short-term and long-term cumulative impacts to anadromous salmonid populations in the basin. Short-term impacts to anadromous salmonids are generally negative and result from: (1) increases in total suspended sediment concentration downstream of the dam during construction and following dam removal, (2) release of coarse sediment from the reservoir, (3) impairment of adult upstream passage during construction and following dam removal, and (4) potential impairment of juvenile downstream passage during construction and following removal. These potential short-term, adverse impacts are discussed in more detail in Section 5.3.3.2. Potential impacts to downstream habitat and adult and juvenile passage would contribute to adverse cumulative effects of land use practices, harvest, and other factors described above to salmonid habitat quality and population abundance in the

basin. In the long term, removal of Marmot dam is anticipated to substantially benefit salmonid populations in the basin. These beneficial impacts include: (1) restoration of natural flow conditions downstream of Marmot dam, (2) improved adult upstream passage, and (3) improved juvenile downstream passage and elimination of entrainment impacts. Combined with implementation of the Northwest Forest Plan on federal land and other actions within and outside of the watershed to improve salmonid habitat conditions, improved access to habitats upstream of Marmot dam and improved flow conditions downstream of the dam would provide a positive cumulative impact to salmonid resources.

Removal of Little Sandy diversion would provide access to 6.5 miles of potential habitat upstream of the dam that is currently inaccessible to anadromous salmonids. In addition, release of sediment from the reservoir and restoration of more natural flow conditions and sediment transport and LWD transport continuity to the river are anticipated to improve salmonid habitat conditions downstream of the dam. Combined with other ongoing and reasonably foreseeable actions within and outside of the basin to improve salmon habitat and population abundance (e.g., the Northwest Forest Plan), removal of Little Sandy diversion would provide a positive cumulative effect to salmonid resources in the basin.

5.3.3.6 Unavoidable Adverse Impacts

Unavoidable adverse impacts to salmonids resulting from removal of Marmot dam include: (1) increases in total suspended sediment concentration downstream of the dam during construction, (2) short-term impairment of adult upstream passage during dam removal and potentially following dam removal, (3) potential short-term impairment of juvenile downstream passage during and following removal, and (4) elimination of the opportunity to use the fish ladder at Marmot dam as a fish sorting facility.

Total suspended sediment concentrations downstream of Marmot dam are expected to increase during construction for all dam removal alternatives, although the magnitude and duration of the increase varies for the alternatives evaluated. The potential effects of increased total suspended sediment concentration on anadromous salmonids are discussed in Section 5.3.3.2. The magnitude of construction-related increases to total suspended sediment concentration could be reduced through implementation of measures to control the release of sediment and turbid water from the construction site. The magnitude of increased concentration resulting from delivery of sediment downstream following dam removal likely could not be reduced through available measures.

For all alternatives, adjustment of the channel upstream of the dam following dam removal may impair adult upstream and juvenile downstream passage through the reservoir reach. The likelihood of passage being impaired varies for the alternatives evaluated, with risk increasing as less sediment is excavated from the reservoir. In addition, sediment deposition in Reach 1 may impair passage through this reach in the short-term. The potential for impairment of adult and juvenile passage for each alternative is discussed in Section 5.3.3.2. Contingency measures may be available to restore passage should barriers form following dam removal, as discussed below.

Because of the uncertainties involved in predicting the impacts of removing Marmot dam on anadromous salmonids and other aquatic organisms, particularly for removal options in which greater amounts of sediment would be released, contingency plans to mitigate some of the potential impacts discussed above have been developed and included in Section 4.6 of the Decommissioning Plan (Appendix A of this FEIS)..

Three primary areas of potential impacts that represent a high enough risk to resources of concern, particularly listed salmonids, to merit development of contingency plans under at least some of the dam removal alternatives have been identified:

Fish passage problems caused by headcutting or bank failure in the reach upstream of Marmot Dam and/or by aggradation immediately downstream of the dam: Erosion of sediment from Marmot reservoir and sediment deposition immediately downstream of the dam could potentially create a barrier to upstream fish migration under some removal alternatives. As discussed above (Section 5.3.1.2), review of scientific literature on headcutting and analysis of the characteristics of reservoir sediment suggest that reservoir headcutting would be unlikely to create a fish passage problem, although there is a possibility of a short-term fish passage barrier being created by bank failures upstream or coarse deposits immediately downstream of the dam site, particularly under Alternative 1. Regardless of this assessment of the probability of occurrence of headcutting or bank failure, a contingency measure to address potential passage problems following dam removal was incorporated into Section 4.6 of the Decommissioning Plan.

Impaired salmonid access to side-channel habitats and /or tributaries in Reaches 3 and 4: As discussed in Section 5.3.1.2 above, sediment release from behind Marmot dam is expected to result in gravel deposition in Reaches 1 and 3 and sand deposition in Reach 5. The model does not predict deposition of sand or gravel in Reach 4, but if such deposition did occur in side-channel areas, it could have deleterious effects on salmonid habitat. A contingency measure to address the risks associated with potential sediment deposition in Reaches 3 and 4, where most side-channel habitats in the Sandy River are located, was incorporated into Section 4.6 of the Decommissioning Plan.

Fish passage problems caused by sand deposition in the Sandy River delta:

Because of its low gradient and the backwater effect of the Columbia River, the Sandy River delta (Reach 5) could experience sand aggradation following removal of Marmot dam, possibly meriting contingency measures to account for potential fish passage problems during low-flow periods. While sediment transport modeling predicts sand deposition of up to 1.3 feet in Reach 5, with fluctuations throughout the year (see Section 5.3.1.2), the actual magnitude of deposition is uncertain because of the potential backwater effect of the Columbia River. A contingency measure to address the risks associated with potential deposition of sand in Reach 5 was incorporated into Section 4.6 of the Decommissioning Plan.

5.3.4 Terrestrial Resources

5.3.4.1 Affected Environment

The Bull Run Hydroelectric Project is located in western Oregon in the West Slope Cascades physiographic province (ODFW 1993). Geologically, this province is characterized by volcanic activity, with soils derived from pyroclastic parent material and igneous rocks. The upper Sandy River Basin, however, was buried by a landslide from Mt. Hood about 200 years ago, and surface materials in the vicinity of Marmot dam are currently composed of sand and cobble. Most of the West Slope Cascades province, including the project vicinity, is within the Western Hemlock (*Tsuga heterophylla*) vegetation zone (Franklin and Dyrness 1973). Elevations in the project vicinity range from about 340 feet at the confluence of the Bull Run and Sandy Rivers to 738 feet at Marmot dam. The area is characterized by a wet, mild, maritime climate (Franklin and Dyrness 1973).

Botanical Resources

Vegetation Cover Types

Plant associations and vegetation cover were mapped in the 2,739-acre study area for terrestrial resources. More information, including cover type maps, can be found in Tressler (2001b).

Conifer forest types: Upland conifer forest types include old-growth, mature, and mid-successional stands and are dominated by Douglas-fir, western hemlock, and western red cedar. About 60 acres of conifer forest is found within the project boundary.

Mixed deciduous/conifer forest types: Mixed deciduous/conifer forest types

dominate the study area and include mature, mid-successional, and early successional stands. Dominant species include Douglas-fir, big-leaf maple, western red cedar, western hemlock, , and red alder. Early successional mixed deciduous/conifer forest is common within the FERC boundary along the entire corridor for the wooden box flume. It is also found on PGE lands along the Marmot dam service road, and east of Roslyn Lake. Mid-successional stands represent about 25 percent of the land within the FERC project boundary.

Deciduous forest types: Deciduous forest types include both mid- and early successional stands. Dominant species include red alder and Douglas-fir. Mid-successional deciduous forest occurs within the FERC boundary along both sides of the corridor for the wooden box flume. Much of this area is bisected by a number of very small streams and seeps. Mid-successional deciduous stands are also found on a large parcel of land owned by the City of Portland along the Bull Run River downstream of its confluence with the Little Sandy River. Early successional deciduous stands are found on PGE lands along part of the Little Sandy diversion service road and both sides of a portion of the Sandy River.

Non-forested uplands: Non-forested uplands represented include shrublands and grasslands. Upland shrublands occur in small patches in the transmission line right-of-way (ROW) and along the Sandy canal, wooden box flume, and roads. Nearly all of the upland shrubland is within the FERC project boundary. Most areas are currently disturbed and are dominated by Scot's broom and blackberry.

Grasslands: Grasslands are uncommon in the study area. Grasslands cover much of the dike along the north end of Roslyn Lake; they also occur on a few small patches of PGE land between the Little Sandy and Sandy drainages. About half of this type is within the FERC project boundary. Most of the grasslands in the study area are currently either pastures or part of recreation areas and are dominated by non-native grasses and forbs.

Riparian types: Riparian vegetation occupies 244 acres, or 9 percent of the study area, and includes three cover types: (1) riparian mixed deciduous/conifer forest; (2) riparian deciduous forest; and (3) riparian deciduous shrubland.

Riparian mixed deciduous/conifer forest represents about 54 percent of the riparian vegetation in the study area; about 5.5 acres are located within the project boundary. Dominated by western red cedar and red alder, this type borders about 3 miles of both sides of the Sandy River below Marmot dam and about 2 miles along one side upstream of the dam. It also borders most of the Bull Run River below the confluence with the Little Sandy River. In contrast, the Little Sandy River is currently bordered by riparian

deciduous forest. This type also occurs in a few locations along the Bull Run River, and in patches along the Sandy River.

Riparian deciduous forest represents about 32 percent of the riparian vegetation in the study area (about 20 acres with project boundary) and is characterized primarily by red alder, although black cottonwood and big-leaf maple also occur. Small patches of maidenhair fern are found on bedrock in the steep canyons of the Sandy and Bull Run Rivers. Riparian deciduous shrublands are relatively uncommon, representing about 14 percent of the riparian vegetation in the study area and about 8 acres within the project boundary. This type occurs in a few patches along all three rivers and consists of willow and small red alder.

Surveys to characterize the structure and composition of riparian vegetation were conducted in August 1999 and more detail is provided in Tressler (2001b). In general, tree and shrub canopy cover naturally exhibits high variability and it is difficult to identify differences between areas. However, overall tree canopy cover was substantially higher at sites downstream of Marmot dam, the Little Sandy diversion, and the Bull Run powerhouse than at sites upstream of these facilities. Shrub cover was high in all riparian areas sampled, and dominated by facultative species (species that can occur in upland and wetland locations). The most noteworthy difference between up- and downstream sites was observed along the Little Sandy River; trees in riparian areas downstream of the diversion were significantly taller and larger in diameter than trees upstream of the diversion. There was also substantially more down wood downstream of the Little Sandy diversion than upstream or in any other riparian zone in the study area.

Wetland types: Wetlands in the study area are rare, occupying only 14 acres and occurring in nine locations (about 11 acres within project boundary). Most of the wetland acreage, including two palustrine forest and five palustrine scrub-shrub wetlands, are associated with Roslyn Lake and are on land owned by PGE. The scrub-shrub wetlands currently consist of dense stands of willow, red alder, and red-osier dogwood. The forested wetlands near Roslyn Lake are dominated by red alder and support a shrub layer of red-osier dogwood, salmonberry, and willow. One of these forested wetlands is maintained by water from a small tributary stream on the east side of the lake. The other receives water from a drainage ditch that carries seepage from the dikes on the south and west sides on the lake.

Two other forested wetlands occur on a slope south of Marmot dam and are located on land managed by the BLM. Supported by seeps, these wetlands are characterized by western red cedar and big-leaf maple, with an understory of salmonberry and skunk cabbage. The single pond in the study area is a small artificial impoundment

near Marmot dam that was created as a fish holding facility.

Deepwater types: Deepwater includes riverine and lacustrine types. Riverine types include the Little Sandy River upstream of the diversion, and the Bull Run and Sandy Rivers. Lacustrine types include Roslyn Lake (160 acres), and the small impoundments behind Marmot dam and the Little Sandy diversion.

Developed/disturbed types: Developed and disturbed cover types include recreational areas, project facilities, and lands used for agriculture. Most of the disturbed and developed lands (about 68 acres) are within the FERC project boundary and include project facilities, roads, and recreation areas.

Threatened, Endangered, and Sensitive Plants and Survey/Manage Plants

Threatened, endangered, and sensitive (TES) species are considered to be declining in population and/or in danger of extinction. Survey and manage (S/M)²⁰ species are designated by the Northwest Forest Plan (USFS and BLM 1994).

PGE consulted with numerous parties to determine which species would be likely to occur in the project vicinity (PGE 2002). Plant surveys were conducted in 1999 and 2000. More information on the survey methods are found in Keany 2001.

Surveys conducted in 1999 documented one TES species in the study area. Lesser bladderwort (*Utricularia minor*) was found at the south end of Roslyn Lake. This species is on OHNP List 2 and is listed as sensitive by the BLM. No S/M lichen, moss, fungi, or liverwort species were found during the November surveys. However, during surveys for S/M mollusks on January 31, 2000, two S/M plant species were located on BLM land near Marmot dam. These were *Otidea onotica*, a level 3 S/M fungi, and *Pseudocyphellaria rainierensis*, a level 1, 2, and 3 S/M lichen.²¹ Level 1 S/M species

²⁰ Standards and guidelines for S/M species apply to USFS and BLM lands and include the following strategies: (1) managing known sites; (2) surveys prior to ground-disturbing activities; (3) extensive surveys; and (4) general regional surveys.

²¹ The Survey and Manage categories used in this FEIS follow the Northwest Forest Plan 1994 Record of Decision. In 2000, a Supplemental EIS was completed that resulted in changes to the S/M category designations as well as the management requirements attached to each designation. Using the 2000 Record of Decision, *Pseudocyphellaria rainierensis* is a Category A species that requires that surveys be conducted prior to habitat-disturbing activities and that known sites be managed. The status of *Otidea onotica* was reviewed in 2001 and the species was (continued...)

require the management of known sites, while Level 2 species require surveys prior to ground-disturbing activities. Surveys for level 3 S/M species are not required prior to ground-disturbing activities. *O. onotica* was found on the north side of the parking lot adjacent to the dam and at two locations south of the dam. The three occurrences were in mid-successional mixed deciduous/conifer forest. *P. rainierensis* was found at one location north of the river, also in mid-successional mixed deciduous/conifer forest.

No S/M plant, lichen, bryophyte or fungi species were found on National Forest System Lands. In addition, no Proposed, Threatened, Endangered or Sensitive plant species were located on National Forest System Lands within the proposed project area or in an area outside the project boundary that may potentially be impacted by the proposed project.

Exotic/Invasive Plant Species

Exotic/invasive plant surveys were conducted in August and November 1999 and 15 species were located in the 2,739-acre study area (Keaney 2001). Himalayan blackberry (*Rubus discolor*) is the most widespread exotic/invasive plant in the study area and often formed dense, impenetrable thickets. This species was particularly dominant along the transmission line ROW. St. John's-wort (*Hypericum perforatum*) is another widespread weed, and was found on disturbed soils along the road and clearings near Marmot dam; along the bypass reaches of the Sandy and Little Sandy Rivers; along the wooden box flume; and near Little Sandy diversion.

Bull thistle (*Cirsium vulgare*) and Canada thistle (*C. arvense*) are two common weeds that have limited distribution in the study area. Canada thistle occurs on disturbed soils near Marmot dam and the Little Sandy diversion dam; bull thistle was observed in the bypass reach of the Little Sandy River. Dense stands of English ivy (*Hedera helix*), an escaped garden plant, were found along the south end of Roslyn Lake and along the bypass reach of the Sandy River. English ivy forms thick mats that suppress the growth of native herbaceous species. English ivy populations were second only to Himalayan blackberry in the density of infestation.

Scot's broom (*Cytisus scoparius*), a non-native shrub often found in upland disturbed areas, occurs in dense stands adjacent to the flume near the Little Sandy diversion and along a wide bench on the south side of the Little Sandy River about 0.25

²¹(...continued)

dropped from the Survey and Manage list; therefore it no longer needs to be considered for management.

mile from the diversion. Tansy ragwort (*Senecio jacobaea*), a non-native weed, and trailing blackberry (*Rubus ursinus*), a native blackberry that favors disturbed sites, both occur near Marmot dam and along Roslyn Lake. Robert's geranium (*Geranium robertianum*), a Eurasian weed, is a common component of the ground cover in the Sandy and Little Sandy bypass reaches.

Yellow starthistle (*Centaurea solstitialis*), tansy (*Tanacetum vulgare*), and giant knotweed (*Polygonum sachalinense*) were found in only a few locations in the study area. Yellow starthistle and tansy were recorded only near Marmot dam; giant knotweed was limited to a single location along the Little Sandy River, and tansy formed dense stands along both sides of the access road to Marmot dam.

Four other exotic/invasive species are known to occur in the project area. Policeman's helmet (*Impatiens glandulifera*) was found on a sandbar just upstream from Marmot dam and adjacent to the Sandy River about 300 yards downstream of the dam. Evergreen blackberry (*Rubus laciniatus*) infestations were found at two locations near Roslyn Lake. Bouncingbet (*Saponaria officinalis*) has a scattered distribution in the project area but does not occur in large patches. Himalayan knotweed (*Polygonum polystachyum*) was found at one location on the north side of Waterwork's Road.

Wildlife Resources

A variety of wildlife reside in the vicinity of the Bull Run Hydroelectric Project year round. Other species occur primarily during migration or as part time residents. Since 1996, PGE biologists have conducted surveys in the Bull Run Hydroelectric Project area to document wildlife use. In addition, PGE hydro maintenance employees have recorded incidental wildlife observations since 1995. Other existing and potentially occurring species were identified by reviewing Csuti et al. (1997) and information available from ODFW, MHNF, and BLM. Apart from the PGE surveys, no other specific wildlife inventories have been conducted on or near the project. Additional information on wildlife habitats and distribution in the project vicinity was collected during several studies conducted in 1999 for project decommissioning.

Mammals

Big game species found on or near the project include black-tailed deer, elk, black bear, and cougar.

Black-tailed deer: The black-tailed deer is the most common big game animal in western Oregon, as well as in the project vicinity. Project personnel have recorded

numerous sightings of this species along the Marmot dam access road, the Little Sandy diversion dam access road, the wooden box flume, and at Roslyn Lake (PGE, unpublished data). Forests in the project vicinity provide ample hiding and thermal cover for deer and forage is generally available in riparian areas, early successional forest stands, and shrublands.

Deer winter range in Oregon is generally defined as forested areas that receive less than 18 inches of snow and includes the entire project vicinity. Sensitive habitat areas for big game include the Little Sandy River drainage and the Sandy River and tributaries above the City of Sandy.

Elk: Elk, including a number of large bulls, are frequently seen in the project vicinity. These animals may cross from the Bull Run Watershed along the ridge that separates the Little Sandy and Sandy river drainages. PGE hydro maintenance personnel occasionally observe elk along the Marmot dam and Little Sandy diversion dam access roads (PGE, unpublished data). Elk in the project vicinity generally use the same habitats as deer for foraging and cover. Seasonally, elk also move between high and low elevation habitats in response to snow cover and changes in forage availability.

Native elk populations in the general vicinity of the project may be increasing (pers. comm., T. Thorton, Wildlife Biologist, ODFW, August 20, 1998). At least two large elk herds use the Upper Sandy River watershed and smaller herds occur throughout the drainage. The highest concentrations occur east of the project, near Marmot and Wildcat mountains. Private lands also support healthy elk herds and the area generally receives a fair amount of hunting pressure.

A 27-acre area approximately 1 mile northeast of Marmot dam is designated as elk winter range by the MHNF (USFS 1996). This area borders another designated deer and elk winter range in the Little Sandy River drainage about 3 miles east of the Little Sandy diversion dam. The lower portion of the Little Sandy River drainage is identified as normal and severe winter range for elk (USFS 1990). Normal winter range areas receive less than 18 inches of snow and are used by animals in mild winters. Severe winter range (typically lower elevation) is used in very cold and snowy conditions, generally 1 or 2 years per decade. The MHNF (USFS 1990) recommends that road densities in winter range not exceed 2.0 miles/square mile. The current road density of 3.12 miles/square mile in the Little Sandy River drainage exceeds this standard (USFS 1997).

Black bear: Black bears are often seen along the wood box flume and the access roads to Marmot and the Little Sandy diversion dams (PGE, unpublished data). While the project vicinity generally provides suitable habitat for bears, the proximity of roads and

human activity may limit use in some areas.

Cougar: The cougar population in the project vicinity is increasing (pers. comm., T. Thorton, Wildlife Biologist, ODFW, August 20, 1998). Hunting is prohibited in the Bull Run watershed upstream of the project, thereby providing a safe haven for cougars.

Incidental observations of other mammal species include the beaver, bobcat, coyote, red fox, mink, northern river otter, and muskrat (PGE, unpublished data). Mountain beaver burrows are evident along most of the corridor for the wooden box flume and on BLM land north of Marmot dam. Other species observed in the project vicinity include the common raccoon, Townsend's chipmunk, Douglas' squirrel, western gray squirrel, ermine, and unidentified skunk, rabbit, bat, mouse, rat, shrew, and mole species

Birds

Waterfowl: A variety of waterfowl (ducks and geese) species occur or potentially occur on the three project impoundments. Waterfowl use is highest at Roslyn Lake. The highest concentrations typically occur in the fall and winter when migrant waterfowl are present. Waterfowl documented in the project include Canada goose, snow goose, mallard, American wigeon, green-winged teal, blue-winged teal, northern shoveler, wood duck, scaup spp., ring-necked duck, canvasback, common goldeneye, bufflehead, ruddy duck, common merganser, and hooded merganser. Mallard broods have been observed at Roslyn Lake but nesting is limited because of the heavy recreational use. Canada goose broods have been seen near Marmot dam.

Gulls, waterbirds, and shorebirds: Over 30 species of gulls, waterbirds, and shorebirds are known or potentially occur in the project vicinity. Although the project is within the range of many of these species, suitable habitat is limited. Eleven species, including the common loon, western grebe, pied-billed grebe, eared grebe, horned grebe, American coot, double-crested cormorant, great blue heron, killdeer, California gull, and ring-billed gull were documented in the project vicinity during the surveys conducted in 1996 and 1997 (PGE, unpublished survey data).

Raptors and vultures: The various habitats in the project vicinity support a number of hawk, eagle, falcon, and owl species, as well as the turkey vulture. The red-tailed hawk, American kestrel, northern pygmy owl, bald eagle, and osprey have all been observed at the project (PGE, unpublished survey data) and over 20 other raptor species potentially occur in the vicinity.

During annual nesting surveys for ospreys in the project vicinity from 1996 to 1998, PGE has documented three osprey nest sites along the Sandy and Bull Run Rivers within 0.75 mile of project facilities. One site located along the Bull Run River downstream of the powerhouse successfully produced young during all 3 years. Ospreys are frequently observed foraging at Roslyn Lake. Bald eagles also occasionally forage at Roslyn Lake and have been seen flying above Marmot dam. There are no known nests or winter communal roost sites in the project vicinity.

Upland game birds: Upland game bird species occupying or potentially occupying the project vicinity include the blue grouse, ruffed grouse ring-necked pheasant, California quail, mountain quail, mourning dove, and band-tailed pigeon.

Amphibians and Reptiles

The project vicinity is within the distributional range of 14 reptile and 17 amphibian species. The common garter snake is the only reptile species that has been observed near the project, but the northern alligator lizard, western skink, and northwestern garter snake are probably some of the more common species present as well.

Amphibian surveys conducted in November 1999 documented five salamander, two frog, and one newt species in the project vicinity. These species include the northwestern salamander, Oregon slender salamander, western red-backed salamander, Dunn's salamander, Cascade torrent salamander, northern red-legged frog, Pacific chorus frog and rough-skinned newt. Several of these species are TES and more information on their distribution in the project vicinity is provided below. Although not observed, there appears to be suitable habitat for the ensatina, western toad, and long-toed salamander in the study area.

Although the impoundment above Marmot dam and the river below appear to be suitable habitat for the Pacific giant salamander, this species was not observed during the November 1999 surveys, nor has it been seen during the numerous snorkel surveys conducted for fish (pers. comm. D. Cramer, Fisheries Biologist, PGE, November 9, 1999). Since density of Pacific giant salamanders is negatively correlated with high amounts of fine sediment (Corn and Bury 1989), it is possible that the naturally high sediment loads in the Sandy River limits use by this species.

Threatened, Endangered, and Sensitive (TES) Wildlife and Survey/Manage (S/M) Wildlife

A total of ten TES and two S/M species have been recorded in or near the study

area to date (Tressler 2001a). The results of the surveys are discussed below and a brief summary on locations and habitat for these species is provided in table 26.

Three TES amphibian species were documented in the Bull Run study area—the Cascade torrent salamander, Oregon slender salamander, and red-legged frog.

Cascade torrent salamander--Cascade torrent salamanders were found in the following locations: (1) a seep in the splash zone immediately downstream of the Marmot dam on BLM land, (2) a forested wetland/seep on the hillside southwest of Marmot dam on BLM land, (3) several wetlands near the wooden-box flume, and (4) along the lower Bull Run River. All of these locations included only small patches of suitable habitat but supported both adult and larval individuals.

Oregon slender salamander--Oregon slender salamanders were found in uplands on USFS property downslope of the wooden-box flume and on BLM land south of Marmot dam. Along the wooden-box flume, one Oregon slender salamander was noted under loose bark near downed logs on a steep north-facing slope. The forest in this area was composed of large diameter Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and western redcedar (*Thuja plicata*). Thirteen Oregon slender salamanders were found during the late April survey of the uplands to the south of Marmot dam. These individuals were associated with large Douglas-fir logs on the north-facing slope. One other Oregon slender salamander was found immediately south of the dam during the February S/M terrestrial mollusk surveys.

Northern red-legged frog--Adult red-legged frogs were seen along the shoreline of Roslyn Lake, in seeps associated with the wooden-box flume, and in a forested wetland to the east of Roslyn Lake. The forests along Roslyn Lake and elsewhere in the study area provide abundant habitat for adult red-legged frogs, while the small wetlands and ponds provide habitat for egg deposition and larvae development.

Amphibian Egg Mass Surveys

The only location in the study area where red-legged frog egg masses or tadpoles were found was the forested wetland east of Roslyn Lake. This wetland is not dependent on the project for water, but its outlet does flow into Roslyn Lake. In April, 23 red-legged frog egg masses were recorded along with several northwestern salamander (*Ambystoma gracile*) egg masses, indicating extensive amphibian breeding. No TES amphibian egg masses were found in project impoundments, seeps under the leaking flume, or the bypass reach of the Little Sandy River.

Table 26. TES and S/M species documented in or near the study area for the Bull Run Hydroelectric Project.¹

Common Name Scientific Name	Within FERC Boundary	BLM Land	USFS Land	Habitat/Locations
Mollusks (2)				
Malone Jumping-slug <i>Hemphillia malonei</i>	X	X	X	Observed on BLM land south of Marmot Dam, on USFS land in riparian habitat along the Little Sandy River, and along several seeps and small tributaries to the Little Sandy River along the flume.
Oregon Megomphix <i>Megomphix hemphilli</i>	X	X	X	Observed on BLM land south of Marmot Dam and on USFS land downslope of the flume.
Amphibians (4)				
Cascade Torrent Salamander <i>Rhyacotriton cascadae</i>	X	X	X	(1) Forested wetland/seep on BLM land south of Marmot Dam; (2) Bedrock splash zone created by the project on the south side of the Sandy River immediately downstream of Marmot Dam; (3) Several seeps and small tributaries to the Little Sandy River.
Dunn's Salamander <i>Plethodon dunni</i>	X	X	X	(1) Edge of forested wetland/seep on BLM land south of Marmot Dam; (2) Seep/boulder field along the north side of Sandy River; (3) Forested slopes between the flume and the Little Sandy River on USFS land; and (4) Riparian zones of the Little Sandy and Bull Run Rivers.
Oregon Slender Salamander* <i>Ambystoma wrighti</i>			X	Forested slope between the flume and the Little Sandy River on USFS land
Northern Red-legged Frog <i>Rana aurora aurora</i>	X		X	(1) North shore of Roslyn Lake, (2) In splash zone and seeps associated with the flume, (3) Little Sandy River bypass reach
Birds (3)				
Harlequin Duck <i>Histrionicus histrionicus</i>				ONHP has records for the Sandy River between Marmot Dam and Revenue Bridge.
Bald Eagle <i>Haliaeetus leucocephalus</i>	X			PGE has observations of perching and foraging at Roslyn Lake during the winter. Observed flying over Marmot Dam in November 1999 and January 2000.
Pileated Woodpecker <i>Dryocopus pileatus</i>	X			Observed in conifer forests near Roslyn Lake.
Spotted Owl <i>Strix occidentalis caurina</i>				Most of the study area is within designated nesting habitat. ONHP has records of a nest territory northeast of the Little Sandy River Diversion
Mammals (2)				
Fringed Myotis <i>Myotis thysanodes</i>				ONHP has records of an observation east of Marmot Dam. Uses a variety of habitats but prefers riparian and forested areas.
Western Gray Squirrel <i>Sciurus griseus</i>	X			Observed in conifer forests near Lake Roslyn.

¹ An "X" is used to identify observations within the FERC project boundary and/or on USFS and BLM lands. This designation was not applied to records from the ONHP for the fringed myotis, spotted owl, and harlequin duck because exact locations of these records is unknown.

Both the southern portion of Roslyn Lake and a small side channel associated with the Marmot dam diversion had concentrations of rough-skinned newts (*Taricha granulosa*) and evidence (egg masses) of breeding by northwestern salamanders. In general, the water velocity in the pools behind Sandy and Little Sandy diversion dams is too high to provide suitable habitat for stillwater-breeding amphibians. It is unlikely that red-legged frogs use Roslyn Lake for substantial egg laying, as there are few sites in the lake that are protected from wave action and recreational boating. Northwestern salamander egg masses were also noted in the forested wetland and drainage ditch just

west of Roslyn Lake.

The bypass reach of the Little Sandy River was surveyed for amphibian breeding activity. Although portions of the reach have very low flow, there does not appear to be adequate backwater area for pond breeding. No larval pond- or stream-dwelling amphibians were found in the Little Sandy River.

Survey and Manage Mollusk Surveys

Surveys for terrestrial mollusks (table 27) documented three S/M species in the study area—the Oregon megomphix (*Megomphix hemphilli*), Malone's jumping-slug (*Hemphillia malonei*), and papillose tail-dropper (*Prophysaon dubium*). The first two species were found on both USFS and BLM lands; the papillose was found only on BLM land. In all, five and ten species of slugs and snails, respectively, were found during field surveys. The jumping-slug and tail-dropper have since been eliminated from the S/M list (USFS and BLM 2000).

Oregon megomphix were found at approximately two-thirds of the plots surveyed in the study area, both on BLM and USFS land. They were particularly common in leaf litter and in the soil near bigleaf maple (*Acer macrophyllum*) and swordfern (*Polystichum munitum*). This is the common habitat association for Oregon megomphix (BLM 1999). The Oregon megomphix has been found to be extremely common throughout the western Cascade Mountains in Oregon (pers. comm., O. Schumacher, Ecologist, Environmental Consultants Oregon, Corvallis, January 31, 2000).

During the terrestrial mollusk surveys, the Malone's jumping-slug was only found in one plot on BLM land. This plot was located in a forested wetland on the north-facing slope southwest of Marmot dam. In addition, a single Malone's jumping-slug was found on the floodplain of the Little Sandy River on USFS land, incidental to amphibian surveys. Malone's jumping-slugs occur in moist to wet forests from the southern Puget Sound of Washington to west central Oregon (BLM 1999). Two papillose tail-droppers were found near Marmot dam—one upstream of the dam and one downstream. Both were found on moss on a downed log. This is a widespread species that is strongly associated with hardwood logs and leaf litter (BLM 1999). The downstream site is in the floodplain and could be affected by dam removal.

Table 27. Relative abundance of terrestrial mollusk species observed at the Bull Run Hydroelectric Project.

	Relative Abundance ^b			
	BLM lands near Marmot dam		USFS land along flume	
	Visit No. 1 ^c	Visit No. 2 ^c	Visit No. 1 ^c	Visit No. 2 ^c
	(14 plots)	(15 plots)	(4 plots)	(4 plots)
Slugs				
Reticulate tail-dropper (<i>Prophysaon andersoni</i>)	low	moderate	--	moderate
Scarlet-back tail-dropper (<i>Prophysaon vanatta</i>)	--	low	--	--
Papillose tail-dropper (<i>Prophysaon dubium</i>)	--	low	--	--
<i>Ariolimax columbianus</i>	low	moderate	--	moderate
<i>Malone's jumping-slug (Hemphillia malonei)</i> ^d	low	--	-- ^d	-- ^d
Snails				
Forestsnail (<i>Allogona</i> sp.)	--	--	-- ^e	-- ^e
Beaded lancetooth (<i>Ancotrema sportella</i>)	high	high	high	high
Oregon lancetooth (<i>Ancotrema hybridum</i>)	low	moderate	low	moderate
Robust lancetooth (<i>Haplotrema vancouverense</i>)	high	high	high	high
<i>Cryptomastix germana</i>	moderate	moderate	moderate	moderate
Columbia Gorge Oregonian (<i>Cryptomastix hendersonii</i>)	--	--	--	moderate
Denticulate tightcoil (<i>Pristoloma linsingii</i>)	low	low	low	--
Striate tightcoil (<i>Pristoloma stearnsi</i>)	low	--	low	--
Pacific sideband (<i>Mnadenia fidelis fidelis</i>)	--	high	--	high
Oregon Mermaphis (<i>Mermaphis hemphilli</i>)	--	high	--	high

^a Bold type = Survey and Manage species (USFS and BLM 2000).^b abundance: low = 1-5 detections, moderate = 6-20, high >20.

^c Visit No. 1--January 31-February 1, 2000; Visit No. 2--February 23-25, 2000.

^d *Hemphillia malonei* observed on USFS land along Little Sandy River during amphibian surveys.

^e *Allogona* sp. Noted on USFS land along flume during amphibian surveys.

No aquatic S/M mollusk species were found in the Bull Run study area. Species not on the USFS/BLM S/M list were noted in a number of locations with the exception of the Sandy River. No aquatic mollusks of any species were found in the Sandy River, either up- or downstream of Marmot dam. It appears that the substrate immediately upstream of the dam is composed almost entirely of sand and silt and is not conducive for mollusks. A number of *Juga (juga) silicula* or *J. (juga) hemphilli* snails were found in a small seep and stream just northeast of the dam. Many *J. (juga) hemphilli* or *J. (juga) silicula* snails were found throughout the Little Sandy River. There were also a few individuals of *J. (juga) plicifera*. Voucher specimens of shells that could not positively be identified as species not on the USFS/BLM S/M list were examined by Tom Burke and Terry Frest, aquatic mollusk experts. Their examination confirmed that the shells were not S/M species and were most likely worn specimens of *J. (juga) hemphilli* (pers. comm. T. Burke, Ecologist, Wenatchee National Forest Research Lab, Wenatchee, Washington, February 3, 2001).

Spotted Owl Surveys

Spotted owl surveys were conducted following the USFS survey protocol on the BLM and USFS land in the study area. No spotted owls were detected during any of the six visits.

Other Observations

The bald eagle (*Haliaeetus leucocephalus*) and bufflehead (*Bucephala albeola*) were the only threatened or endangered bird or mammal species detected in the study area during the 1999-2000 surveys; in addition, the pileated woodpecker (*Dryocopus pileatus*) has been observed in the study area incidentally by PGE biologists. Bald eagles were observed on several occasions during 1999 and 2000. Eagles were observed soaring over the area or perching at Roslyn Lake. It is possible that eagles forage for salmonids along the Sandy River, both up and downstream of Marmot dam. Also, eagles likely forage occasionally for waterfowl and fish at Roslyn Lake. The Little Sandy River does not have accessible foraging habitat for bald eagles. Buffleheads were observed on Roslyn Lake on one occasion outside of the breeding season. There was no evidence of bufflehead breeding in the study area. Virtually all of the conifer, upland mixed, and riparian forests surrounding the project provide suitable habitat for pileated woodpeckers.

Project structures were examined for evidence of use by roosting bats. The underside of the wooden-box flume has wood beams with potentially suitable crevices for bat roosting. However, the moisture level is too high for bats to make use of the structures. No bats were observed roosting under Revenue Bridge downstream of Marmot dam or the pedestrian bridge that provides access to the south abutment of Marmot dam.

Red tree vole (*Arborimus longicaudus*) surveys were not conducted because no suitable habitat would be affected by project decommissioning.

Surveys of project impoundments conducted during the summer of 1999 failed to detect northwestern pond turtles or painted turtles (*Chrysemys picta*). The flow velocities through Marmot and Little Sandy diversion dams is probably too high for these species, which both prefer ponds and slow-moving water. Roslyn Lake is unlikely habitat for turtles because of a combination of disturbance from recreationists during the spring and summer, and a lack of well-developed wetland habitat and basking sites. Much of the lake shoreline is composed of steep levees that support only a very narrow band of rushes (*Juncus* spp.) along the water's edge; only small sections along the southern shore have somewhat protected "bays" with good shoreline vegetation.

5.3.4.2 *Effects of Alternatives*

Removal of Marmot Dam

Removal of Marmot dam is likely to result in substantial negative short-term effects on wildlife and vegetation communities in the project vicinity. The duration and magnitude of short-term effects from dam removal on terrestrial resources are dependent on the removal method. Regardless of the alternative selected for removal, however, there are three primary short-term effects on terrestrial resources: (1) disturbance to wildlife from construction, traffic, and removal activities; (2) short term loss of vegetation and habitat; and (3) the potential for establishment of exotic and invasive plants on land disturbed by removal activities and the spread of these species. Each of these short-term effects is discussed below.

Disturbance: All alternatives for removal of Marmot dam include construction of a number of temporary structures as well as the use of blasting and excavators to remove the dam. Construction, blasting, and excavation would greatly increase the amount of activity, noise, and human presence near Marmot dam and would likely disturb wildlife in the vicinity. Since all in-water activity, including blasting, would be limited to the period between July and October, effects from disturbance would be less than if they were to occur during the spring or winter, when many bird and mammal species are breeding and more sensitive to noise and other activities. Greater activity along the access road to Marmot dam would also result in more disturbances to wildlife and increase the potential for mortality from collisions.

Most of the lands surrounding Marmot dam are within nesting or dispersal habitat for the northern . However, there have been no recent surveys conducted to determine the use of habitats near Marmot dam by spotted owls. PGE plans to consult with the USFWS to determine if specific actions are needed to prevent disturbance to spotted owl prior to initiating the proposed action. It is expected that blasting and most of the other activities that could potentially disturb spotted owls would occur during July through October, after the sensitive nesting period.

Habitat loss/degradation: All alternatives involve stockpiling concrete from Marmot dam, which would result in the short-term loss of some vegetation and wildlife habitat. Other short-term habitat losses are expected from construction equipment storage and activities. In addition, the increased sediment load in the Sandy River immediately following dam removal under all alternatives may result in the temporary loss or degradation of downstream habitats, such as side channel pools and some riparian vegetation.

Establishment of exotic/invasive plants: Activities associated with Marmot dam removal would result in disturbed lands, which would greatly increase the potential for the spread of exotic/invasive plant species. If measures are not implemented to control the establishment of exotic/invasive plants in disturbed areas and their spread, it is possible that much of the area in the current vicinity of Marmot dam would be dominated by these species for the foreseeable future. PGE would revegetate all areas disturbed by removal activities with native species and would implement measures to identify and control infestations of exotic/invasive plant species in these areas for 3 years following revegetation (PGE 2002c, exhibit A). Best management practices would be implemented to reduce the spread of exotic/invasive species.

PGE would monitor areas disturbed during project deconstruction annually for noxious weeds. If noxious weeds are found, they would be treated in accordance with the Revegetation, Noxious Weed Control, and Site Restoration Plan (PGE 2002c, Exhibit A).

Longer term effects of Marmot dam removal include the following: (1) the potential loss of existing habitat for amphibians, aquatic mollusks, and benthic macroinvertebrates above and below the dam; (2) potential changes to riparian habitat in the currently impounded area upstream of the dam; and (3) potential changes to downstream riparian habitats from restored natural flows and processes. Each of these potential longer-term effects is discussed below.

Loss of amphibian habitat: Surveys of riparian and instream habitats above and below Marmot dam indicated very little use by amphibians. The ability of the Sandy River to support amphibians may be generally low because of the amount of sediment that this river naturally carries. However, the Cascade torrent salamander, a state-listed sensitive species, was found in an area of bedrock in the splash zone of the dam. This habitat would be lost when the dam is removed. The Cascade torrent salamander occupies several locations in the project vicinity, including a seep on BLM land just south of the dam, and may eventually re-colonize suitable habitat areas along the Sandy River once the channel has stabilized.

Several amphibians that potentially occur in the project area reproduce in stillwater habitats, including ponds, puddles, and the slow-moving side channels of streams: northwestern salamander, long-toed salamander, rough-skinned newt, Pacific chorus frog, northern red-legged frog, and western toad. A small seasonally flooded pond on a sand bar above the dam may provide habitat for amphibians that breed in stillwater habitats. This pond may be lost, or its ability to flood seasonally reduced, as the channel incises to its new gradient when the dam is removed.

Also, if stream channel aggradation and increased sedimentation results in the filling of side-channel pools downstream of the dam, then stillwater amphibians could potentially experience a loss of breeding and larval rearing habitat.

The Pacific giant salamander has not been observed in the project area but has been identified as potentially occurring; the larval forms of this species live in pools and riffles of streams. It is possible that this species could be affected by disturbance of the channel bed and filling of pools and interstitial spaces.

Disturbance to aquatic mollusk populations and habitat: No data are available on the occurrence and distribution of aquatic mollusks in the Sandy River Basin. A general discussion of potential sediment-related impacts to aquatic mollusks is provided below. Because many species of freshwater mollusks require relatively stable substrates with well-oxygenated water (Holthausen et al. 1994), they may be adversely affected by siltation and infiltration of fine sediments into rocky substrates. In this respect, naturally high sediment loads in the Sandy River may limit mollusk populations. The highest mussel densities and species diversity are typically associated with riffle or shoal areas (Layzer et al. 1993, Bogan 1993), although this generalization may not apply to those species that appear to prefer silt, sand, or other fine substrates (Taylor 1981, d'Eliscu 1972). Bedrock and shifting sandbars do not support mussel populations, which appear to prefer stable alluvial substrates. Distribution of "small, protected patches of fine sediment" providing unionid habitat may significantly influence numbers of individuals and species in a given stream (Strayer and Ralley 1993, p. 255). Bivalves may be unable to withstand heavy silt loads and may be suffocated or buried by excess siltation or sedimentation (Bogan 1993).

Disturbance to aquatic macroinvertebrate habitat: Increased fine sediment may reduce habitat for macroinvertebrates by filling interstitial spaces and reducing intragravel flow, which typically causes lower species diversity and productivity of aquatic insects (Chutter 1969, Luedtke et al. 1976; as cited in Minshall 1984).

Changes in upstream riparian vegetation: Following dam removal, the channel through the substrate in the area that is currently impounded is expected to be highly mobile. Bank failure and mass wasting of banks would occur frequently as the channel adjusts to the restored gradient through this area (see Section 5.3.1.2). Consequently, it is likely that much of the existing riparian vegetation would be lost from erosion. As the channel stabilizes, riparian vegetation would eventually reestablish along the banks of the river through this area. The size and configuration of the riparian zone in this area would depend on bank height and substrate, as well as channel configuration. In the worse case, all the existing riparian habitat, about 13 acres (PGE 2003a), would be lost:

riparian habitat type	acres
riparian mixed deciduous/conifer forest	10.5
riparian deciduous forest	0.4
riparian deciduous shrubland	1.7
mid-successional mixed deciduous/conifer forest	10.2

PGE will monitor these riparian areas. If necessary, revegetation plans would be developed after the river gradient stabilizes which could take several years (PGE 2002c, exhibit A).

Changes in downstream riparian vegetation: The effects of the Marmot dam removal on downstream riparian vegetation and habitat are difficult to predict, but are expected to vary with distance from the dam, as well as channel configuration and substrate. Median monthly flows downstream of the dam would increase substantially and would follow the natural hydrograph, with median peak flows occurring in April. Median flows during the growing season (April-October) would increase by 93 to 560 cfs, depending on the month. Median winter flows would increase by 600 to 700 cfs (see Section 5.3.1.2).

Initially, erosion and deposition are expected to have the most substantial effects on riparian vegetation, particularly in the 1.5-mile-long reach (Reach 1) immediately downstream of the dam. Coarse sediment up to 6 feet deep may aggrade in portions of this area, resulting in localized flow deflection and increased erosion along the left bank, which is composed of alluvial terrace material (see Section 5.3.1.2). Depending on the extent of the erosion, some amount of mid-successional mixed deciduous/conifer forest on PGE land along the south side of the river would be lost. In addition, it is likely that the riparian vegetation along this entire reach may be scoured or buried by coarse sediment. Sites particularly vulnerable appear to be Beaver Island (RM 29.4-29.2), which now supports shrub alder; and an alcove/backwater pool (RM 28.7) dominated by alder trees and shrubs (see Section 5.3.1.2). Eventually riparian vegetation would reestablish along Reach 1; the amount, structure, and composition would depend on bank configuration and substrate, as well as flow. Banks composed largely of small boulders and cobble may support more shrubs; finer materials may provide a better substrate for trees. Aggradation of the riverbed and higher flows in this reach might also cause areas that are currently upslope from the influence of the river to become wetter. For example, a bench on the right bank of the river may be more frequently affected by the river during the growing season, eventually resulting in the establishment of species more tolerant of

wetter conditions and the conversion of mixed deciduous/conifer forest to riparian mixed forest.

Relatively little erosion or deposition is expected in the 4-mile Sandy River gorge (Reach 2; see Section 5.3.1.2.). This area is bounded by bedrock and has relatively few unconfined sections that support riparian vegetation. However, the higher flows in this area would inundate more of the channel in less confined areas, and may result in less riparian vegetation over the long term if there are no upslope areas suitable for reestablishment.

The potential for sediment deposition in the Sandy River increases from the downstream end of the gorge to the confluence with the Bull Run River (Reach 3; see Section 5.3.1.2). The channel in this area is wider, has a lower gradient, and is characterized by cobble/boulder bars and substrates. Increased flows might result in the loss of riparian vegetation from low islands and bars that are permanently inundated by higher water levels. Conversely, sediment deposition might result in creation of additional area that would support riparian vegetation. In wider areas, the return to natural flows may result in greater amounts of vegetation if more water is available at the upland margin of riparian zone, particularly later in the growing season. This process, however, may be influenced by encroachment from the residential developments that exist along Reach 3. Overall, however, the net change in riparian vegetation expected in this reach is small.

PGE will monitor these riparian areas. If necessary, revegetation plans would be developed after the river gradient stabilizes which could take several years (PGE 2002c, exhibit A).

In general, the long- and short-term effects of removing Marmot dam on terrestrial resources are expected to be similar, regardless of removal alternative. The few differences between alternatives are discussed below.

Alternative 1 (PGE's Proposal)--Single Season Dam Removal with Minimal Sediment Removal

The short-term effects of Alternative 1 on wildlife and habitat are likely to be less than the other alternatives because there are fewer activities associated with sediment excavation and disposal. Activities also would be limited to one season and the lack of sediment disposal would result in less temporary loss of habitat.

Because very little of the sediments impounded upstream of Marmot dam would be

mechanically removed, Alternative 1 would result in the greatest channel instability and highest amounts of downstream sedimentation compared to other alternatives (see Section 5.3.1.2). High channel instability would likely result in the loss of existing riparian vegetation from erosion, particularly above and immediately below the dam. Riparian vegetation would ultimately re-colonize the banks in these areas. Higher sedimentation may result in more area available for the establishment of riparian vegetation, especially in Reach 3. Increased aggradation in Reach 1 may also convert some upland vegetation to riparian.

Alternative 2--Removal of Top of Dam in Year 1. Complete Dam Removal in Year 2 with Sand Layer Excavation

Overall, Alternative 2 would probably have the greatest short-term effects on terrestrial resources compared to other alternatives because of the activities associated with construction of a fish barrier dam, as well as dam removal and sand excavation and disposal. In addition, these would take place over a period of about 3 years. Sand disposal would result in the short-term loss of about 3 acres of habitat on BLM land north of the dam; this area would be eventually revegetated.

Compared to Alternative 1, partial removal of the dam and excavation of the sand layer from the reservoir would reduce the amount of time needed for the upstream channel to reach equilibrium and would result in less downstream sedimentation (see Section 5.3.1.2).

Alternative 3--Remove the Maximum Amount of Sediment Possible During One Construction Season

Among the alternatives that involve removal activities over the course of a single season, Alternative 3 would cause the greatest amount of short-term disturbance to wildlife because of the combined effects of dam removal and sediment excavation and disposal. In addition, Alternative 3 includes an option for off-site disposal of sediments, which would require construction of a new road. A new road would result in additional disturbance to wildlife and increase the potential for mortality from collisions.

Short-term habitat loss would also be greatest for Alternative 3, which requires a site large enough to dispose of up to 300,000 cy of sediments. The proposed on-site disposal location is about 2,500 feet upstream from Marmot dam in a recent clearcut. The off-site disposal site has not been identified yet. Regardless of location, the disposal site would be about 100 acres and would be covered with sediments to a depth of about 7.1 feet. On-site disposal would require improvements to several hundred feet of existing

road, resulting in the loss of a small amount of mid-successional mixed deciduous/conifer forest. The new road required for disposal of sediments off-site would result in the removal of about 4 acres (3,500 feet of road, 50 feet wide) of existing vegetation. Most of the new road would be through an area that has been recently clearcut. The temporary loss of early successional vegetation would slightly reduce the amount of available habitat for some mammals and birds. The sediment disposal site would be covered with topsoil and revegetated. The new road would be closed, regraded and reseeded.

Because most of the sediments impounded upstream of Marmot dam would be mechanically removed, Alternative 3 would result in less channel instability and lower amount of downstream sedimentation compared to other alternatives. Greater channel stability may result in fewer impacts on riparian vegetation from erosion and faster reestablishment in some areas particularly above and immediately below the dam. Conversely, reduced sedimentation may result in less habitat available for the establishment of riparian vegetation, especially in Reach 3. Lower aggradation in Reach 1 may also prevent some upland vegetation from converting to riparian.

Removal of Little Sandy Diversion Dam

Removal activities associated with Little Sandy diversion dam would result in some short-term disturbance of wildlife in the vicinity but no temporary loss of habitat is expected. The ONHP has a record of a spotted owl territory northeast of the Little Sandy diversion dam. PGE would consult with the USFWS to determine the need for measures to ensure the removal activities do not disturb spotted owls.

Activities associated with Little Sandy diversion dam removal would result in disturbed lands, which would greatly increase the potential for the spread of exotic/invasive plant species. Areas of soil disturbance near the diversion would be revegetated to reduce the establishment of exotic/invasive plant species. Monitoring would be conducted to detect exotic and invasive species and if noxious species are found, they would be treated in accordance with the Revegetation, Noxious Weed Control, and Site Restoration Plan (PGE 2002c, Exhibit A).

Long term effects of removing the Little Sandy diversion dam include the following: (1) the potential loss of existing amphibian habitat below the dam and (2) potential changes to downstream riparian habitats from restoration of natural flows and geomorphological processes. Each of these potential effects is discussed below.

Amphibian habitat: The lack of flow in the Little Sandy River has resulted in a number of pools in the bypass reach. The pools are maintained primarily by water that

seeps from the diversion and box flume, and by input from small side tributaries. These pools potentially provide habitat for amphibians that breed in stillwater, such as the red-legged frog and Pacific chorus frog, which have been observed in riparian habitat downstream of the diversion. No larval pond- or stream-dwelling amphibians were found in the pools in this reach of the river. Restoration of flows would eliminate these pools as breeding habitat for stillwater species. It is, likely, however, that other amphibian species, such as the Pacific giant salamander, may eventually occupy the riverine habitat provided by restored flows. Temporarily flooded ponds may also occur in some riparian areas along the river that would provide stillwater breeding habitat.

Downstream riparian vegetation: The Little Sandy River currently supports approximately 20 acres of riparian vegetation between the diversion and confluence with the Bull Run River. Removal of the Little Sandy diversion would result in the movement of the sediments stored behind the diversion and would restore natural flows downstream. These processes are expected to have a substantial impact on the amount, structure and composition of downstream riparian vegetation. Median monthly flows at the mouth of the Little Sandy River during the growing season (April-October) would increase from current levels, which range from 1.4 to 13.1 cfs, to 21 to 193 cfs. Median winter flows, which currently range from 9.7 to 13.1 cfs, would range from 143 to 173 cfs once the diversion is removed.

The 0.3-mile reach immediately below the Little Sandy diversion (Reach 1) has virtually no flow and consists primarily of pools maintained by water from accretion and seeps. The channel in this reach is up to 30 feet wide in places but appears narrower because of encroachment from riparian vegetation (see Section 5.3.1.1). Following dam removal, coarse sediment aggradation and increased flows in Reach 1 would probably scour and kill most of the riparian shrubs and trees growing in the active channel. The higher flows may also result in erosion in some locations, reducing the amount of available habitat for riparian vegetation. In wider areas, restoration of natural flows may result in greater amounts of vegetation if more water is available at the upland margin of the existing riparian zone, particularly later in the growing season. Ultimately, it is expected that the riparian vegetation that re-establishes along the river in Reach 1 would be similar in structure and composition to existing riparian vegetation upstream of the diversion. Smaller deciduous trees and shrubs currently characterize these areas.

The 1.4-mile reach of the Little Sandy River upstream of the confluence of the Bull Run River has a steep gradient and is very confined (see Section 5.3.1.1). Most of the riparian vegetation along this reach is growing outside the active channel in narrow bands along the shoreline and on cobble bars. Very little sediment aggradation is expected in this reach (see Section 5.3.1.2); riparian vegetation may be eliminated from

very narrow areas of the channel if restored flows inundate all suitable habitat. Shorelines and cobble bars may also experience the loss of some trees and shrubs with higher flows. These areas would also be subjected to higher flows during flood events and are likely, over the long term, to be inundated and scoured more often. Consequently, riparian vegetation in Reach 2 may ultimately consist primarily of shrubs instead of trees.

Riparian habitat along the Little Sandy River currently supports the Malone jumping slug (*Hemphilla malonei*), a S/M terrestrial mollusk. Populations of this species along the river may be temporarily affected by changes in riparian habitat, but no long-term effects are expected. The Malone's jumping slug appears to be fairly widespread in the Little Sandy drainage and would likely recolonize areas once suitable habitat has reestablished.

Removal of Canals, Tunnels, Flumes, and Ancillary Structures

Activities associated with removing the canals and wooden box flume and sealing the tunnels would result in some short-term disturbance to local wildlife. In the long term, removal of the canals and wooden box flume and sealing the tunnels would result in several benefits to wildlife and other terrestrial resources, including the following.

Additional habitat: The land occupied by the canals and box flume would be recontoured, if necessary, and revegetated with native shrubs and seedlings. The existing transmission line ROW would also be revegetated. Eventually, it is expected that these lands would support forest plant and wildlife communities similar to existing adjacent habitats. In addition, tunnel no. one would be sealed in such a way to provide habitat for bats that roost in caves.

Improved habitat connectivity and reduced entrapment: The canal and wooden box flume currently impede the unobstructed movement of several wildlife species. Removal of these facilities would eliminate an impediment to wildlife movement between the Sandy and Little Sandy Rivers and upslope areas. Removal of the canals would also reconnect several small streams to the Sandy River that are currently diverted, benefitting amphibians and small mammals that use riparian corridors. Although fenced along its entire length, the canals represent a source of entrapment and mortality to smaller wildlife species. Removal of the canals would also eliminate entrapment and associated mortality.

Reduced infestations of exotic/invasive plant species: Currently, much of the transmission line ROW and lands adjacent to the canals are dominated by exotic/invasive plant species. A corridor of early successional vegetation that also includes some

exotic/invasive plants borders the wooden box flume. Removal of these facilities and revegetation with native species should reduce the distribution and extent of exotic/invasive plant infestations in the project vicinity. PGE would implement measures to control exotic/invasive plants during the revegetation process.

The only long-term negative effect of removing the canals and flumes may be the loss of very small wetlands that occur in several places from seepage from these structures.

Project Powerhouse

Removing or mothballing the powerhouse would result in some minor, short-term disturbance to local wildlife. No long-term impacts are expected.

Removal of Roslyn Lake

While Roslyn Lake and the adjoining lands are far from pristine, the area does provide habitat for several wildlife species. The bald eagle has been documented foraging in Roslyn Lake and perching along the shoreline during the winter. The lake is also used for foraging by osprey during the summer. In addition, the red-legged frog, a state sensitive species, and several other amphibians have been recorded at Roslyn Lake. Lesser bladderwort, a species on ONHP List 2 (taxa threatened with extinction or presumed to be extirpated from Oregon but stable elsewhere) and considered sensitive by the BLM, was documented in the southern portion of the lake.

Removal of Roslyn Lake would result in the loss of 160 acres of open water habitat as well as about 2 acres of scrub-shrub wetland, 5.5 acres of forested wetlands, and 14 acres of riparian vegetation. The 4-acre forested wetland east of the lake does not appear to be hydrologically connected and would not be affected by removal. The population of lesser bladderwort in the lake would also be lost.

Loss of the open water habitat provided by Roslyn Lake would effect waterfowl and a number of waterbird (e.g. great blue herons) and passerine bird species (e.g. swallows). The loss of shallow water and wetlands is also likely to be detrimental to several amphibian species, including the northwestern salamander, Pacific chorus frog, and red-legged frog. Although the removal of Roslyn Lake would reduce the amount of forage habitat for the bald eagle during the winter and for the osprey during the summer, no effects on these species are expected. The nearby Sandy and Bull Run Rivers support ample fish populations and foraging habitat is not currently limiting the populations of these two raptors in the vicinity. Revegetation and restoration of the site could result in

additional forested habitat for wildlife.

Summary of Impacts on Listed Terrestrial Species

Removal of project features could potentially result in substantial negative short-term effects on spotted owls in the project vicinity, primarily due to disturbance from construction, traffic, and removal activities. Construction, blasting, and excavation would greatly increase the amount of activity, noise, and human presence near the project and would likely disturb wildlife in the vicinity. Disturbance of spotted owls could occur from March 1 to July 15. Since all in-water activity, including blasting, would be limited to the period between July and October, effects from disturbance would be less than if they were to occur during the spring, when spotted owls are breeding and more sensitive to noise and other activities. More information on listed terrestrial species can be found in the biological evaluation prepared for the project (PGE 2002d)

Most of the lands surrounding the Project are within nesting or dispersal habitat for the northern spotted owl. No owls were detected during spotted owl surveys conducted by in 2000 (Tressler 2001a).

PGE will conduct additional surveys for spotted owls in 2005 and 2006 to determine the location of nesting pairs prior to removal-related disturbance activities. If new survey information indicates that there are nesting owls that could be disturbed in association with removal activities, PGE will shift the work schedule, to the extent possible, as per section 2.1 of the Decommissioning Plan (PGE 2002c), to a time that minimizes any potential disturbance to nesting owls. In addition, standard protection measures will be implemented, including no mechanized equipment or increases in background noise during the breeding season (February 1 to August 30) within a 3-mile radius of nesting sites. In the long-term, removal of the Project will result in several benefits to spotted owls, including reduced risk of electrocution from power lines, reduced human presence, and reduced habitat fragmentation.

Implementation of the measures outlined in the BO issued by USFWS to protect the spotted owl (see Section 4.5.4) would further protect this listed species.

Roslyn Lake and the adjoining lands provide habitat for bald eagles. A bald eagle has been documented foraging in Roslyn Lake and perching along the shoreline during the winter. Removal of the lake would likely reduce foraging habitat for eagles in the short-term. In the long-term, bald eagles would likely benefit from reduced habitat fragmentation, reduced risk of electrocution from power lines, reduced human presence, and increased health of aquatic communities in the Sandy, Little Sandy, and Bull Run

Rivers.

5.3.4.3 Staff Modifications to PGE's Proposal

Revegetation, Noxious Weed Control, and Site Restoration Plan

PGE has developed a revegetation, noxious weed control, and site restoration plan to control erosion, prevent the establishment and control the spread of invasive/exotic species, and promote the establishment of native plant communities (PGE 2002c, exhibit A). These measures would benefit wildlife and aquatic species. The plan does not include the final mix of species or planting densities, a final list of tree and shrub species and planting densities, contingencies for replanting, or detailed exotic/invasive species control plans for pre-construction and monitoring period. PGE should develop a final revegetation, noxious weed control, and site restoration plan for Commission approval after consultation with BLM, USFS, ODFW, and USFWS.

The streambank and riparian areas upstream and downstream of Marmot dam are likely to be unstable for a number of years after dam removal. PGE would monitor these areas, but plans to revegetate these areas are premature. If necessary, revegetation plans would be developed after the river gradient stabilizes which could take several years (PGE 2002c, exhibit A). The final revegetation, noxious weed control, and site restoration plan should include a discussion of the criteria that would be used to determine the need for revegetation of these areas and time frames.

Spotted Owl Protection

Most of the lands surrounding the project are within nesting or dispersal habitat for the northern spotted owl. Surveys conducted in 2000 did not detect any owls. Noise, particularly from blasting, noise, and increased disturbance could affect the owl if they inhabit lands in the vicinity of the project. Disturbance during nesting could result in nest abandonment and interference with incubation and feeding of young.

PGE proposes to survey for spotted owls using six field calling surveys (3 per year) between March 15 and August 31 in 2005 and 2006. If spotted owls are determined to be in the project area, PGE would conduct a nesting status survey to determine whether nesting is occurring. The monitoring information would be used to adjust timing and intensity of decommissioning activities, to the extent possible, to avoid potential disturbance to nesting spotted owls.

PGE should file, for Commission approval, the results of spotted owl surveys and

any measures to protect nesting spotted owls located. PGE should also develop a plan to implement the measures included in the BOs issued by USFWS (see Section 4.5.4).

5.3.4.4 Cumulative Impacts

The cumulative effects of decommissioning the Bull Run Hydroelectric Project on terrestrial resources are generally beneficial. The area surrounding the project is experiencing substantial growth and resultant conversion of natural communities to residential, recreational, and retail development. Decommissioning the project would result in the restoration of some lands that are currently disturbed or occupied by facilities, increasing the amount of available habitat. Decommissioning would also restore natural flows to portions of three rivers and reduce the number of impediments to wildlife movement and sources of mortality (roads, canals). The loss of Roslyn Lake would result in a reduction in the amount of open water habitat in the general vicinity.

5.3.4.5 Unavoidable Adverse Impacts

The most significant unavoidable adverse impact on terrestrial resources from decommissioning the Bull Run Project is the loss of Roslyn Lake and associated effects on wetlands, wildlife habitat, and the population of lesser bladderwort. In addition, there are potential unavoidable adverse impacts associated with deconstruction activities, as most of the lands surrounding Marmot dam are within nesting or dispersal habitat for the northern spotted owl.

5.3.5 Recreation Resources

5.3.5.1 Affected Environment

Recreation resources associated with the Bull Run Hydroelectric Project include: (1) Roslyn Lake - a man-made storage reservoir that serves as the forebay for the Bull Run powerhouse; (2) Roslyn Lake Park - a developed recreation facility located on the shores of Roslyn Lake; and (3) public access to the Sandy and Bull Run Rivers provided for by the project at Marmot dam and the Bull Run powerhouse. Public access to a portion of the Sandy River affected by the project also exists at Revenue Bridge, just outside of the City of Sandy.

Recreation Use of Project Lands and Waters

Recreation facilities and public access areas associated with the project (including the Revenue Bridge area) supported approximately 46,000 recreation visits during the

1999 summer recreation season (Memorial Day to Labor Day) (Kleinschmidt Associates 2000a). The vast majority of this use occurred at Roslyn Lake Park, which accounted for approximately 33,000 visits, or about two thirds of the total recreation activity associated with the project. Other sites such as Marmot dam and the powerhouse receive much lower levels of use (approximately 3,000 and 1,500 visits respectively for the 1999 summer recreation season). Because these sites are used primarily for fishing, annual use, which would include the winter steelhead season, is likely higher than displayed above. Table 28 shows estimated recreation visitation associated with each use area. Use estimates shown for Roslyn Lake Park are based on gate receipts and concessionaire

Table 28. Estimated Visitation at the Bull Run Project during the 1999 Summer Recreation Season, with 95% Confidence Intervals (in number of visits).

Site	Weekdays	Weekend/Holidays	Total
Roslyn Lake Park	16,611	16,724	33,335
Roslyn Lake Shoreline	3,287 $\pm$ 952	4,172 $\pm$ 883	7,459 $\pm$ 1835
Marmot Dam	1,107 $\pm$ 427	1,594 $\pm$ 318	2,701 $\pm$ 745
Powerhouse	740 $\pm$ 438	557 $\pm$ 240	1,297 $\pm$ 678
Revenue Bridge	527 $\pm$ 277	502 $\pm$ 159	1,029 $\pm$ 436

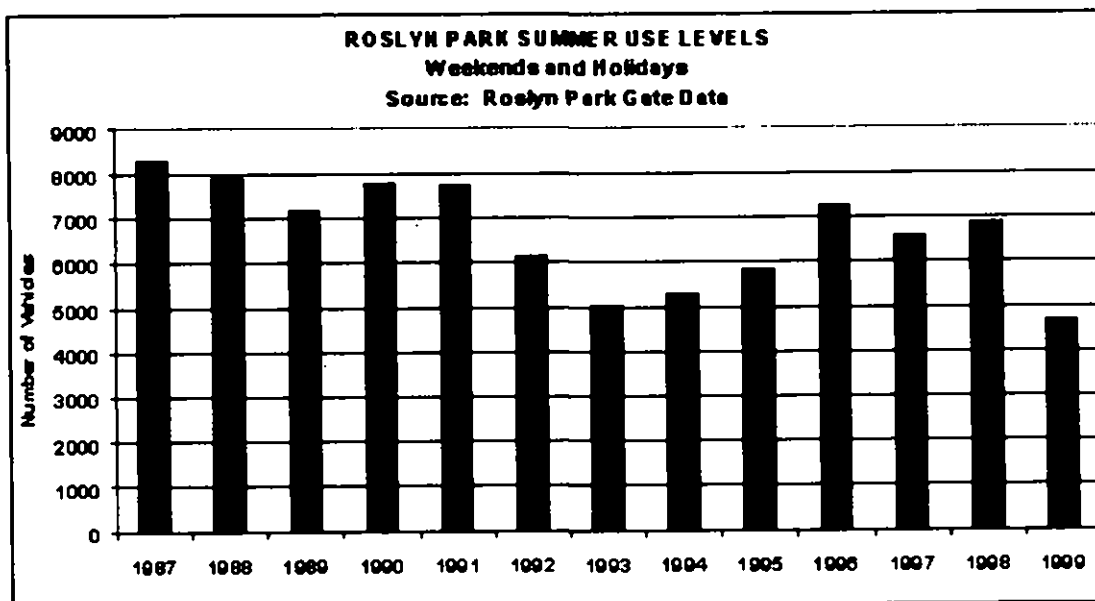
observations. Use estimates for other sites are based on vehicle counts made during the 1999 summer recreation season (Kleinschmidt Associates 2000a).

Overall, recreation use of the project area is relatively low, particularly compared to other similar recreation areas in the region (as shown in table 29). In relative terms, recreation opportunities at the Bull Run Hydroelectric Project can be characterized as small, locally used recreation areas. Results of a recent visitor survey indicate that relatively few users travel a long distance to recreate at the project area, with about half of all summer season visitors traveling 20 miles or less to recreate at the project (Kleinschmidt Associates 2000a).

Demand for recreation at the project, as reflected by weekend visitation data for Roslyn Lake Park, fluctuates from year to year (see figure 5). Data shown in figure 5 indicates that the highest recorded seasonal weekend use of Roslyn Lake Park was 8,308 vehicles in 1987. The lowest recorded use was approximately 4,696 vehicles recorded in 1999. These data suggest that the trend in recreation at the project over the past 13 years has been towards a slight decline in overall use.

Table 29. Comparison of Use Estimates at Other Recreation Sites in the Region.

Site	Estimated Annual Visits
Oxbow Park	222,000
Dodge Park	90,000
McIver Park	239,000 day use 14,547 overnight
Dabney State Park	154,600
Lewis & Clark SP	238,000
Harriet Lake	6,000 day use 2,000 overnight
Promontory Park	77,000 day use 8,500 overnight
Sandy River boating, Dodge Park to Dabney	30,000
Sandy River angling, Dodge Park to Dabney	Over 100,000
Timothy Lake FS Campgrounds	200,000 overnight

**Figure 5. Roslyn Park Summer Use Levels for Weekends and Holidays.**

Recreation Opportunities Associated with the Project

Existing recreation opportunities associated with the project are centered at Roslyn Lake Park, the Roslyn Lake shoreline (outside the park), the Sandy River downstream of Marmot dam, and the Bull Run River near the Bull Run powerhouse. The most common recreation activity pursued at the project is fishing, with 46 percent of the users contacted in 1999 indicating that this was their primary activity (Kleinschmidt Associates 2000a). Approximately 30 percent of the fishing use is lake fishing at Roslyn Lake, while roughly 16 percent is river fishing at Marmot dam, the powerhouse, and Revenue Bridge. At

Marmot dam and along the Roslyn Lake shoreline (outside the park), fishing accounted for 90 percent and 80 percent of the surveyed use respectively. Other commonly pursued activities in the project area include, picnicking, walking, swimming, and boating. Specific opportunities, activities and facilities associated with the five primary public access points in the project area are summarized in tables 30 and 31, and briefly described below.

Table 30. Recreation Opportunities and Facilities in the Project Area.

Site	Activities/ Opportunities	Facilities
Roslyn Lake Park	Picnicking Fishing (lake) Non-motorized Boating (lake) Swimming Outdoor Games	Picnic Areas Group Picnic Areas (5) Ballfields Boat Rentals Restrooms Boat Ramp Concession Stand Accessible Fishing Dock Parking
Roslyn Lake	Fishing (lake)	Boat Ramp Parking
Marmot Dam Area	Fishing (river) Boating (river)	Parking
Powerhouse	Fishing (river) Boating (river)	Parking
Revenue Bridge*	Fishing (river) Boating (river)	None

* Not located within the Project Boundary

Table 31. Primary Activities Pursued in the Project Area.

		Top Five Activities				
Location	n	1	2	3	4	5
All Locations	417	Shoreline fishing (46%)	Picnicking (13%)	Relaxing (13%)	Swimming (5%)	Walking/Hiking (4%)
Revenue Bridge	30	Shoreline fishing (67%)	Kayaking (13%)	Swimming (7%)	Sightseeing (7%)	Walking/Hiking (3%)
Roslyn Lake Park	202	Picnicking (27%)	Relaxing (21%)	Shoreline fishing (12%)	Swimming (10%)	Canoeing (6%)
Roslyn Lake Shoreline	100	Shoreline fishing (79%)	Walking/Hiking (6%)	Relaxing (6%)	Sightseeing (3%)	Sunbathing (2%)
Powerhouse	22	Shoreline fishing (41%)	Walking/Hiking (27%)	Sightseeing (14%)	Kayaking (9%)	Canoeing (9%)
Marmot Dam	62	Shoreline fishing (90%)	Relaxing (3%)	Other (3%)	Picnicking (2%)	Wildlife viewing (2%)

Roslyn Lake Park, the only developed recreation facility associated with the project, is a 26-acre facility originally constructed by PGE in 1957. The park offers day-

use recreation activities including non-motorized boating, fishing, picnicking, swimming and outdoor games. Facilities at the park include picnic areas, ball fields, a hard surface boat ramp, an accessible fishing dock, restrooms, a concession stand, and parking. Group sites including five group picnic areas are available and can be reserved for a fee. Two of these areas are sheltered and have electric cooking facilities. Various non-motorized boats are also available for rent at the park. PGE contracts the operation and maintenance of the park to an independent contractor. A general admission fee is charged for automobiles and motorized bikes on weekends and holidays. Pedestrian and weekday traffic may enter without charge. The park is regularly open 7 days a week from 8 a.m. to 8 p.m. during the summer season - from Memorial Day weekend to Labor Day weekend plus on one or two weekends before and after, depending on attendance. Approximately 28 percent of the use of the Roslyn Lake Park involves primary water-based recreation activity (i.e., fishing, swimming, and boating) (Kleinschmidt Associates 2000a).

Access to Roslyn Lake is also available from outside of Roslyn Lake Park. The majority of the lake shoreline is safely accessible to the general public. Recreation activities available from the shoreline access include fishing, non-motorized boating and walking. The lake surface area is 160 acres and has approximately 3 miles of shoreline area. It is open for fishing all year and provides good trout and warm water fishing. The lake is routinely stocked by ODFW with trout and steelhead. Trout are the primary target species for anglers. Facilities include a hard surface boat ramp and parking. There are no fees charged for access to the lake shoreline areas.

The Sandy River is accessible from two locations in the vicinity of the project. These include Revenue Bridge and the Marmot dam area. Recreation activities available at these locations include fishing and boating. Most anglers at these areas target species including steelhead, chinook and coho salmon. There are no developed facilities at Revenue Bridge. Users who access the river at this location park along the roadside. At the Marmot dam area access there are several pullouts along the Marmot dam Service Road for users to park their vehicles.

The Bull Run River is accessible from the area around the Bull Run powerhouse. Recreation activities available at this location include fishing and boating. Anglers at the powerhouse fish for species including cutthroat trout, steelhead, chinook and coho salmon. Facilities include a paved parking area for approximately eight to ten vehicles. Whitewater boaters enter the Bull Run River just downstream of the powerhouse and float downstream to Sandy River. The 1.5-mile-long section of the Bull Run River from the powerhouse to the Sandy River is rated as a Class III opportunity (intermediate). Opportunities for whitewater recreation downstream of the powerhouse are enhanced by project releases, particularly when the Bull Run River upstream of the powerhouse is low.

5.3.5.2 Effects of Alternatives

Removal of Marmot Dam

Specific effects to recreation resources would vary slightly depending on how Marmot dam is physically removed. The potential effects associated with each of the Marmot dam removal options are briefly described below. In all cases there exists the potential for short-term adverse effects to public access and recreation due to deconstruction activities, including temporary access restrictions for public safety and effects related to construction noise, dust, and traffic. In all cases, the period of proposed deconstruction (July through October) coincides with relatively low recreation use of the Marmot area, therefore potential short-term deconstruction effects would be minimal.

In the long-term, regardless of the specific removal option pursued, removal of Marmot dam would have a direct beneficial effect on whitewater boating opportunities on the Sandy River. Permanent removal of the dam would allow for unimpeded downstream boat passage. Dam removal would also result in a natural flow regime in the river, which would result in a greater frequency of suitable flows for whitewater boating below the dam. More days of whitewater recreation opportunity in the river below the existing dam would enhance existing opportunities by extending the whitewater boating season.

Alternative 1 (PGE's Proposal)--Single Season Dam Removal with Minimal Sediment Removal

This removal option would minimize construction activity associated with removal and would therefore further minimize potential short-term effects to recreation associated with noise, dust, and traffic. However, sediment released from behind Marmot dam as a result of this removal alternative could result in adverse effects to downstream recreation activity, including both boating and angling. Primary potential downstream effects would include short-term turbidity, which could impact angling, and sediment deposition, which could have localized effects to boating opportunities and fishing. Channel instability at the dam site could also result in hazardous conditions for downstream boating.

Alternative 2--Removal of Top of Dam in Year 1. Complete Dam Removal in Year 2 with Sand Layer Excavation

This removal option would have greater potential effects to recreation opportunities than the other removal options being considered because it would involve two construction seasons and would span the whitewater boating and downstream fishing seasons. A longer deconstruction period would result in a longer period of restricted

public access to the river in the immediate vicinity of Marmot dam. Potential downstream effects associated with turbidity and possible sediment deposition described in removal Alternative 1 above would also apply to this option.

Alternative 3--Remove the Dam and the Maximum Amount of Sediment Possible During One In-water Work Period

This removal option would likely have the least impact on instream recreation activity. The existing structure, and associated sediment, would be removed from the river channel thereby minimizing the potential for adverse effects to occur downstream, including potential modifications to the river channel and existing rapids. The structure would also be removed in 1 year, thereby minimizing any short-term construction effects to recreation, including potential temporary loss of public access. Noise, dust, and truck traffic associated with sediment removal activities could have short-term adverse effects to recreation.

Removal of Little Sandy Diversion Dam

Removal of Little Sandy diversion dam would result in long-term beneficial effects to recreation, particularly whitewater recreation opportunities. Removal of the diversion dam would result in a natural flow regime in approximately 1.5 miles of river below the diversion dam, including flows sufficient for whitewater boating. A review of the river gradient and channel conditions below the diversion dam indicates that this section of river might be a Class IV or V whitewater run suitable for advanced kayakers.

Removal of Canals, Tunnels, Flumes, and Ancillary Structures

Removal of the canals, tunnels, flumes, and ancillary structures would not have any short- or long-term effects to recreation resources, either adverse or beneficial, as none of these project features support recreation activity.

Project Powerhouse

Removal of the powerhouse could have short-term adverse effects to recreation associated with stabilization and temporary access restrictions for public safety. However, recreation use in the vicinity of the powerhouse is extremely light (approximately 1,300 visits during the 1999 summer season), and therefore very few users would be impacted. In the long-term, removal of the powerhouse itself would not be expected to adversely impact recreation use.

Removal of Roslyn Lake

Removal of Roslyn Lake would result in a loss of all existing water-dependent recreation opportunities associated with the lake, including shoreline fishing, swimming, and flat-water boating. This would include a loss of approximately 3 miles of shoreline and 160 acres of water surface area available for recreation activities. Based on visitor use estimates collected during the 1999 summer recreation season, as described in Section 5.3.5.1 above, removal of the lake in 1999 would have affected approximately 10,000 angler visits, 3,000 swimming visits, and 2,000 boating visits, for a total summer season impact of approximately 15,000 visits (including use at both Roslyn Lake Park and the shoreline outside the park). Roslyn Lake Park, and the recreation facilities associated with the park would remain in place and therefore would continue to provide opportunities for picnicking, group events, and other day-use activities. The nature of these opportunities would be different without the attraction of the lake itself. Removal of the lake would significantly reduce the overall diversity of opportunities available at the park, which may adversely affect overall park visitation. Park users would also be adversely affected in the short-term by deconstruction activity associated with removal of the lake.

Under the Proposed Action Alternative, individuals that have traditionally used the lake for water-based recreation would be directly affected over the long-term. These users would choose to either use their leisure time pursuing some other activity, or would have to go to some other location offering similar water-based recreation opportunities. There are a relatively limited number of lakes in the area with road access; particularly lakes that offer year-round fishing opportunities for hatchery stocked trout as Roslyn Lake does (Kleinschmidt Associates 2000b). However, alternative sites offering similar opportunities to Roslyn Lake do exist within the regional area. These include, Faraday Lake, North Fork reservoir, Clear Lake, Collins Lake, Benson Lake, Trillium Lake, Memaloose Lake, Harriet Lake, and Timothy Lake. Some users may also choose to visit the Sandy River or one of the other numerous rivers in the area to pursue their water-based activities. When asked where they would go for similar recreation opportunities during the 1999 Visitor Use survey, visitors to the Roslyn Lake shoreline noted a total of 36 different locations. The most frequently mentioned alternative site was North Fork reservoir on the Clackamas River, which was noted by 15 percent of the surveyed lake users. Other alternative sites noted by respondents included Mt Hood Lakes (11 percent), the Clackamas River (9 percent), Trillium Lake (9 percent), Clear Lake (9 percent), and Harriet Lake (9 percent) (Kleinschmidt Associates 2000a). These results suggest that users displaced by the removal of Roslyn Lake would likely disperse to a wide range of other areas. Given the relatively low number of users affected, and the likelihood that these users would choose a variety of other sites, it is unlikely that the removal of Roslyn

Lake would adversely impact use at other surrounding recreation sites.

In addition to the direct effect of lake removal on existing and future water-based recreation opportunities, removal of Roslyn Lake may also adversely effect long-time users that have traditionally visited and used the lake. Roslyn Lake is popular with families and children in the community, many of whom have visited the lake on a regular basis for many years. For these users, removal of the lake may have a social impact greater than just the loss of future recreation opportunities.

The Bull Run Community Association recommend that public use of the lands associated with Roslyn Lake continue after the lake is drained. Once the license is surrendered, the Commission no longer has jurisdiction over the PGE property and thus cannot require that a former licensee provide for public use on those lands.

5.3.5.3 Cumulative Impacts

Under the Proposed Action Alternative, project lands owned by PGE would be conveyed to a private, non-profit conservation organization who would ultimately convey these lands into public ownership, or use the lands to acquire other lands within the river corridor for conveyance to public ownership, for the primary purpose of conserving these lands for their fish, wildlife, and recreation values. This would exclude lands and facilities at Roslyn Lake Park as well as lands created by the removal of Roslyn Lake itself. Existing public lands within the project boundary, such as lands under the jurisdictional authority of the Bureau of Land Management located at the Marmot dam site, would also revert to public use once the project is surrendered and removed. Any future recreational developments on conveyed lands would have a beneficial cumulative impact on recreation resources. Specific future recreation developments that may occur are unknown at this time, and would involve actions by parties other than PGE. However, it is likely that some recreation development would occur to accommodate use of these public lands, particularly at the Marmot site.

In addition to conveying project lands into public ownership, PGE also intends to convey a number of non-project lands in the vicinity of the project to public ownership. When combined with conveyed project lands, these lands would result in additional public access and recreation opportunities in the Sandy River corridor that do not exist today.

5.3.5.4 Unavoidable Adverse Impacts

Potential unavoidable adverse impacts to recreation resources include short-term

effects associated with deconstruction activities and long-term effects associated with the removal of Roslyn Lake.

5.3.6 Land Use and Aesthetic Resources

5.3.6.1 Affected Environment

Land Use

PGE's Bull Run Project is an existing hydroelectric project that is located in Clackamas County, Oregon. Total land within the FERC project boundary is approximately 606 acres of which 509 acres are owned by PGE. Seventy-three acres of the land are federally owned or managed. BLM is responsible for managing 55 acres of land, while USFS is responsible for managing 18 acres of land. The remaining 24 acres of land are privately held.

Current land use information for the area surrounding the Bull Run Project is well documented. Mount Hood National Forest (MHNF) borders project lands on the north and east side. Similarly, BLM manages three parcels within the project area -- two inside the project boundary and one just outside it. Several land management plans and legislative and regulatory requirements guide the activities on the MHNF and on BLM property. Management documents include Land and Resource Management Plan - Mt. Hood National Forest (1990), Record of Decision and Resource Management Plan -- Salem District (1995), and the Northwest Forest Plan -- Record of Decision (1994).

The intent of the Mt. Hood Forest Plan is to guide all natural resource management activities and establish management standards and guidelines for the MHNF. The Record of Decision adopts and approves a resource management plan for BLM administered lands and the NW Forest Plan provides detailed requirements on forest management within the range of the northern spotted owl. The NW Forest Plan amends and overlays current management plans for both the National Forests and BLM Districts.

Local management plans and ordinance include Clackamas County Comprehensive Plan (1992), Clackamas County, Oregon Zoning and Development Ordinance (1998), and the City of Sandy, Parks Master Plan (1997). The Clackamas County Plan directs future decisions on land use actions, ordinance amendments, zone changes, procedures and programs. The county ordinance implements the county plan and the parks master plan provides policy and direction for improving existing parks and providing guidelines for acquisition and development of new parks, open spaces, and trails.

The land surrounding the project area is fairly remote. The majority of lands are forested and undeveloped, however, a scattering of residential structures can be found east of Roslyn Lake along Phelps, Shipley, and Marmot dam roads. Residential property also occurs south and west of Roslyn Lake gradually increasing as development nears the City of Sandy. North of the lake there are several plant nurseries and small farms.

In addition to primary project facilities, secondary support features or project infrastructure are present throughout project lands. At the eastern most end of the project near Marmot dam and Little Sandy diversion dam, there is no potable water or sanitation service available. A 13-kV transmission line and a communications line are present and the gravel service roads provide limited access into the area. Infrastructure features within Roslyn Lake Park and near the forebay and powerhouse include city water and sewer services, transmission lines, commercial phone service and paved county roads.

Aesthetic Resources

The Bull Run Project encompasses a landscape character typical of the Sandy River Basin and the west slope of Mt. Hood in northwestern Oregon. The Sandy River is the only major river on the West Side of the Cascades Mountains in Oregon that is glacial in origin and character. Project lands include steeply sloping woodlands, wooded mountains, and talus slopes and piles of boulders (PGE 1998b). The upper reaches of the Sandy River flow through rolling mountainous terrain, falling 1,600 feet in the first 13 miles. Surface water occurs in the form of an open lake and narrow riverine settings. Many of the river reaches are unstable, composed of alluvial rock and very susceptible to erosion during high flows (PGE 1998b).

Marmot dam is located along the upper reaches of the Sandy River. Moderately steep, sloped rock walls characterize this portion of the Sandy River Basin. The dam rises about 47 feet above the riverbed and has a total length of approximately 345 feet. Water worn boulders fill the riverbed. Visitors to Marmot dam can view the Sandy River and the surrounding countryside, which is mostly composed of open stands, including grasses, shrubs, saplings, and a variety of trees.

Between Marmot dam and Little Sandy diversion dam, the water (600 cfs) is diverted through a system of concrete canals and a tunnel. The canals run along the broad river terraces of the north bank for approximately 2 miles before entering Tunnel No. 1. A dirt and gravel service road parallels the canal system for about a mile and a half before turning north into the woods. The vegetation is a mix of conifers, hardwoods, and shrubs in rocky unconsolidated soils.

Tunnel No. 1 bisects a ridge known as the "Devil's Backbone" and empties into the Little Sandy River, a mile north of the Sandy River. The diversion dam is 15.75 feet high and 114 feet long, and at this location, the water (800 cfs) from the Little Sandy River is diverted into the wooden flume. The narrow more steeply sloping river canyon supports a dense stand of mixed conifers, hardwoods, and shrubs. A river gaging station is just north of the Little Sandy diversion dam. A private dirt and gravel service road winds through the forest and is used for maintenance purposes only.

The forested river canyon provides a natural backdrop as the water from the Little Sandy River is diverted into the wood box flume. The flume is 15,838 feet long and was completely rebuilt in 1948 to an increased capacity of 800 cfs. The flume parallels the original riverbed for approximately a mile before turning gradually, slightly upslope and in a westerly direction. The flume crosses Phelps Road where the water is diverted into Tunnel No. 0, after which it flows through a short section of concrete canal, and eventually empties into Roslyn Lake. Residential development is present along the south side of the flume as it approaches Roslyn Lake.

Water from the Sandy and Little Sandy Rivers and from the City of Portland's municipal water supply is the source of water for Roslyn Lake. The 160-acre lake is maintained at its full elevation of 655 feet msl, and the forested stands of Douglas fir, western hemlock, western red cedar, and pine contribute to the overall serene setting of the park and adjacent lands. The park offers seasonal day-use activities primarily for families and large groups, although the lake is open year-round for fishing. Residential development borders the county roads that surround the lake and park, and the City of Sandy is less than 2 miles southwest from the park's entrance. Land north of Roslyn Lake supports commercial and some residential endeavors.

No aesthetic or visual resource assessments have been previously completed for the Bull Run Project area. However, the Bureau of Land Management (BLM) and the United States Forest Service (USFS) have visual assessment guidelines that are implemented as part of their land management responsibilities. Both the BLM and USFS manage property within the Bull Run FERC Project Boundary.

Project lands at Marmot dam are currently "withdrawn for hydropower use" and any administrative activities related to dam operation fall under BLM's Visual Resource Management (VRM) classification system. Marmot dam, the fish passage structures, concrete canal, and fish screens are located on lands managed by BLM. BLM manages approximately 55 acres of land near Marmot dam.

Further downstream, the linear project corridor parallels the Little Sandy River.

The project boundary at this location is 100 feet on each side of the flume centerline. The wooden flume is part of the water conveyance system that is associated with the Bull Run Project and crosses USFS managed lands. USFS manages approximately 18 acres of land north of Little Sandy diversion dam, along the Little Sandy River.

In September 1999, PGE conducted an aesthetic analysis of lands within the Bull Run Project Boundary (Kleinschmidt Associates 2000c). The reconnaissance study identified six viewsheds suitable for evaluation. At each viewshed the existing project features and the relationship of these features to the landscape were assessed. The viewsheds include:

- Views from Roslyn Lake Park
- Views of Roslyn Lake and project facilities from Ten Eyck Road
- Views from the dikes surrounding Roslyn Lake
- Views of the wood flume on Phelps Road
- Views of the Bull Run powerhouse area
- Views of the Marmot development vicinity

Results of the aesthetic analysis indicate that the existing project features are visible from immediate foreground locations, such as access roads and project recreation areas, but are not visible from any major vantage points within the study area. The existing features are generally small in scale and blend with the surrounding landscape. As currently configured, the project and facilities do not have an adverse effect on the visual quality of the area. (Kleinschmidt Associates 2000c).

5.3.6.2 Effects of Alternatives

Removal of Marmot Dam

Alternative 1 (PGE's Proposal)--Single Season Dam Removal with Minimal Sediment Removal

Land Use

PGE's proposal to remove Marmot dam, the water conveyance canal, associated fish passage structures, and sediments from the back of the dam would have a long-term beneficial effect on land management responsibilities and land use designations. Once the structures are removed the existing environment would cease to be industrial in nature, and would eventually be reestablished as a naturally appearing landscape. The final results of this action would be compatible with existing land use plans developed by

federal, state and local entities. PGE proposes to continue agency consultation to ensure land use requirements are met under the terms of this alternative.

However, short-term adverse effects would be associated with the removal process. Under this alternative, a cofferdam would be constructed in the river above and below Marmot dam. A fish trap would be installed and the stream flow would be diverted. These activities would have a temporary adverse effect on land use and the industrial nature of the site would become a deconstruction area. Implementing Best Management Practices (BMPs) and sediment erosion control plans would minimize these impacts.

Aesthetic Resources

PGE's proposal to remove Marmot dam, the water conveyance canal, associated fish passage structures, and sediments from the back of the dam would have a beneficial effect on the aesthetic resources of the Sandy River. Once the structures are removed the existing environment would cease to be industrial in nature, and would eventually be reestablished as a naturally appearing landscape.

However, short-term adverse effects would be associated with the removal process. Under this alternative, a cofferdam would be constructed in the river above and below Marmot dam. A fish trap would be installed and the stream flow would be diverted. These activities would have a temporary adverse effect on the visual aspects of the river and the industrial nature of the site would become a deconstruction area. Implementing BMPs and sediment erosion control plans would minimize these impacts.

Removal of debris and sediment would require the use of heavy equipment and machinery, which could impact normal noise levels. The area surrounding Marmot dam is heavily wooded and as such, the dense vegetation would serve as a buffer for sound. However, for the off-site sediment disposal option deconstruction traffic may be a concern to local residents. Under the off-site sediment disposal option, a substantial amount of traffic would traverse very lightly used roads. Implementing BMPs and dust control measures would minimize these impacts.

Alternative 2--Removal of Top of Dam in Year 1. Complete Dam Removal in Year 2 with Sand Layer Excavation

Land Use

The information that was stated in Alternative 1 is the same for Alternative 2 with

the following exceptions. The time frame for this alternative is 2 years and the amount of sediment removed is more than Alternative 1. In addition, excavated sediment would be disposed of over a 100-acre area with the resulting sediment mound of 2.7 feet. Implementing BMPs and erosion control measures would minimize these impacts.

Aesthetic Resources

The information that was stated in Alternative 1 is the same for Alternative 2 with the following exceptions. The time frame for this alternative is 2 years and the amount of sediment removed is more than Alternative 1. Truck traffic would be a consideration. In addition, excavated sediment would be disposed of over a 100-acre area with the resulting sediment mound of 5.3 feet. Implementing BMPs and erosion and dust control measures would minimize these impacts.

Alternative 3—Remove the Dam and the Maximum Amount of Sediment Possible During One In-water Work Period

Land Use

The information that was stated in Alternative 1 is the same for Alternative 3 with the following exceptions. The amount of sediment removed is more than Alternative 1. In addition, excavated sediment would be disposed of over a 100-acre area with the resulting sediment mound of 5.3 feet. Implementing BMPs and erosion control measures would minimize these impacts.

Aesthetic Resources

The information that was stated in Alternative 1 is the same for Alternative 3 with the following exceptions. The amount of sediment removed is more than Alternative 1. Truck traffic would be a consideration. Implementing BMPs and erosion and dust control measures would minimize these impacts.

Removal of Little Sandy Diversion Dam

Land Use

PGE's proposal to remove Little Sandy diversion dam would have a long-term beneficial effect on land management responsibilities and land use designations. Once the structures are removed the existing environment would cease to be industrial in nature, and would eventually be reestablished as a naturally appearing landscape. The final

results of this action would be compatible with existing land use plans developed by federal, state and local entities. PGE proposes to continue agency consultation to ensure land use requirements are met under the terms of this alternative.

Conventional means such as controlled blasting, jack hammers, and excavators would be employed to remove the dam. Removal of debris and sediment would require the use of heavy equipment and machinery, which could have a short-term adverse impact on land management activities. However, the area surrounding Little Sandy diversion dam is densely wooded and as such, the vegetation would serve as a buffer for deconstruction activities. Implementing BMPs and erosion control measures, as well as restoration of lands to naturally appearing conditions would minimize any impacts associated with this alternative.

Aesthetic Resources

PGE's proposal to remove Little Sandy diversion dam would have a short-term effect on aesthetic resources. Conventional means such as controlled blasting, jack hammers, and excavators would be employed to remove the dam. Removal of debris and sediment would require the use of heavy equipment and machinery, which could impact normal noise levels. However, the area surrounding Little Sandy diversion dam is densely wooded and as such, the vegetation would serve as a buffer for sound.

Under this alternative, debris from the dam removal would be "landfilled" on adjacent PGE property. PGE lands surround Little Sandy diversion dam so the hauling distance would be relatively short and would not require access to public roads. Therefore, increased traffic and dust would not impact local area residents. Implementing BMPs and erosion control measures, as well as restoration of lands to naturally appearing conditions would minimize any impacts associated with this alternative.

Removal of Canals, Tunnels, Flumes, and Ancillary Structures

Land Use

PGE's proposal to remove all canals and flume, close or modify the tunnels, remove any ancillary structures would have a long-term beneficial effect on land management responsibilities and land use designations. As stated previously, once the structures are removed the existing environment would cease to be industrial in nature, and would eventually be reestablished as a naturally appearing landscape. The final results of this action would be compatible with existing land use plans. PGE proposes to continue agency consultation, implement BMP's and erosion control measures, and to

restore lands to a naturally appearing condition in an effort to minimize any impacts associated with this alternative.

Aesthetic Resources

PGE's proposal to remove all canals and flume, close or modify the tunnels, remove any ancillary structures would have a short-term effect on aesthetic resources. Conventional means such as controlled blasting, jack hammers, and excavators would be employed to remove these features. Removal of debris and sediment would require the use of heavy equipment and machinery, which could impact normal noise levels. However, the area surrounding these features is densely wooded and as such, the vegetation would serve as a buffer for sound.

Under this alternative, debris from the canals would be buried in place. The tunnels would be closed with grout plugs at each end. The flume would be dismantled, stored on project lands and all salvageable materials would be sold. Damaged or dangerous (chloropickerin treatment) timbers would be taken to an appropriate landfill. Therefore, increased traffic and dust would have minimal impact on local area residents. Implementing BMPs and erosion control measures, as well as restoration of lands to naturally appearing conditions would minimize any impacts associated with this alternative.

Project Powerhouse

Land Use

If this action were implemented there would be no effect on land management responsibilities or land use designations.

Aesthetic Resources

If this action were implemented there would be no effect on aesthetic resources.

Removal of Roslyn Lake

Land Use

Complete removal of the lake would have a short-term effect on land management responsibilities and land use designations. This task would require removal, disposal or redistribution of all existing fill material associated with the lake and no changes would

be planned for the park. The removal activities would have a direct effect on existing vegetation along the edge of the lake and the "lawn-like" grassy dikes. Once deconstruction activities have been completed the restored land would reflect a "meadow-like" environment. Implementing BMP's, erosion control measures, as well as restoration of lands would minimize any impacts associated with this alternative.

The Bull Run Community Association is concerned with the preservation of the existing rural and scenic character of the area. They would like to see assurances that these lands associated with Roslyn Lake are protected from development into rural residential tracks so as to maintain the existing rural and scenic character of the area.

After decommissioning, the lands would continue to be owned by PGE who is free to dispose of them as they desire. Use of those lands would be subject to local zoning regulations. The lands are currently zoned as timber land. Once the license is surrendered, the Commission no longer has jurisdiction over the PGE property and thus cannot require that a former licensee control development on those lands.

Aesthetic Resources

PGE's proposal for complete removal of the lake would have a short-term effect on aesthetic resources. This task would require removal, disposal or redistribution of all existing fill material. These activities would have a direct effect on existing vegetation along the edge of the lake and the "lawn-like" grassy dikes. Roslyn Lake is bounded on all sides by county roads. Agricultural lands and some residential properties are located near Roslyn Lake Park. Under this alternative, traffic and deconstruction noise would impact local property owners for a short period of time. Implementing BMPs, erosion and dust control measures, as well as restoration of lands to naturally appearing conditions would minimize any impacts associated with this alternative.

5.3.6.3 Staff Modifications of PGE's Proposal

Development of a erosion and sediment control plan, as described in section 5.3.1.3 would minimize impacts from project removal.

5.3.6.3 Unavoidable Adverse Impacts

Land Use

Under the proposed actions there is potential for short-term unavoidable adverse impacts to land resources. The proposed decommissioning removal plan would require

major earth moving activities and sediment/debris disposal. Given the nature of deconstruction activities in general, the natural landscape would sustain temporary adverse impacts related to these actions. To minimize the unavoidable adverse impact of the proposed action, PGE would continue agency consultation and implement BMPs, erosion control measures, and restore lands to naturally appearing conditions.

Aesthetic Resources

Under the proposed actions there is potential for short-term unavoidable adverse impacts to aesthetic resources. The proposed decommissioning removal plan would require major earth moving activities and sediment/debris disposal. Given the nature of deconstruction activities in general, the natural landscape would sustain temporary adverse impacts related to these actions. To minimize the unavoidable adverse impact of the proposed action, PGE would continue agency consultation and implement BMPs, erosion control and dust control measures, and restore lands to naturally appearing conditions.

5.3.7 Cultural Resources

5.3.7.1 Affected Environment

Archeological Resources

Although very little is known about the archeological resources in the vicinity of the Bull Run Hydroelectric Project, several archeological investigations have occurred elsewhere in the foothills and uplands of the Western Cascades east of Portland. These investigations were conducted by federal agencies such as the Mt. Hood National Forest (MHNP) and the Salem District, Bureau of Land Management (BLM). Prior to this undertaking, only one archeological site has been recorded within 5 miles of the Bull Run Hydroelectric Project facilities. However, syntheses of studies conducted in neighboring upland drainages have resulted in overviews of upland prehistory and models for prehistoric and historic land-use that are applicable to this project (Bryant et al. 1978, Burtchard 1990, Burtchard and Keeler 1991, Burtchard et al. 1993, Minor et al. 1980).

Burtchard (1990, Burtchard et al. 1993) developed a five stage model for the prehistory of the central Cascades Mountains region. Each stage is based on a reconstruction of major environmental periods and accompanying settlement and subsistence patterns. This model is inferred from current archeological theory and recent archeological data. An uplands-oriented chronology supplemented with lowland data from Minor et al. (1994), and Pettigrew (1990) is presented below.

Early broad-spectrum foraging (ca. 13,000-8,500 BP) is defined as the terminal Pleistocene-Early Holocene period; a time of changing environment as the glaciers retreated. Environmental conditions, once cool and generally moist were gradually becoming warmer. Typical of the period, human groups were small and highly mobile. Fluted lanceolate projectile points and large lanceolate stemmed points were characteristic of this period, and reflected a bias towards hunting as the principal economic endeavor. At present, there are no archeological materials from the Portland region that date to this period.

Mesofaunal broad-spectrum foraging (ca. 8,500-5,000 BP) is a period of coping with and adapting to the developing environment of the Holocene which was often described as a warmer and drier time. Populations are still low but increasing. Human groups remain small and mobile, but they were learning about and using an increasing variety of plant and animal resources. This meant foraging groups were following game and making greater use of the upland areas (Burtchard et al. 1993). Initial occupations at numerous archeological sites in the Cascades appear to date to this period. Although few absolute dates have been obtained, correlation of these sites to this stage is based on the presence of leaf-shaped projectile points known as Cascade points. A half dozen sites of this stage have been recorded within the Clackamas region.

Early semisedentary foraging (ca. 5,000-2,500 BP) is characterized once again by cooler more moist climatic cycles. Forests are expanding and displacing grasslands in the western Cascades. Population densities have increased to the point that foraging is no longer economically effective. The mobility of groups decreases while the population increases and food procurement, processing, and storage activities now require more time. Groups continue to move about the landscape to acquire specific resources, but these were more often small task-specific parties rather than the whole group. The archeological evidence for these kinds of organizational changes is difficult to isolate but inferences can be made based on the location of residential sites, development and use of storage facilities, and intensive more specialized use of specific sites. Cascade points probably continue into this period but the primary point types diagnostic of this period are broad-necked specimens, large side-notched points, and stemmed points (Roulette and Ellis 1995). A wide variety of formed stone tools are found in artifact assemblages and Burtchard and Keller (1991) suggest that winter villages were located in lowland valleys adjacent fishing sites, camas meadows, or deer and elk winter ranges. Few sites within the Clackamas region date to this time period.

Intensive semisedentary foraging (ca. 2500-500 BP) is defined as established modern floral communities. Cultural developments during this time are perceived as a refinement of previous cultural patterns. Populations continue to grow and become more

sedentary, reliance on dependable and storable foods increases, and complex social organizations emerge to effectively cope with the logistic and social needs of larger populations. The major technological innovation of this period is the narrow-necked projectile point associated with the use of the bow and arrow.

This stage of the model is poorly represented in the uplands. Although the model envisions even more use of upland resources, few sites in the region have dated to this period. It is, however, well represented in the Portland Basin. Numerous archeological surveys and excavations have documented the presence of large possibly sedentary village sites. These sites are generally characterized by the presence of rectangular houses similar in most respects to the plank houses used by the ethnographic Chinookan groups of the region. The cultural chronology for the Portland Basin (Pettigrew 1981, 1990) emphasizes a strong pattern of continuity in artifact assemblages and land use patterns throughout this period, culminating in the cultural lifeways of the ethnographic Chinookan groups.

Post apocalypse strategies (ca. 500 BP-Present) Catastrophic population losses suffered by indigenous groups, due to epidemic European diseases, had profound effects on their cultural and economic lifeways. Disease devastated populations before and after contact with Euro-Americans in the eighteenth century. Surviving individuals and groups coalesced into composite groups in an effort to maintain cultural traditions. Still, changing population demographics and disruption of traditional social interactions most likely altered settlement and subsistence practices. Many village and task sites were abandoned, and the effects of these changes, in the Cascades uplands, are thought to have altered the use of this region. At present, no sites in this region have reliably documented late prehistoric occupations.

Previously, there have been no extensive archeological studies conducted on Bull Run Project lands. Nonetheless, the BLM conducted two archeological surveys on public lands located within 2 miles of the Bull Run Project diversion dams. The surveys were for timber sale contracts, and no cultural resources were identified (PGE 1998c, Peters et al. 1991, Philipek 1987).

According to Oetting (2000) one prehistoric archeological site has been recorded within 5 miles of the Bull Run Project facilities. The site was discovered in 1971-1972 and contained a rich midden deposit that yielded a variety of tools and flakes. The location and the artifact assemblage indicate that the site was a camp used for fishing, hunting, and plant food gathering. The site dates to 1,340 BP. In addition to this, the FS has recently commented that there are in fact 10 archeological sites on National Forest System lands within 5 miles of the project facilities (FS comments on DEIS, dated

September 5, 2003). These sites include cabin ruins, bridge structure ruins, FS administrative sites, and fences. All of these sites in some capacity contribute to the overall historic context of the area

PGE conducted a limited cultural resource reconnaissance survey on project lands in 1997. Two obsidian flakes were found in the back fill of a rodent hole. No other materials were located during this survey and the two flakes were classified as an isolated find. Additional work was recommended to determine whether an archeological site is present and to assess the size, structure, and function of the site (PGE 1998d).

From September 9 through September 28, 1999, PGE conducted archeological survey and evaluation of Bull Run Project lands. The area of potential effect (APE) for this task is defined as the 606 acres of land within the FERC project boundary. A surface survey was conducted as a total inventory of all lands in the APE, excluding the unsafe areas (e.g. steep slopes >20 percent grade). The subsurface site discovery test probes focused on areas defined by the site location model (Burtchard and Keeler 1991) as having high potential for containing archeological sites (Oetting 1999).

No archeological artifacts, features or sites were identified during the 1999 surface inspections, but high probability landforms were noted for subsequent subsurface tests. Three archeological sites were identified during the subsurface testing. Additionally, four locations with isolated prehistoric artifacts and two locations with modern or historic refuse were documented.

The first prehistoric site (35CL264) was discovered along the Sandy River. Thirty-seven site discovery probes (units) were excavated within and around the vicinity of the site. The units ranged in depth from 20 centimeter (cm) to 130 cm; most were excavated to a depth of 60-80 cm before reaching bedrock. The artifact assemblage from this site includes chert, basalt, and obsidian flakes, and unidentified small mammal bone fragments. This site is recommended as potentially eligible for the National Register of Historic Places pending further testing and consultation.

The second prehistoric site (35CL265) was discovered in a transmission line right-of-way (ROW) that is associated with the Bull Run Project. Seven site discovery probes (units) were excavated within and around the vicinity of the ROW. All units were excavated to a depth of 30 cm. The artifacts found at this site are chert flakes. This site is recommended as potentially eligible for the National Register of Historic Places pending further testing and consultation.

The third site (35CL266), a lithic scatter, is located in the vicinity of Roslyn Lake

Park. Fourteen site discovery probes (units) were excavated within and around the site. All units were excavated to a depth of 60cm. The artifact assemblage from this site includes chert flakes, a chert biface fragment, and twentieth-century artifacts such as bottle glass, ceramic fragments, nails, fishing weights, plastic and Styrofoam. This site is recommended as potentially eligible for the National Register of Historic Places pending further testing and consultation.

Through our February 21, 2003, additional information request, PGE conducted formal National Register evaluations of these three prehistoric sites (Oetting 2003). Additional sub-surface shovel test probes were placed at each site as part of an extensive testing program to determine whether any of these sites were eligible. The results determined that site 35CL264 was eligible for listing in the National Register, while sites 35CL265 and 35CL266 were determined not to be eligible. Site 35CL264 was determined eligible because its contextual integrity seemed to be intact, while sites 35CL265 and 266 appeared to represent lighter lithic scatters with did not have any integrity left for further research value.

Historic Structures

The Mt. Hood Railway and Power Company, an early competitor to PGE's predecessor, first started construction on the Bull Run Project in 1906. Upon takeover of the Mt. Hood Railway and Power Company, the Portland Railway Light & Power Company (PRL&P) (PGE's predecessor), completed construction of the project between 1912 to 1913. The project was designed to be the terminus for an interurban electric railroad that originated in Portland. The Bull Run Project provided the necessary electric power to this electric rail line, as well as to other parts of PRL&P's elaborate transportation system (PGE 1998b).

The establishment of regular rail service between downtown Portland and the Bull Run area encouraged commuter use and provided increased economic development by opening up downtown Portland markets to area farmers and their agricultural products. The use of electric rail service also provided regular and reliable shipment of goods to the growing population within the Bull Run area (PGE 1998a).

In addition, PRL&P ran excursion trolleys to the powerhouse and to Roslyn Lake, which facilitated the recreational opportunities of the area. Roslyn Lake consequently became a popular fishing and picnic spot. The availability of a rail line to Bull Run created huge development opportunities in this part of the county by making goods and services from Portland more accessible to this previously isolated area (PGE 1998a).

In 1997 to 1998, PGE conducted an evaluation of the historic structures associated with the Bull Run Project. Project facilities were evaluated separately and together for their contribution to the development of Clackamas County and the importance of rail transportation to the area. Each component of the project was subject to a three-tier rating system. This system determined whether a component was primary historic, secondary historic-compatible, or non-historic (PGE 1998b).

The Bull Run Hydroelectric Project consists of a dispersed group of buildings, sites and structures ranging in construction date from 1906-1913 through the late 1960s. The major built resources for the Bull Run Hydroelectric Project include Marmot dam and associated fish passage structures, Little Sandy diversion dam, water conveyance systems, earth-fill dikes, powerhouse forebay and intake structure, Bull Run powerhouse and associated structures, and Roslyn Lake recreation buildings (PGE 1999).

In September 1999, PGE finalized the historic structure's evaluation and prepared a Request for Determination of Eligibility (DOE) for the National Register of Historic Places. PGE submitted the DOE to the Oregon State Historic Preservation Office (SHPO) requesting concurrence. The following structures have been determined eligible for the National Register of Historic Places:

- Marmot dam
- Little Sandy diversion dam
- Bull Run water conveyance systems
- Roslyn Lake earth-fill dikes
- Powerhouse intake
- Penstocks and surge tank
- Bull Run powerhouse
- Bull Run transformer building
- Machine shop

Structures not eligible for the National Register of Historic Places include Marmot dam fish ladder and associated structures, and Roslyn Lake Park recreation buildings (PGE 1998b, 1998c, and 1999).

Ethnographic Resources

Prior to Euro-American contact and colonization, the Lower Columbia River Valley, including the Portland Basin, was populated by the Clackamas to the south and west, the Multnomahs to the west and north, and the Cascades to the north and east of the Columbia River (French et al. 2000). The westernmost village of the Cascades is thought

to have been on the north shore of the Columbia, across and slightly east of the mouth of the Sandy River (French and French 1998). The project area is in land ceded by the Cascades in 1855 (French et al. 1995). All three groups were speakers of Chinookan languages with additional ties through trade and marriage (French et al. 2000).

The Chinookan speakers were riverine people who relied on the great salmon runs up the Columbia River and its tributaries as a major source of food. For Chinookan populations on the lower Columbia eulachon (smelt) and sturgeon were also important fish resources. Plant foods such as camas, wapato, and huckleberries were gathered in quantity. Additionally, animals and waterfowl of all sorts were hunted. Winter villages often consisted of multi-family plank houses while summer camps were less established. In some areas, winter villages may have been occupied year round, with families moving about in the warm weather (French et al. 2000).

The Sahaptin speaking groups from the north and the east had a similar economic base, although they relied less on fishing and more on the procurement of plant foods. They had less wealth and social differentiation, and there were differences in house types from the Chinookan-speaking groups (Hunn and French 1998).

The Bull Run project area is documented as being “outside the territories” of the lower Columbia River Chinookans, Kalapuyans, upriver Chinookans, Western Columbia River Sahaptins, and the Molala. It is suggested that prior to Euro-American presence, travel by Native Americans throughout the area was common for the purpose of obtaining food and socializing (French et al. 2000).

Traditional use of the project study area was probably limited to the summer season, extending from spring to late fall. Spring runs of chinook salmon would have drawn people to the Sandy River to fish, although it's not certain how far upriver they would go. It is suggested that movement through the project area for procurement of subsistence resources would have continued at low levels through most of the summer, and peaked by late summer through mid-fall. This was the major season for taking fall salmon, hunting and gathering huckleberries, one of the most important food plants in the Cascades Range (French et al. 2000).

The project study area historically lacked sufficient resources to support large numbers of native peoples. Major plant foods are not abundant and huckleberries grow best at elevations of 3500' and higher. Such elevations are found only on ridges and buttes at the extreme eastern edge of the project study area. Fishing was good and there was a wide variety of game. Medicinal plants were valuable, however most people collected them opportunistically. In other words, the project area contained nothing that

would regularly attract groups in large numbers for extensive collecting or foraging purposes (French et al. 2000).

Previously, no ethnographic studies have been conducted on Bull Run Project lands. As part of this undertaking, PGE requested that a traditional cultural properties (TCP) study be conducted to determine if there are or are likely to be significant locations of traditional use within the project's Area of Potential Effect (APE). [See French et al. 2000 for a definition of the project's APE.] The TCP study included consultation with interested Tribal governments and knowledgeable individuals, and a literature search and review. The study concluded that while the data were sketchy, nineteenth and early twentieth century Indians traveled through the project study area enroute to their final destination. The only location for which there are several references of regular and frequent use is near Brightwood. Brightwood is in the APE defined for the ethnographic studies, however this location is approximately 7.5 miles above Marmot dam.

5.3.7.2 Effects of Alternatives

Removal of Marmot Dam

The impact of the removal of Marmot dam on cultural resources would be the same, regardless of the alternative chosen.

Archeological Resources

The proposed action, dam removal, would have a long-term adverse effect on archeological resources recorded within the defined "area of potential effect" (APE). The APE is the FERC Project Boundary and the effects of the proposed action are discussed below.

An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualifies it for inclusion in the National Register of Historic Places. An adverse effect is defined as any action that has the potential to diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Physical destruction of or damage to all or part of a historic property is an example of an adverse effect [38 CFR Part 800.5(1)(2)].

PGE's proposal to remove Marmot dam, the water conveyance canal, associated fish passage structures, and sediments from the back of the dam has the potential to affect the archeological site (35CL264) located along the Sandy River. The three alternatives analyzed would require land suitable for off-site disposal of deconstruction debris and/or

sediments, and to serve as a staging area for removal activities. The archeological site is in proximity to where these activities would take place.

Given the need for burial or storage of deconstruction debris, it is possible that the land where the archeological site is located could be used for these tasks. If that occurs, the site would be adversely affected by these activities. If the land was not used to bury or store the debris, the unconsolidated nature of the soils along the north bank of the Sandy River and the extensive need for heavy equipment and blasting as options for facility removal have the potential to adversely affect this resource. These effects could occur through soil compaction, bank or slope erosion, or general overuse of the area caused by trucks, heavy equipment, etc.

Historic Resources

The proposed action would have a long-term adverse effect on historical resources recorded within the defined "area of potential effect" (APE). The APE is the FERC Project Boundary. Physical destruction of or damage to all or part of a historic property is considered an adverse effect (38CFR Part 800.5(1)(2)).

PGE's proposal to remove Marmot dam, the water conveyance canal, associated fish passage structures, and sediments from the back of the dam would adversely affect the historic structures located along the Sandy River and within the APE. Four alternatives are being considered as part of the Engineering Removal Plan for this location. The actions associated with the four alternatives would have the same effect on the historic resources. The only difference between the alternatives, with respect to the structures, is whether the task occurs over 1 year or 2.

Marmot dam and the water conveyance canal have been determined eligible for the National Register of Historic Places (PGE 1999). The proposed action would have a long-term adverse effect on these resources, as they are considered significant for their role in the generation of hydropower at the Bull Run Project. Further documentation would be required prior to removal of the structures.

Ethnographic Resources

The proposed action would have no effect on ethnographic resources.

Removal of Little Sandy Diversion Dam

Archeological Resources

PGE's proposal to remove Little Sandy diversion dam would not effect known archeological sites within the APE. However, if removal alternatives require the use of land outside the defined APE (i.e., the FERC Project Boundary), then the potential exists for undiscovered archeological resources to be affected by the proposed action. Further evaluation would be required if this was necessary.

Historic Resources

PGE's proposal to remove Little Sandy diversion dam has the potential to affect historic structures on the Little Sandy River and within the APE. PGE proposes to remove the complete structure during a low-water season by controlled blasting and conventional air hammers. The debris would be removed simultaneously upstream and downstream, and buried on adjacent PGE property. Little Sandy diversion dam has been determined eligible for the National Register of Historic Places (PGE 1999). The proposed action would have a long-term effect on these resources, as they are considered significant for their use in the generation of hydroelectricity. Further documentation would be required prior to removal of the structures.

Ethnographic Resources

The proposed action would have no effect on ethnographic resources.

Removal of Canals, Tunnels, Flumes, Ancillary Structures, and Securing the Powerhouse

Archeological Resources

PGE's proposal to remove or close the canals, tunnels, and flume would not affect known archeological sites within the APE.

Historic Resources

PGE's proposal to remove or close the canals, tunnels, and flume would adversely affect known historic structures within the APE. PGE proposes to rip and bury the concrete canals, and close all tunnels except one using concrete plug rock. The tunnel that would remain open would have a louvered opening to provide for bat habitat. The

flume would be dismantled from within the box. The water conveyance system has been determined eligible for the National Register of Historic Places (PGE 1999). The proposed action would have a long-term effect on these resources, as they are considered significant for their use in the generation of hydroelectricity. Further documentation would be required prior to removal of these structures.

Ethnographic Resources

The proposed action would have no effect on ethnographic resources.

Project Powerhouse

Archeological Resources

If this action was implemented, there would be no effect on known archeological resources.

Historic Resources

PGE's proposal to remove the powerhouse would adversely affect known historic structures within the APE. If the powerhouse remains standing after surrender of the license, the effect would still be considered adverse, since the powerhouse would no longer remain under federal jurisdiction. As a result, some additional documentation of the powerhouse structure would be necessary.

The Bull Run powerhouse is a four-story concrete structure that is nested into a steep bank of the Sandy River. The main power floor, set two-floors below parking grade, holds the generation equipment. The main generation equipment is of Westinghouse manufacture and connected to four Francis-type turbines. The powerhouse has been in continuous operation since its completion, has sustained minimal modification, and retains very high integrity. Further evaluation of a mothballing program is suggested prior to removing the structure.

Ethnographic Resources

The proposed action would have no effect on ethnographic resources.

Removal of Roslyn Lake

Archeological Resources

Complete removal of the lake has the potential to affect archeological site (35CL266), which is located near the day-use area. This task would require removal, disposal or redistribution of all existing fill material. The archeological site would be directly affected by these activities. However, since this site has been determined ineligible for listing in the National Register, adverse effects to it would not be considered significant.

Historic Resources

Removal of Roslyn Lake has the potential to affect the earth-filled dikes, the powerhouse intake structure, and the penstocks. The removal of these features would have an adverse effect on the historic properties, as this action would be considered a permanent loss of these resources. These resources have been determined eligible for the National Register of Historic Places as contributing features in the generation of hydroelectricity for the Bull Run Project. Further documentation would be required prior to removal of the structures.

Ethnographic Resources

The proposed action would have no effect on ethnographic resources.

5.3.7.3 Staff Modifications to PGE's Proposal

Through our February 21, 2003, additional information request in regard to PGE's APEA, we have directed PGE to take the relevant measures in their MOA--involving minimizing the unavoidable adverse impacts to archeological and historic resources--and craft a Historic Properties Management Plan (HPMP). PGE filed the draft with the Commission on May 21, 2003 (PGE 2003c), and has distributed the HPMP to the SHPO, BLM, FS, affected tribes,²⁰ ACHP, and other interested party for review and comment. After the HPMP has been finalized, and in consultation with the above parties, the Commission would then issue a standard FERC MOA that would implement the HPMP. The MOA would be incorporated into any surrender order.

²⁰ These tribes are the Grand Ronde, Siletz, Warm Springs, Yakama, Chinook, Umatilla, and Cowlitz Tribes.

5.3.7.4 Unavoidable Adverse Impacts

Archeological Resources

Under the proposed actions, there is potential for unavoidable adverse impact to one known archeological site (35CL264) which is considered to be eligible for listing in the National Register. Unavoidable adverse impact could occur to the other two known archeological sites (35CL 265 and 266), but since these sites are considered ineligible for the National Register, adverse impacts to these sites is not considered significant. The proposed decommissioning removal plan would require major earth-moving activities and sediment/debris disposal. If these activities occur on or adjacent to archeological site 35CL264, there is potential for this site to be damaged or destroyed. Damage to or destruction of a historic property constitutes an adverse effect. To minimize the unavoidable adverse impact of the proposed action, PGE has undertaken agency consultation and prepared a HPMP to address issues relating to this archeological site at Bull Run.

Historic Resources

Under the proposed actions, there is potential for unavoidable adverse impacts to known historic structures. The decommissioning plan would require demolition of two dams, a powerhouse, a water conveyance system, and ancillary structures. Physical destruction of a historic property constitutes an adverse effect. To minimize the unavoidable adverse impact of the proposed action, PGE has undertaken agency consultation and prepared an initial Memorandum of Agreement (MOA) to address issues relating to the demolition of the historic structures at Bull Run.

Ethnographic Resources

There are no unavoidable adverse impacts on ethnographic resources.

5.3.8 Socioeconomic Resources

5.3.8.1 Affected Environment

The Bull Run Hydroelectric Project is located entirely within Clackamas County. The City of Sandy is the closest population center to the project (located approximately 10 miles from the Bull Run powerhouse). The Bull Run Hydroelectric Project does not play a significant role on the socioeconomic picture of the County, or the City of Sandy. The project employs few people and does not generate any direct revenues in the County.

The project does support recreation activity, which may contribute to expenditures in the County and the City of Sandy (including some expenditure of dollars originating from outside the County), but total visitation to the project area is relatively small when compared to other recreation destinations within Clackamas County (see Section 5.3.5 – Recreation Resources). In addition, a significant percentage of the project area visitors originate from within the County.

Population

Clackamas County, located in the rapidly growing northwest corner of the state of Oregon had a 1998 estimated population of 323,000, making it the third most populated county in the state. The nearest incorporated city (and only one in the near vicinity of the Bull Run Hydroelectric Project) is the City of Sandy, with an estimated 1998 population of 5,135.

Much of the increase in population in Clackamas County is due to in-migration. Of the almost 45,000 new residents added to the population between 1990 and 1998, over two-thirds (69 percent) migrated from outside the county. The remaining growth was due to natural increase (more births than deaths).

From 1990 to 1998 the population of the state of Oregon grew about 15 percent. Over the same period, the population of Clackamas County grew just slightly faster, at 16 percent. Growth within the boundaries of the City of Sandy surpassed both that of the State and County, at 23.6 percent (see table 32).

Table 32. State, County, and City Population Estimates (1990-98).

State, County and City Population Estimates				
	Population		Change	
	1998	1990	Level	Percent
Oregon	3,267,550	2,842,321	425,229	15.0%
Clackamas County	323,000	278,850	44,700	16.0%
Sandy	5,135	4,154	981	23.6%

In the beginning of the next century, the population of Clackamas County is projected to grow at a faster rate than that of the State of Oregon. Between 2000 and 2010 the County's population is projected to grow 19.4 percent, compared with 13.4 percent statewide (Center for Population Research and Census 1998).

Employment

Between 1988 and 1998, the Civilian Labor Force in Clackamas County grew by

approximately 36 percent, from 140,280 to 191,317. Over the same period, total employment in the county grew at about the same rate, from 134,940 to 183,772 jobs.

Since the early 1980's the average annual rate of unemployment in Clackamas County has consistently been below that of the State of Oregon and the United States as a whole. Between 1988 and 1998 the rate of unemployment within the county peaked at 5.5 percent in 1992 and fell to a low of 3.2 percent in 1995. During the same years, unemployment rates in the state of Oregon were 7.5 percent and 4.8 percent, respectively. For the United States overall, they were 7.5 percent and 5.6 percent, respectively.

As of 1998, the largest percentage of jobs in the county was in trade-related industries (30 percent), services (23 percent), and manufacturing (14 percent). Trade related jobs (30 percent of all jobs in 1998) included both retail trade (70 percent) and wholesale trade (30 percent). Eating and drinking places were the largest trade employers, making up about 21 percent of all trade jobs (7,965 jobs). Most service related jobs were in health services (28 percent) and business services (21 percent). Most manufacturing jobs were in the manufacture of metals (30 percent), machinery (21 percent), and instruments and electronics (11 percent).

Other types of jobs in Clackamas County in 1998 included government (12 percent), construction (7 percent), finance, insurance and real estate (6 percent) and transportation, communications, and utilities (4 percent). Agriculture also provided a large number of jobs.

Between 1988 and 1998 the largest growing industries in Clackamas County, in terms of jobs, were business services (228 percent growth), special trade contractors (79 percent growth) and retail trade eating and drinking places (61 percent growth). During the same period, jobs in manufacturing industries had decreased. The largest decreases were in miscellaneous manufacturing (-59 percent), apparel and textiles (-40 percent), instruments and related products (-39 percent) and lumber and wood products (-26 percent). Between the period of 1998 and 2008, employment in Clackamas County is projected to grow by about 21 percent (Oregon Employment Department 1999).

Income

Total personal income in Clackamas County in 1997 was estimated at \$9.3 billion, 12 percent of the statewide total. Approximately 72 percent of personal income was derived from net earnings (labor income), 17 percent from dividends, interest and rent (investment income), and 11 percent from transfer payments.

Residents of Clackamas County derived about the same percentage of their personal income from investment income as the state as a whole, but generated a higher share from net earnings (72 percent v. 65 percent, respectively) and smaller share from transfer payments (11 percent v. 19 percent, respectively). This situation is largely explained by the County's age structure of having a lower percentage of retirement age residents than the state overall.

Per Capita income in Clackamas County has historically exceeded that of the State of Oregon and the Country overall. For the Oregon and the United States, 1997 per capita income was \$23,920 and \$25,288, respectively. During the same period, per capita income in Clackamas County was \$28,149, the third highest county in the state, 17.7 percent more than the state average and 11.3 percent more than the national average.

Clackamas County also had a relatively low rate of persons living in poverty compared to the Portland metropolitan area and the state overall. In 1990, the poverty rate for the county was 6.9 percent, compared with 9.9 percent within the Portland metropolitan area and 12.4 percent for the State of Oregon (Oregon Employment Department 1999).

5.3.8.2 Effects of Alternatives

Decommissioning and removal of project features could require considerable construction activity in the short-term, depending on the specific removal option. This activity could result in a short-term impact on employment and income in the local area. The degree to which construction activity could impact socioeconomic resources would depend on the extent of work that is contracted (as opposed to being done by existing PGE staff), the business location of any selected contractors and labor source, and the extent to which new employees would be needed to meet the workload. Regardless of who performs the work, and the subsequent employment impacts, the construction activity itself would likely have a short-term impact on the local service industry.

However, this effect would be expected to be small relative to the total amount of service business occurring in the area, and would be expected to last one or two construction seasons.

Displacement of recreation visitors due to the removal of Roslyn Lake and potential changes to sportfishing opportunities below Marmot dam could have an indirect adverse impact on local service businesses that support these users, including bait and tackle shops. However, as with the construction-related impacts, the total number of users affected is relatively small compared to the total volume of service business activity in the area. In addition, displaced users may continue to visit the same businesses for

their recreation needs, even if they do not intend to recreate in the project area.

Removal of Marmot Dam

The removal of Marmot dam would have essentially the same impact on socioeconomic resources, regardless of the removal methodology chosen. To the extent that more construction was involved, the impact would be slightly greater.

Removal of sediments from behind Marmot dam would generate the most construction activity and therefore the greatest potential short-term impact on socioeconomic resources. Thus, Alternatives 2 and 3 would have greater impacts associated with this component of the removal process. If sediments are disposed of off-site, this would result in additional beneficial impacts associated with an increased need for labor and resources, particularly gasoline, to haul the material off-site. However, this option would also result in potential adverse impacts to existing roads and traffic, as well as air quality that would be considerably less with on-site disposal options. Other removal options involving lesser amounts of dredging would have less of an effect on socioeconomic resources.

Improved opportunities for whitewater boating associated with the removal of Marmot dam would likely result in an increase in the number and frequency of whitewater boating users traveling into the area, which may result in beneficial impacts to local service businesses. Again, the anticipated level of use would not likely be significant relative to the total service business industry in the area.

Removal of Little Sandy Diversion Dam

Removal of Little Sandy diversion dam would not require extensive construction activity and would not be expected to affect socioeconomic resources.

Removal of Canals, Tunnels, Flumes, and Ancillary Structures

Removal of canals, tunnels, flumes, and ancillary structures would involve additional construction activity, which could result in short-term beneficial impacts to socioeconomic resources, particularly employment and business income. Overall, this impact would be expected to be small relative to the total employment and business income activity in the county, and would occur over a short period of time (1 or 2 years).

Project Powerhouse

Removal of the project powerhouse would involve additional construction activity, which could result in short-term beneficial impacts to socioeconomic resources, particularly employment and business income. Overall, this impact would be expected to be small relative to the total employment and business income activity in the county, and would occur over a short period of time (1 or 2 years).

Removal of Roslyn Lake

Removal of Roslyn Lake would require additional construction activity, which as with the removal of other project features, could result in short-term beneficial impacts to socioeconomic resources, particularly employment and business income. However, as stated above, this impact would be expected to be small relative to the total employment and business income activity in the County. As described in Section 5.3.5 (Recreational Resources), removal of Roslyn Lake would also result in the loss of some recreation opportunities at the site and the displacement of some visitors to other recreation areas. The overall reduction in visitation to the project area could have some small, localized socioeconomic impacts, including potential reductions in business at local bait and tackle shops. However, the total number of users directly affected by the action would be relatively small (see Section 5.3.5), particularly when compared to the total customer base of the recreation service provider industry. In addition, many of the potentially affected anglers may continue to patronize local bait shops regardless of where they fish.

The Bull Run Community Association commented that draining Roslyn Lake could affect the local fire departments ability to respond to fires. According to the Sandy Fire District,²¹ Roslyn Lake serves as the Fire District's primary water source for the northern 15 to 20 square miles of the district. The Fire District believes that loss of the lake would add at least 20 to 30 minutes per trip to refill equipment and could increase insurance costs.

The association, citing the fire chief, states that any effects can be mitigated by the installation of a hydrant tying into the City of Portland Water Bureau's water mainline where it passes the Roslyn Lake fire station. The mainline is the only available comparable alternative water source that are as centrally located, reliable, and voluminous.

²¹ Scoping comments from Ron Smith, Fire Chief, Sandy Fire District No. 72, late 1999.

As noted above, the Fire District benefits from the water source provided by Roslyn Lake and the removal of the lake would have an adverse effect on the Fire District's capability to respond to fire emergencies in a portion of its northern district. In turn, the loss of this water source would have an indirect adverse affect on residents and businesses in the area who rely on the Fire District in such emergencies.

It appears that the installation of a hydrant connected to the City of Portland Water Bureau's water mainline is a possible alternative water source. Although we don't believe PGE has any responsibility to compensate for loss of a body of water it created for another purpose and from which the Sandy Fire District got a collateral benefit (see Section 5.3.2.2), given the importance of Roslyn Lake to the Fire District and in consideration of public safety, we recommend that PGE initiate discussions with the Fire District and others to resolve this issue. PGE should investigate possible measures that could be implemented to mitigate for the loss of Roslyn Lake as a water source for fire emergencies. This investigation should be conducted in consultation with the Fire District, the City of Sandy, Clackamas County, and the City of Portland's Water Bureau. The investigation should consider the feasibility of various alternative water source measures, including installation and operation costs, implementation method, and implementation schedule. Upon completion of this investigation, PGE should file with the Commission, a report summarizing the results of the investigation, including identification of the preferred mitigation measure and any plans by PGE and/or others to implement such a measure. The filing should also include documentation of PGE's consultation with the above entities.

5.3.8.3 Staff Modifications of PGE's Proposal

As discussed in Section 5.3.8.2, we recommend that PGE initiate discussions with the Sandy Fire District and others to investigate possible measures that could be implemented to mitigate for the loss of Roslyn Lake as a water source for fire emergencies.

5.3.8.4 Unavoidable Adverse Impacts

Removal of Roslyn Lake would have adversely affect fire-fighting capability in the local area.

5.4 NO-ACTION ALTERNATIVE

5.4.1 Geology

The no-action alternative would maintain geological resources in their existing condition. Although the effects of Marmot and Little Sandy diversions on geomorphic processes have not been well documented, it is likely that these dams have altered natural patterns of sediment and large woody debris transport, and such impacts would continue to occur if the dams remain in place. The impoundments formed by Marmot and Little Sandy diversions are currently filled with sediment, and transport of coarse and fine sediment currently occurs over these dams. It is possible that partial trapping of coarse sediment occurs upstream of these dams as a result of the grade control created by these dams, although most coarse and fine sediment from upstream reaches is likely transported over these dams during high-flow events. Marmot and Little Sandy diversions also may interrupt natural recruitment of large woody debris to downstream reaches. PGE maintenance crews currently remove LWD trapped at Little Sandy diversion from the Little Sandy River.

Operation of the Little Sandy diversion dam also likely affects downstream channel morphology and aquatic habitats by reducing the magnitude, frequency, and duration of high-flow events and winter baseflows. Field surveys indicate that these changes in flows may have contributed to encroachment of riparian vegetation into the stream channel downstream of Little Sandy diversion, particularly in the first 0.3 mile below the dam. This appears to have reduced the width of the active channel and stabilized substrates in areas where willows and alders have established. These impacts to channel morphology would continue if Little Sandy diversion remained in place and flow diversions continued. Flow reductions may also reduce the transport of sediment over Little Sandy diversion, although sediment transport does likely occur during large events that result in substantial spillage over the dam.

The project flume has had a history of failures associated with landslides, which have contributed fine sediment to adjacent stream channels. The influx of fine sediment from landslides can affect aquatic habitat by covering spawning gravels; thus resulting in salmonid egg suffocation. To date, four areas of significant geologic hazards associated with the flume have been inventoried.

5.4.2 Water Quality and Quantity

The no-action alternative would maintain water quantity and quality resources in their existing condition. Potential issues and data needs related to water quantity and

quality could include the following.

The Sandy River is relatively high in suspended sediment, especially during the summer, because of the high proportion of glacial melt water. Transfer of turbid water from the Sandy River to the less turbid Little Sandy and Bull Run Rivers may be an issue. The Sandy River below Marmot dam and the Bull Run River below the City of Portland's reservoir 2 are included on the ODEQ 303(d) list of water quality limited streams for temperature.

Current data reveals that dissolved oxygen levels consistently surpassed the ODEQ dissolved oxygen standard for salmonid rearing of 8 mg/l, but at select sites and times, did not meet the 11 mg/l standard for salmonid spawning. Levels of dissolved oxygen at site SR01 appeared depressed relative to downstream reaches.

5.4.3 Fishery Resources

The no-action alternative would continue the operation of the current project. The effects of the existence of the project, and the effects of current project operations are discussed below.

ODFW (1997a) has identified upstream and downstream passage of anadromous salmonids at Marmot dam as an important management concern. Marmot dam has been equipped with a fish ladder since its construction in the early 1900s, although in the early part of the century the ladder was used for trapping adult salmon and steelhead for hatchery production rather than for facilitating upstream migration (Taylor 1998). Since 1913, the ladder has been modified and improved several times. While these changes improved fish passage at the dam, egg-taking operations (which continued until the early 1950s at or below the dam), fish ladder damage, and low flows hindered fish migration to the upper basin through the 1950s (Taylor 1998). In the 1970s, PGE installed an exit gate to the ladder and increased minimum flows downstream of the dam to improve adult fish passage and increase juvenile salmonid rearing habitat in the lower Sandy River (Taylor 1998). In 1983, the fish ladder was completely remodeled to further enhance fish passage effectiveness at the site. No evaluation of the performance of the fish ladder at Marmot dam has been conducted. A temporary trap was installed at the Marmot dam fish ladder and began operation on November 1, 1998 (D. Cramer pers. comm. 1999). This trap is used for sorting out hatchery fish and allowing only unmarked fish to pass upstream to the upper Sandy River watershed-thus facilitating protection of native fish runs and greater harvest of hatchery fish.

Attraction flows are deliberately released from this dam to facilitate use of the fish

ladder by adult fish. NMFS has expressed concern that flow over the dam may attract fish to the base of the dam rather than to the fish ladder. Since the attraction flow from the fish ladder remains fixed (in theory), the potential for upstream migrants to be distracted from the ladder entrance to the dam increases with increased spill over the dam. Fish attraction to flow spilled over Marmot dam and potential delays in upstream migration have not been evaluated.

Trap operations and shutdowns of the fish ladder during high flows may result in delays in upstream migration of salmonids. PGE currently checks and clears the trap at Marmot every day. The degree to which the fish ladder or trap operations at the Marmot dam causes migration delays, compared to unrestricted upstream passage, is not known.

Juvenile salmonids produced upstream of Marmot dam can migrate downstream by three methods: (1) passing over the dam via the spillway, (2) entering the Marmot dam canal and being redirected to the Sandy River via a juvenile bypass facility, or (3) being entrained into the Marmot dam canal and transported to the Little Sandy River or Roslyn Lake. From Roslyn Lake, fish can return to the river only via the Bull Run powerhouse turbines.

Until 1952, when PGE installed a downstream migrant screen system, the Marmot diversion dam included no juvenile screening or diversion facilities. Currently, downstream migrants that enter the canal are screened out and enter a bypass system that returns juveniles to the Sandy River downstream of Marmot dam. Since its initial installation, the Marmot dam juvenile bypass facility has been improved several times. However, the design of the fish screen and bypass system does not meet current ODFW criteria, and ODFW has identified the juvenile bypass facility as a potential concern (ODFW 1997a).

As required by their FERC license, PGE has evaluated the performance of the juvenile bypass facility (Cramer 1993, Ward and Friesen 1998). These studies identified few impacts to fish larger than 2 inches fork length. For these larger fish, trap efficiency was high. Estimated survival for fish entering the canal was 95 percent for hatchery spring chinook and 97.3 percent for hatchery steelhead. Mean passage time for test groups released into the canal was 2–5 days. Fry, however, experienced low bypass efficiencies and high mortality rates. Efficiency was related to the elevation of the water surface in the canal, with the percentage of fry using the bypass decreasing as water surface elevation (and depth to the bypass ports) increased. The percentage of fry using the bypass exceeded 94.6 percent for water surface elevations ranging from 2.75 to 3.81 feet but was much lower (averaging 49.4 percent) for water surface elevations exceeding 5 feet. In 1998, PGE evaluated the effectiveness of the surface collector ports added to

the juvenile bypass system that year to improve passage of fry (Ward and Friesen 1998). The total mortality rate (not corrected for handling mortality) for wild salmonid fry averaged 27.5 percent (range 10.9–46.7 percent). The total mortality rate (corrected for handling mortality) for marked hatchery chinook salmon fry averaged 35.2 percent (range 14.4–52.9 percent). Overall, the Ward and Friesen (1998) study observed higher mortality among salmon fry diverted at Marmot dam than did Cramer's (1993) study. Mortality of wild fry (27.5 percent) was lower than that for hatchery fry (35.2 percent). No relationship was found between canal elevation and impingement rate of fry.

Little Sandy diversion dam has no facilities for upstream fish passage and blocks anadromous fish access to approximately 6.5 miles of upstream habitat (USFS 1996). ODFW (1997b) has identified loss of access to spawning and rearing habitat in the Bull Run River watershed (which includes the Little Sandy River watershed) as a principle management concern. The production potential for anadromous salmonids upstream of the Little Sandy diversion dam has not been specifically estimated; it is therefore difficult to evaluate the impacts of loss of access to this area on anadromous salmonid populations.

Upstream migration of fish in the Little Sandy River has been blocked by the Little Sandy diversion dam since 1911. Spill over the dam during high water events, however, may attract anadromous fish into the Little Sandy River. When flows subsequently decrease, fish attracted to the flows may become stranded (ODFW 1997a). PGE avoids spilling water over the Little Sandy diversion dam in order to prevent attracting anadromous fish into the Little Sandy River. Operation of Little Sandy diversion dam affects downstream physical habitat by nearly eliminating flows, resulting in reductions in wetted channel and water depth.

The Little Sandy diversion dam is not equipped with juvenile downstream passage facilities nor screens. Because the dam is a barrier to upstream anadromous fish passage, no anadromous fish are produced upstream of the dam. Resident coastal cutthroat and rainbow trout populations, however, occur upstream of the dam. The Little Sandy diversion dam prevents juveniles from these populations from dispersing to the Little Sandy and Bull Run Rivers downstream of the Little Sandy diversion dam, except via entrainment to Roslyn Lake (as discussed below) or during spill events over the dam.

Discharge from Bull Run powerhouse into the Bull Run River may attract upstream migrating adult salmonids, including summer steelhead and spring chinook salmon (ODFW 1997a), due to: (1) the magnitude of this flow and (2) the source of this water. Because a portion of the Bull Run powerhouse outflow originates from the Sandy River, anadromous salmonids homing to the Sandy River may be falsely attracted into the Bull Run River. Attraction of adult fish to the Bull Run powerhouse may reduce

spawning success because: (1) fish that migrate upstream past the Bull Run powerhouse in spring or early summer are exposed to poor habitat conditions, including reduced flows, high water temperature, and limited gravel availability, and (2) fish that move downstream back into the Sandy River experience migration delays.

Juvenile anadromous salmonids produced upstream of Marmot dam can be transported to Roslyn Lake during malfunctions of the Marmot dam juvenile bypass system screens. In addition, adult and juvenile coastal cutthroat and rainbow trout can be entrained in the Little Sandy diversion and conveyed to Roslyn Lake. Some juveniles rear in Roslyn Lake, but once they have entered Roslyn Lake, fish cannot return to the Little Sandy River and the only path of return to the Bull Run River is via the Bull Run powerhouse penstocks and turbines. The numbers of native resident trout entrained in this diversion is not known, but the diversion of native resident fish to Roslyn Lake is a principle management concern identified by ODFW (1997b) for the Sandy River Basin. PGE conducts sampling in Roslyn Lake to assess the number of juvenile salmonids entering the lake, but the mortality rate of fish passing through the turbines is not known.

5.4.4 Terrestrial Resources

The no-action alternative would maintain terrestrial resources in their existing condition. Continuing impacts include the following three general categories of effects: (1) the effects of reduced flows on riparian vegetation; (2) the effects of project facilities on wildlife movement and mortality and habitat quality; and (3) the effects of project-related maintenance activities and recreation on wildlife and habitat. Each of these is discussed below.

Reduced flows: Continued operation of the Bull Run Hydroelectric Project would result in continued reduced flows in the Sandy River below Marmot dam; the Little Sandy River below the diversion; and the Bull Run River between the confluence of the Little Sandy River and the Bull Run powerhouse. The timing and magnitude of flows influence the composition, structure, and distribution of riparian vegetation, although other factors, such as channel configuration and substrate, play significant roles as well. Differences in riparian vegetation possibly related to reduced flows are most apparent for the Little Sandy River. Flows in the river downstream of the diversion are provided primarily by tributaries and seeps and riparian vegetation has encroached into the channel. Trees in the riparian zone downstream of the diversion provide more canopy cover, and are significantly larger in diameter and taller than those upstream of the diversion. Downstream sites also have substantially more down wood.

The effects of reduced flows on riparian vegetation are less apparent for the Sandy

and Bull Run Rivers. The structure and composition of riparian vegetation at sites up- and downstream of Marmot dam were similar. Riparian vegetation downstream of the Bull Run powerhouse has significantly greater tree canopy cover and substantially less shrub cover than upstream sites. The river upstream of the powerhouse, however, is in a very confined bedrock channel, with little habitat suitable for trees. Consequently the differences in the structure of riparian vegetation, above and below the powerhouse may at least be partially related to variations in channel configuration and substrate.

Project facilities: Under the no-action alternative, several project facilities, including Marmot dam, the box flume, and sections of canal, would continue to affect wildlife movement across the landscape. Marmot dam represents an impediment to wildlife moving along the Sandy River corridor. This structure probably has relatively little effect on the movement of larger mammals and reptiles but is a greater obstacle to small mammals and amphibians. Although the 1.8-mile-long box flume is elevated along much of its length, it may impede the movement of some wildlife species in a few locations. Since the flume is on footings, most small mammals, amphibians, and reptiles are able to move underneath. Larger mammals, however, are not able to move underneath in all locations; many of these areas, however, are on very steep slopes that would not be expected to be major wildlife use corridors. The three sections of canal that carry water from the Sandy River to the Little Sandy River, are 1,520, 1,562, and 4,220 feet long, respectively. These canals are fenced and do not represent a source of entrapment for larger mammalian species. Small mammals, reptiles, and amphibians, however, can move under the fence, enter the canal, and probably drown. The canals also represent a barrier to wildlife movement, although some portions of the 4,220-foot-long section are bordered by very steep slopes and would not be expected to be travel corridors for most species.

Concerns related to power lines and wildlife under the no-action alternative include avian electrocution and collision. Birds are electrocuted when they contact two energized conductors or an energized conductor and grounded hardware (APLIC 1996). Raptors are at greatest risk of electrocution because of their large wingspans and tendency to perch on power poles. Any bird can collide with a power line, but the risk is greatest for large, heavy-bodied birds (e.g. herons). Collision risk is also influenced by a number of other factors, including behavioral characteristics; environmental conditions (e.g. weather, lighting); and line location, configuration, and orientation (APLIC 1994). The project's transmission and distribution lines potentially represent an on going impact in terms of avian electrocution and collision but there are measures that can be implemented to greatly reduce the risk.

The no-action alternative would involve continued use and maintenance of project

roads. The primary roads associated with the Bull Run Hydroelectric Project are service roads to Marmot dam (3 miles) and the Little Sandy diversion (1.5 miles), and Phelps Road (1.6 miles), which provides access to the speeder train along the flume and a maintenance area. There is also approximately a mile of road that runs along the 4,220-foot section of canal between tunnels. The entire Little Sandy diversion dam service road, the road along the canal, and about 1 mile of the Marmot dam service road are closed to the public. Roads are known to decrease big game use of adjacent habitats even with relatively low use (Thomas et al 1979); are a source of wildlife mortality; and represent corridors for the dispersal of noxious weeds. However, since none of the project roads are in areas heavily used by big game, their continued impacts on habitat effectiveness are estimated to be minor. Similarly, because use of project roads is low and primarily limited to PGE staff, potential for wildlife mortality is less than that of other roads in the area. Project roads would, however, continue to serve as corridors for the dispersal of noxious weeds and reduce habitat value for some wildlife species.

Project maintenance activities and recreation: Under the no-action alternative, project maintenance activities would continue to result in some disturbance to local wildlife. Most maintenance activities along the project power lines (e.g. tree removal) occur later in the summer after the breeding season for most wildlife. Consequently, maintenance-related disturbance is unlikely to result in nest abandonment, but some wildlife may temporarily leave the area. Maintenance of the power line ROWs would continue to preclude the development of mature forest and habitat for species associated with later successional stages. In addition, the disturbed nature of the ROW in some areas would continue to provide conditions suitable for the establishment of noxious weeds and other exotic/invasive plant species. Disturbed areas near buildings would also continue to provide potential locations for the establishment of noxious weeds.

Under the no-action alternative recreation activities at Roslyn Lake would continue. Some recreation activities have the potential to disturb wildlife that use the lake and adjacent habitats. The only TES species known to use habitats near Roslyn Lake are the bald eagle and western gray squirrel. Bald eagles mainly use the lake for foraging during the winter, a time when recreational use is low.

5.4.5 Recreation

Recreation resources under the no-action alternative would remain similar to those that currently exist in the project boundary (as described in Section 5.3.5.1 above). The project would continue to accommodate approximately 46,000 recreation visits during the summer recreation season (Memorial Day to Labor Day), providing opportunities for picnicking, flat-water and river angling, flat-water and whitewater boating, swimming,

sightseeing, and wildlife viewing. This would include use at Roslyn Lake Park (the only developed recreation facility associated with the project), as well as dispersed use occurring in the project area.

Visitation data for Roslyn Lake Park collected over the past 13 years indicates that there has been a slightly declining trend in use levels and that demand for, and use of, the facility would not likely increase under the no-action alternative. Use of other areas of the project, such as the Sandy River below Marmot dam and the Bull Run River at the Bull Run powerhouse, may experience some increased use as a result of increasing population levels in the regional area over the next 30 years. However, because current use levels in these areas are low, increased use would not be expected to exceed the existing capacity of these areas, and additional facilities, or opportunities, are not anticipated.

5.4.6 Land Use and Aesthetic Resources

Land Use

The no-action alternative would retain land use designations as they currently exist. Under the no-action alternative property management and ownership would continue to be PGE's responsibility. Daily project operations have no effect on current land management responsibilities or land use designations. PGE's general management of project lands is compatible with existing land management plan requirements as the majority of the land is forested and undeveloped. The only "development" occurs at the project facilities, and in those areas the land is well maintained and landscaped as appropriate to blend with the existing environment.

On federally designated lands, PGE's current land management policies are compatible with the managing agencies plan requirements. For example, the portion of forested land within the project boundary that is managed by the USFS, is also the location for a segment of the wooden flume. Under the forest management plan this land and adjacent lands are part of the "C1 Management Area" which is managed for timber harvest, wildlife, and recreation (USFS 1990). PGE's management of the same land emphasizes facility maintenance, and timber and wildlife management. The steep slope at this location discourages use of this land as a recreation area. Under the no-action alternative if future land management responsibilities change, PGE would consult with the appropriate land managing agency to ensure that the proposed changes would be compatible with current land management plans.

Aesthetic Resources

The no-action alternative would maintain the physical features of the project on the landscape in their current condition. Daily project operations have no effect on the aesthetic resources located within the Bull Run FERC project boundary. The project facilities were constructed from 1908 to 1912 and the effects of that activity have long since disappeared. The existing landscape is now described as mature. The steeply sloping woodlands, forested canyons, and talus slopes found in the project area are representative of the Sandy and Little Sandy Rivers watersheds historic landscape.

Scattered cleared areas are found adjacent to project structures, and roads and development within the project boundary are confined to project facilities. General visibility of the structures is limited to public roadways and recreation areas.

The industrial nature of the Bull Run Hydroelectric Project is complementary with the existing land use (e.g., rural, agricultural, and forest related). As part of the operations and maintenance program, PGE implements regular maintenance activities for all structures and landscape.

5.4.7 Cultural Resources

Archeological Resources

The no-action alternative would maintain archeological resources in their current condition (Oetting 1999). Many issues concerning archeological effects under the proposed action would not be addressed under this option. The three known archeological sites would remain in their existing condition and would not require further investigation for removal and disposal of project facilities and sediment. No new information would be submitted to the State Historic Preservation Office regarding the archeological resources since no further evaluation would be necessary at this time. No new archeological sites could potentially be discovered since non-removal of the dams would not affect flow levels of the river. New terraces or alluvial sediment deposits would not be exposed, thus reducing the potential for site discovery. No new archeological sites could potentially be discovered since no additional land outside the APE would be needed for materials or sediment disposal.

The following discussion provides an overview of impacts, on archeological resources, associated with existing operations of the project.

Daily project operations have no effect on the archeological resources located

within the APE of the Bull Run Project. Two sites, 35CL264 and 35CL266 are located in extremely low-traffic areas. 35CL264 is a buried site that is currently protected from maintenance traffic and activities by 120 cm of sediment. 35CL266 is a shallower site than 35CL264; however, a grass lawn and a scatter of trees stabilize the soil. Given the current license requirements, PGE proposes no new enhancements that would impact these resources.

Daily project operations have no effect on archeological site 35CL265. This site is located in and adjacent to a transmission line ROW. Natural vegetation was removed when the line was constructed, and now the ROW contains a mix of conifer trees, blackberry brambles, and grass. Under PGE's easement rights, general vegetation management that is associated with the transmission line is conducted every 3 years. The company hand-cuts the ROW to keep vegetation low and away from the lines, to ensure uninterrupted service and meet safety and fire requirements. The current landowner owns and operates a tree farm on this property. At that time, the owners replant, and the cycle starts again. The growth cycle of the trees does not interfere with the operation and maintenance of the transmission line. However, it is suggested that cultivation activities associated with the tree farm have and would continue to disturb this site.

Historic Structures

The no-action alternative would maintain historic structures in their current condition (PGE 1998b, 1998c, 1999). All structures would remain in their existing condition and would not require documentation for removal of project facilities. Suggested documentation could include creating a HABS/HAER photographic record of project facilities under the proposed action.

The following discussion provides an overview of impacts on historic structures associated with existing operations of the project.

Daily project operations have no effect on the historic resources located within the APE of the Bull Run Project. In an effort to ensure that all project related activities take into account the significance of the historic structures within the Bull Run Project, PGE prepared a Cultural Resources Management Guide in 1998. The purpose of this guide is twofold. First, minimize the potential for effects on cultural resources from operation and maintenance of the existing project. Second, avoid or mitigate impacts on cultural resources from proposed modifications to the project, including construction staging areas and construction activities.

All structures were evaluated for their National Register of Historic Place's

eligibility. Once the evaluation was complete, PGE classified each of the structures into one of three tiers or categories – primary historic (red), secondary historic/compatible (yellow), and non-historic (green). For management purposes, a color was assigned to each of the categories. Red denotes the most stringent level of protection, yellow has more flexibility in management options, and green denotes no constraints on management responsibilities. This information is in table format for easy use by plant personnel.

Ongoing operations at the Bull Run Hydro Project entail numerous tasks and activities. If any activity cannot be conducted in accordance with the procedures defined in the Management Guide, then it becomes necessary for PGE's Historic Preservation Coordinator to consult with the Oregon State Historic Preservation Office (SHPO) on how to proceed.

Ethnographic Resources

The no-action alternative would not affect ethnographic resources. Current studies have determined that there are no traditional use properties located within the Bull Run Project boundary.

5.4.8 Socioeconomics

The Bull Run Hydroelectric Project, as currently operated, has little to no effect on the overall socioeconomic conditions of the surrounding area. The project employs very few individuals and does not generate any direct revenues for the local community. Under no-action alternative, continued operation of the project would therefore not be expected to have any effect, positive or negative, on socioeconomic resources.

5.5 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

5.5.1 PGE's Proposal

Removing Marmot dam and Little Sandy diversion would irreversibly and irretrievably commit PGE's financial resources. Electric generation at the project would cease, and dam removal would permanently remove structures eligible for National Register listing.

5.5.2 Staff's Modification of PGE's Proposal

Same as PGE's proposal.

5.6 RELATIONSHIP BETWEEN SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

5.6.1 PGE's Proposal

The project as proposed by PGE would adversely affect water quality, aquatic resources, terrestrial resources, recreation, and socioeconomic resources in the short-term. Over the long-term, removal of the dams would restore riverine habitat for use by non-anadromous fish and anadromous fish, including federally listed endangered threatened and endangered species, restore free-flowing sections of river for unimpeded whitewater recreation, and restore overall ecological productivity.

5.6.2 Staff's Modification of PGE's Proposal

Same as PGE's proposal.

6.0 DEVELOPMENTAL RESOURCES

This section presents the costs of project removal in accordance with the proposed Decommissioning Plan and with additional measures recommended by staff.

6.1 COSTS OF PROJECT DECOMMISSIONING AND REMOVAL

Table 33 presents the estimated costs associated with project decommissioning and removal for each alternative analyzed in this document.

6.2 COSTS OF ADDITIONAL MEASURES RECOMMENDED BY STAFF

Additional measure recommended by staff include:

- development of an erosion and sedimentation control plan
- development of a fish facility design and operation plan
- development of a final revegetation, noxious weed control, and site restoration plan
- development of a plan to implement the terms and conditions outlined in the BOs issued by the USFWS and NOAA Fisheries

Table 33. Estimated Costs Associated with Project Decommissioning and Removal (PGE 2003b).

	Alternative 1	Alternative 2	Alternative 3
Cost Estimate / Component	Single season dam removal with minimal sediment removal (PGE's proposal)	Removal of top of dam in year 1; complete dam removal in year 2 with sand layer excavation	Remove the dam and the maximum amount of sediment possible during 1 in-water work period
Marmot Dam Removal	\$3,344,000	\$12,418,000	\$10,054,000
Project Removal	\$9,500,000	\$18,574,000	\$16,210,000
Total Project Decommissioning	\$17,060,000	\$26,134,000	\$23,770,000

- development of a spotted owl protection plan
- requiring PGE give homeowners sufficient advance notice of its specific plans and schedule to drain Roslyn Lake
- requiring PGE to work with local agencies to investigate alternative sources of water for fire-fighting purposes
- implementation of the final historic properties management plan

These measures would add about \$20,000 to the cost of decommissioning the project.

7.0 COMPREHENSIVE DEVELOPMENT AND RECOMMENDED ALTERNATIVE

In determining whether, and under what conditions, to surrender a project, the Commission must weigh the various economic and environmental tradeoffs involved in the decision. Accordingly, any surrender order issued must be in the public interest.

This section of the environmental impact statement compares the alternatives considered as presented below:

No-action Alternative—represents the environmental status quo, in this case the continued operation of the project under its existing license granted by FERC. Potential issues warranting enhancement and protection measures are discussed in Section 5.4.

PGE's Proposal—includes the surrender of the Bull Run Hydroelectric Project operating license and the subsequent removal of project facilities. Marmot dam would be removed in one season and with minimal sediment removal. Specific measures related to this alternative are discussed in Section 3.

Marmot Dam Removal Alternatives—includes three alternatives for removing the dam, including PGE's proposal.

PGE's Proposal as Modified by Staff—includes additional measures recommended by FERC staff.

7.1 COMPARISON OF ALTERNATIVES

Table 34 summarizes a comparison of the environmental effects of the PGE's proposal and the no-action alternative.

The project with additional measures recommended by staff is almost identical to the proposed action. Additional measures primarily include the development of final plans to implement the proposed mitigative and enhancement measures.

The differences in the environmental effects of the alternatives to remove Marmot dam are summarized in table 35. The differences in impacts are based largely on the amount of sediment released downstream versus dredged and disposed of on land and the number of seasons that dam removal would take.

7.2 STAFF CONCLUSIONS

Based on our independent review of agency and public comments filed and our review of the environmental and economic effects of the proposed action and alternatives, we reach the following conclusions.

- (1) Decommissioning the project would result in the cessation of generation at the a 22-MW project, which represents about 1 percent of the capacity owned by PGE, and loss of about 111,000 MWh per year (1995-1999 average). The loss of generation would have a negligible effect on the region. Replacing the power

Table 34. Comparison of Alternatives for the Bull Run Hydroelectric Project.

Resource Area	No-action Alternative	Proposed Action Alternative
Geological	Maintain geological resources in their current condition, meaning the operation of both Marmot and Little Sandy diversion dams would continue to impact geomorphic processes by reducing the frequency of high-flow events (particularly in the Little Sandy River), and possibly by reducing recruitment of gravel and large woody debris into the stream reaches located below these dams. This situation would result in continued impairment of channel morphology conditions in the affected streams reaches, which in turn would affect the maintenance and quality of aquatic and riparian habitats. Structural modifications would be required to make the powerhouse safe under seismic loading conditions. In addition, ongoing monitoring and maintenance would be required for dam safety issues because of the active slide area affecting the two project penstocks.	Decommissioning of the Project would help restore natural geomorphologic processes to the Sandy and Little Sandy Rivers. This would result in the improved maintenance of aquatic and riparian habitats in previously affected stream reaches by reestablishing natural hydrology, sediment, and large woody debris regimes. Temporary increases in turbidity would occur downstream of Marmot and Little Sandy diversion dams during construction activities. Downstream of Marmot dam, turbidity increases would also occur following dam removal as fine sediment stored behind the reservoir are transported downstream, with the magnitude of this effect depending on the removal method selected and the flows following dam removal. Deposition of sediments released from the Marmot dam impoundment have the potential to impact aquatic habitat in select reaches of the Sandy River below Marmot dam. Potential impacts include infiltration of fine sediment into spawning gravels, degradation of side-channel rearing areas, and filling of pools with fine sediment. To mitigate for this potential adverse impact, several contingency measures have been developed for reaches of the Sandy River that are expected to experience significant erosive or depositional events. Deposition of sediments released from the Little Sandy diversion dam impoundment are not expected to adversely affect aquatic habitat in the Little Sandy River. Minor impacts to slope stability in the area of the flume due to deconstruction work. Removal of Roslyn Lake would result in some minor disturbance of soils and surficial deposits. During the removal period, drawdown of the lake would result in short-term impacts to turbidity levels in the Bull Run River.

Resource Area	No-action Alternative	Proposed Action Alternative
Water	Maintain water resources in their current condition, which includes continuation of the current flow regime. Sandy River below Marmot dam and the Bull Run River below the City of Portland's reservoir 2 remain on the ODEQ 303(d) list of water quality limited streams for temperature. Continuation of flow fluctuations in the lower Bull Run and Sandy Rivers as a result powerhouse operations.	Restoration of natural streamflow to the Sandy River below Marmot dam and the Little Sandy River below the Little Sandy diversion dam. Elimination of flow fluctuations in the lower Bull Run and Sandy River as a result of powerhouse operations. Water yields from as many as 58 wells located adjacent to Roslyn Lake could potentially be affected, to some degree. Elimination of leakage would cause a small creek and several ponds located to the north of Roslyn Lake to dewater immediately. Springs and seeps located on the west and south of the lake would probably cease to exist. During the removal period, deconstruction activities would result in short-term impacts to turbidity levels in affected stream reaches. Increased dissolved oxygen levels and decreased stream temperatures in the Sandy River below Marmot dam, in the Little Sandy below Little Sandy diversion dam. Removal of Roslyn Lake, and a return of natural flows to the Little Sandy, should generally improve water quality conditions of the lower Bull Run River. Water temperatures can be expected to be lower, oxygen levels raised and turbidity lowered.
Fisheries	Maintain fisheries resources in their existing condition. Management concerns (i.e., false attraction flows, migration delays, and entrainment/mortality) related to upstream and downstream passage of anadromous salmonids at Marmot diversion dam. Impacts to downstream physical habitat from reduced flows in reaches of the Sandy River downstream of Marmot dam.	Restoration of natural streamflows and geomorphic processes in the Sandy and Little Sandy Rivers. Decrease in water temperatures downstream of Marmot dam since increased flows would move water through this reach more quickly with less time for exposure to solar radiation and consequent heating. Upstream and downstream fishways would no longer be present in the Sandy River Basin, allowing for unrestricted fish passage but eliminating capacity to count and sort fish at Marmot dam.

Resource Area	No-action Alternative	Proposed Action Alternative
	Blockage by Little Sandy diversion dam of anadromous fish access to approximately 6.5 miles of upstream habitat Impacts to downstream physical habitat from reduced flows in reaches of the Little Sandy River downstream of the Little Sandy diversion dam. Discharge from Bull Run Powerhouse into the Bull Run River may attract upstream migrating adult salmonids.	Sediment release from Marmot dam could adversely affect downstream salmonid habitats, including infiltration of fine sediment into spawning gravels, reduction in pool depths, and reduction in the suitability of side-channel areas for rearing. The duration and magnitude of these impacts are uncertain and would vary with the removal method selected. Removal of Marmot dam would result in loss of low-gradient spawning areas immediately upstream of the dam due to excavation and/or downstream transport of this sediment. Upstream movement of Sandy River fish would no longer be affected by the attraction of fish into the Bull Run River during generation periods. Removal of the Little Sandy diversion dam would return flow to the lower 1.7 miles of the stream and reconnect the riverine habitats upstream of the dam to the rest of the watershed. Approximately 6.5 miles of stream would be open to anadromous fish. Removal of Roslyn Lake would eliminate the associated lentic habitat and warmwater fishery.
Terrestrial	Maintain terrestrial resources in their existing condition. Current flow regime would continue to influence the composition, structure, and distribution of riparian vegetation. Marmot dam and the Little Sandy diversion, as well as the flume and canals would continue to represent impediments to wildlife movement. The project's transmission and distribution lines could potentially be an ongoing impact in terms of avian	Removal of Marmot dam would result in short term effects on terrestrial resources due to disturbance to wildlife from construction, traffic, and removal activities; and short term loss or degradation of vegetation and habitat. Long-term effects of Marmot dam removal include the potential loss of existing habitat for amphibians above and below the dam; potential changes to riparian habitat in the currently impounded area upstream of the dam; and potential changes to downstream riparian habitats from restored natural flows. Removal activities associated with Little Sandy diversion dam would

Resource Area	No-action Alternative	Proposed Action Alternative
	electrocution and collision. Project roads would continue to serve as corridors for the dispersal of noxious weeds and reduce habitat value for some wildlife species. Recreation and project maintenance activities would continue to result in some disturbance to local wildlife.	result in some short term disturbance of wildlife in the vicinity but no loss of habitat is expected. Long-term effects of removing the Little Sandy diversion include the potential loss of existing amphibian habitat below the dam and potential changes to downstream riparian habitats from restoration of natural flows. Construction activities associated with removing the canals and flume and sealing the tunnels and penstocks would result in some short-term disturbance to local wildlife. However, land supporting the canals and box flume would be revegetated and eventually support forest plant and wildlife communities similar to existing adjacent habitats. Tunnels would be sealed in a way to provide habitat for bats that roost in caves. Removal of the canal and flume would eliminate an impediment to wildlife movement between the Sandy and Little Sandy Rivers and upslope areas. Removal of the canals would also reconnect several small streams to the Sandy River that are currently diverted, benefiting amphibians and small mammals that use riparian corridors. Removal of the canals would eliminate entrapment and associated mortality. Powerhouse disposition would result in some short-term disturbance to local wildlife. Removal of Roslyn Lake would result in the loss of 160 acres of open water habitat as well as about 2 acres of palustrine scrub-shrub wetland and 20 acres of riparian vegetation. A nearby 4-acre forested wetland is hydrologically connected to the lake and would be affected by removal. A population of lesser baldderwort would also be lost. Loss of the open water habitat provided by Roslyn Lake would effect

Resource Area	No-action Alternative	Proposed Action Alternative
		waterfowl and a number of waterbird (e.g., great blue herons) and passerine bird species (e.g., swallows). The loss of shallow water and wetlands is also likely to be detrimental to a number of amphibians species Removal of Roslyn Lake would likely reduce foraging habitat for bald eagles in the short-term. In the long-term, bald eagles would likely benefit from increased health of aquatic communities in the Sandy, Little Sandy, and Bull Run Rivers. Removal of the project would result in several long-term benefits to both spotted owls and bald eagles, including reduced risk of electrocution from power lines, reduced human presence, and reduced habitat fragmentation.
Recreation	Maintain existing recreation facilities and use.	Potential for short-term adverse effects to public access and recreation due to deconstruction activities, including temporary access restrictions for public safety and effects related to construction noise, dust, and traffic. Removal of Marmot and Little Sandy diversion dams would have a direct beneficial effect on whitewater boating opportunities on the Sandy and Little Sandy Rivers. Removal of the Marmot dam may also result in indirect adverse effects to sportfishing downstream of the dam if hatchery management programs operated by ODFW are modified as a result of the action. Removal of Roslyn Lake would result in a loss of all existing water-dependent recreation opportunities associated with the lake, including shoreline fishing, swimming, and flat-water boating.
Land Use & Aesthetics	Retain land use designations as they currently exist. Property management and ownership would continue to be PGE's responsibility.	Removal of Marmot and Little Sandy diversion dams, the water conveyance canal, associated fish passage structures, and sediments from the back of the dam would have a beneficial effect on the land use and aesthetic resources of the Little and Sandy Rivers, as the area would cease to be industrial in nature, and would eventually be

Resource Area	No-action Alternative	Proposed Action Alternative
	Maintain the physical features of the project on the landscape in their current condition.	reestablished as a naturally appearing landscape. Temporary adverse effect on the land use and visual aspects of the river and noise levels during deconstruction. Impact on land use and aesthetic resources from the loss of existing vegetation along the edge of the Roslyn Lake and the "lawn-like" grassy dikes.
Cultural	The three known archeological sites would remain in their existing condition. No new information would be submitted to the State Historic Preservation Office regarding the archeological resources since no further evaluation would be necessary at this time. No new archeological sites could potentially be discovered since non-removal of the dams would not affect flow levels of the river. Maintain historic structures and ethnographic resources in their current condition.	Preparation of a Historic Properties Management Plan and MOA to address unresolved issues relating to the significant cultural resources associated with the Bull Run Hydroelectric Project. Removal of Marmot dam, the water conveyance canal, associated fish passage structures, and sediments from the back of the dam, as well as the removal of Roslyn Lake have the potential to affect two separate archeological sites. However, one of these sites is not considered significant. Replacement of the existing transmission line has the potential to affect an archeological site, located within and adjacent the transmission line ROW. However, this site is not considered significant. Adverse affects associated with the removal of the historic structures at Marmot dam, Little Sandy diversion dam, the project powerhouse, intake structure, penstocks, and the water conveyance structures as they have been determined eligible for the National Register of Historic Places.
Socioeconomic	Little to no effect on the overall socioeconomic conditions of the surrounding area.	Removal of project features could require considerable construction activity in the short-term. This activity could result in a short-term impact on employment and income in the local area. Displacement of recreation visitors due to the removal of Roslyn Lake and potential changes to sportfishing opportunities below Marmot dam could have an indirect adverse impact on local service businesses that

Resource Area	No-action Alternative	Proposed Action Alternative
		support these users, including bait and tackle shops. However, the total number of users affected is relatively small compared to the total volume of service business activity in the area.

Table 35. Comparison of Marmot dam removal alternatives.

Resource	Alternative 1	Alternative 2	Alternative 3
	Single season dam removal with minimal sediment removal (PGE's proposal)	Removal of top of dam in year 1; complete dam removal in year 2 with sand layer excavation	Remove the dam and the maximum amount of sediment possible during 1 in-water work period
Sediment (Excavated)	20,000 to 30,000 cubic yards of sediment excavated from behind dam	340,000 cubic yards of primarily sand excavated	Removal of between 125,000 and 300,000 cubic yards of sediment
Sediment (Transported Downstream)	950,000 to 960,000 cubic yards of sediment transported downstream	640,000 cubic yards of sediment transported downstream over 2-year period	680,000 to 855,000 cubic yards of sediment transported downstream
Water Quantity	Restoration of natural flows to approximately 10 miles of the Sandy River between Marmot dam and the confluence of the Bull Run River	Same as alternative 1	Same as alternative 1
Water Quality—short-term	Short-term increases in suspended sediment loads as a result of dam removal activities and limited dredging	Greater short-term effects because of more dredging than under alternative 1	Greater short-term effects because of more dredging than under alternative 1
Water Quality—long-term	Reduction in water temperatures and increase in dissolved oxygen	Same as alternative 1	Same as alternative 1

Resource	Alternative 1	Alternative 2	Alternative 3
	Single season dam removal with minimal sediment removal (PGE's proposal)	Removal of top of dam in year 1; complete dam removal in year 2 with sand layer excavation	Remove the dam and the maximum amount of sediment possible during 1 in-water work period
Fisheries	Benefits include: restoration of natural flow regime in downstream reaches of the Sandy River; unrestricted upstream and downstream fish passage; elimination of existing operational effects (false attraction, entrainment/impingement mortality, etc.) Adverse effects include: use of a temporary fish barrier and trap during the construction season Increased suspended sediment levels downstream could affect adult and juvenile salmon Increased downstream sediment disposition effects on spawning habitat and passage	Similar to alternative 1 but magnitude and duration of sediment deposition and channel and bank instability in the reservoir reach would be less and alternative fish passage would be in place for two construction seasons	Similar to alternative 1 but greater downstream suspended solid concentrations due to greater excavation; less downstream deposition of sediment and less severe channel and bank instability in the reservoir reach due to greater sediment removal
Land Disposal Requirements	Minimal	100-acre disposal site	100-acre disposal site

Resource	Alternative 1	Alternative 2	Alternative 3
	Single season dam removal with minimal sediment removal (PGE's proposal)	Removal of top of dam in year 1; complete dam removal in year 2 with sand layer excavation.	Remove the dam and the maximum amount of sediment possible during 1 in-water work period
Terrestrial	Short-term effects from disturbance to wildlife from construction, traffic, and removal activities; short-term loss of vegetation and habitat; potential for establishment of exotic and invasive plants Long-term effect include potential loss of habitat for amphibians, aquatic mollusks, and benthic microinvertebrates above and below the dam; potential changes to riparian habitat in the currently impounded area; and potential changes to downstream riparian habitat from restored flows	Impacts would be greater than alternative 1 because of the longer construction period and greater sediment excavation and disposal Fewer impacts to riparian vegetation from channel instability and less sediment Reduced sedimentation may result in less habitat available for riparian habitat reestablishment	Impacts would be greater than alternative 1 because of greater sediment excavation and disposal and construction of 3,500 feet of new road; Fewer impacts to riparian vegetation from channel instability and less sediment Reduced sedimentation may result in less habitat available for riparian habitat reestablishment
Recreation	Short-term construction impacts on recreation associated with noise, dust, and traffic; downstream sedimentation effects on boating and angling; turbidity effects on fishing; sediment deposition effects on boating and fishing; channel instability may create hazardous conditions for boating	Construction impacts would be greater than alternative 1 and 3 because of the two-season construction period; downstream effects similar to alternative 1.	Construction impacts would be similar to alternative 1; less downstream effects than alternatives 1 and 2 because of the greater amount of sediment removed
Archeological	Long-term adverse effects on archeological site 35CL264	Same as alternative 1	Same as alternative 1

Resource	Alternative 1	Alternative 2	Alternative 3
	Single season dam removal with minimal sediment removal (PGE's proposal)	Removal of top of dam in year 1; complete dam removal in year 2 with sand layer excavation	Remove the dam and the maximum amount of sediment possible during 1 in-water work period
Historic Structures	Long-term adverse effects on resources determined to be eligible for listing on the National Register of Historic Places	Same as alternative 1	Same as alternative 1
Ethnographic Resources	None	None	None
Land Use	Temporary adverse effect on land use Land use would change from industrial to natural landscape	Same as alternative 1 except for 2-year construction period versus 1 year and greater removal of sediment	Same as alternative 1 except greater removal of sediment
Aesthetics	Temporary adverse effect on visual quality as a result of construction activities Removal of project structures would reestablish naturally appealing landscape	Same as alternative 1 except for 2-year construction period versus 1 year and greater sediment removal would increase truck traffic as a result of disposal of dredged sediment.	Same as alternative except greater sediment removal would increase truck traffic
Socioeconomics	Dam removal would create need for labor and resources Increased whitewater boating would result in benefits to local business	Same as alternative 1 except greater sediment removal may require the need for more labor and resources	Same as alternative 1 except greater sediment removal may require the need for more labor and resources

would create a need for an equivalent amount of fossil-fuel-derived energy and capacity, with resultant use of non-renewable resources and atmospheric pollution.

- (2) Decommissioning would cost about \$17 million. Removing Marmot dam as proposed by PGE would be the cheapest of the three Marmot dam removal alternatives (see table 33).
- (3) Removal of project facilities would result in short-term and long-term environmental impacts (see table 34). The most important include:
 - short-term impacts to downstream aquatic and salmonid habitats, including listed salmon and steelhead species, as a result of sediment deposition in the Sandy River downstream of Marmot dam, resulting in blockage to upstream fish passage, tributary passage due to sediment deposition, burying of spawning beds, loss of mainstem habitat for juvenile fish, and sedimentation and turbidity.
 - short-term increases in turbidity in the Little Sandy River
 - effects of construction-related activities, such as increases in traffic, human activities, and noise levels, and associated disturbance to wildlife and restrictions to public access
 - removal of Roslyn Lake, which would result in: the loss of a 160-acre lake that provides open-water habitat for wildlife and a warmwater fishery and receives substantial (33,000 visits in 1999) local recreational use (fishing, swimming, picnicking, boating); the loss of 20 acres of riparian habitat and 2 acres of scrub-shrub wetland and hydrological effects on a 4-acre forested wetland; loss of a population of the lesser bladderwort, a sensitive plant species; reduced water yields from as many as 58 water wells; and the removal of a source of water for fire fighting
 - impacts to facilities determined eligible for the National Register of Historic Places (Marmot dam, Little Sandy diversion dam, powerhouse, intake structure, penstocks, water conveyance structures) and impacts to one archeological sites considered eligible for the National Register
- (4) The proposed action, particularly removal of Marmot dam, would be likely to adversely affect the following listed, proposed, or candidate salmonid ESUs and DPSs:

- Northern spotted owl (threatened)
- Columbia River bull trout DPS (threatened)
- Lower Columbia River chinook salmon ESU (threatened)
- Lower Columbia River steelhead ESU (threatened)
- Lower Columbia River/Southwest Washington Coast coho salmon ESU (candidate)

As discussed below, measures are proposed to minimize short-term effects to these species. Removal of the project dams would have substantial long-term benefits to listed salmon and steelhead species (see below). USFWS and NMFS issued BOs concluding that the proposed action would be likely to jeopardize the continued existence of listed species. Insignificant effects on the threatened bald eagle are expected.

(5) PGE proposes extensive measures to minimize and eliminate effects including (see section 3.8.8) :

- implementing a detailed endangered species monitoring and contingency plan to evaluate post-dam fish passage barriers and address key blockages in a rapid and effective manner to minimize incidental take of listed species overseen by a monitoring and implementation team
- implementing a water quality and sediment monitoring plan
- providing temporary fish passage during project removal
- implementing a revegetation, noxious weed control, and site restoration plan to control erosion, prevent the establishment and control the spread of invasive/exotic species, and promote the establishment of native plant communities
- undertaking measures to mitigate adverse effects to properties determined to be eligible for the National Register of Historic Places through recordation and photo documentation of facilities, salvaging significant architectural elements of certain project features, and seeking adaptive reuse of the powerhouse, and protection or mitigation through data recovery of prehistoric archeological resources

(6) Decommissioning and removing the project would result in long-term benefits to the environment (see table 34). The most important include:

- restoring natural streamflows and geomorphic processes in the Sandy and Little Sandy Rivers resulting in the improved maintenance of aquatic and riparian habitat in previously affected reaches by reestablishing natural hydrology, sediment, and woody debris regimes
 - providing anadromous fish access, including listed endangered species, to 6.5 miles of the Little Sandy River upstream of the Little Sandy diversion dam and 1.7 miles downstream (bypass reach) and improving anadromous fish habitat by increasing flows and restoring connectivity with the upper basin
 - restoring natural flows to 10 miles of the Sandy River downstream of Marmot dam used by listed endangered species
 - improving both upstream and downstream passage for anadromous fish and other migratory species in the Sandy River, eliminating false attraction of summer steelhead and spring chinook into the Bull Run River, eliminating migration delays associated with the existing fish ladder, eliminating mortality, stress, and injury associated with upstream and downstream passage, and eliminating fish stranding and entrapment
 - increasing dissolved oxygen levels and decreased water temperatures
 - eliminating impediments to wildlife movement by removing the canal and flume
 - improving whitewater boating opportunities on the Sandy and Little Sandy Rivers
 - creating an approximately 1,500-acre conservation corridor
 - restoring a naturally appearing landscape after removal of project facilities and restoration of the area
- (7) Additional staff measures, including development of an erosion and sedimentation control plan, a fish facility design and operation plan, a final revegetation, noxious weed control, and site restoration plan, a spotted owl protection plan, a plan to implement the terms and conditions outlined in the BOs issued by the USFWS and NOAA Fisheries, requiring PGE give homeowners sufficient advance notice of its specific plans and schedule to drain Roslyn Lake in order to give these homeowners adequate time to implement necessary measures, such as redrilling, to

meet their water supply needs, implementation of the final historic properties management plan, and investigation of alternative sources of water for fire-fighting purposes would further protect environmental resources and have an insignificant cost (about \$20,000).

- (8) The proposal to surrender the project would be consistent with existing comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project (see section 9), and would aid in the restoration of aquatic ecosystems consistent with the aquatic conservation strategy of the Northwest Forest Plan.

7.3 RECOMMENDED ALTERNATIVE

Surrender Application

The decommissioning proposal was developed collaboratively with federal, state, and local agencies and non-governmental organization, which culminated in a comprehensive settlement agreement. The settlement agreement includes detailed measures to minimize the effects of removing project facilities on environmental resources, and includes extensive monitoring and contingency measures. Although the agreement is comprehensive, the preservation of Roslyn Lake was not feasible even after considerable study and evaluation.

The proposed action would result in short-term and long-term environmental impacts along with long-term environmental benefits as outlined in section 7.2.

The most significant effects would be the short-term impacts on the aquatic ecosystem downstream of the dam, including threatened species, from the release of 960,000 acre feet of sediment stored behind Marmot dam. Effects would include increases in turbidity and sedimentation and resulting effects on fish spawning, feeding, and migration.

It may take as long as 10 years for the aquatic system to stabilize. PGE has developed a fish monitoring and contingency plan and other measures to minimize many of the effects. A monitoring and implementation team would oversee the monitoring of impacts. The long-term benefits of eliminating existing impacts to anadromous fish associated with existing operation of the project (mortality, false attraction, etc.), providing access to 6.5 miles of the Little Sandy River and 1.7-mile-long bypass reach for anadromous fish, restoring natural flows in 10 miles of the Sandy River, and improving water quality would outweigh the short-term impacts. Further, creating a 1,500-acre

conservation corridor on the Sandy and Little Sandy Rivers and conversion of PGE's water rights to instream use would benefit riparian habitat and the river ecosystem and allow low-impact public access to the rivers and surrounding lands.

Roslyn Lake is a man-made lake that was built in 1912 to serve as the project's forebay. The loss of this 160-acre lake, a popular local recreational area, would eliminate recreational opportunities such as fishing and boating. Although these activities would be available elsewhere, a popular local resource would be lost. No feasible alternative was developed to preserve the lake because of unavailability of water to maintain lake levels and an agency willing to manage the lake. Loss of the lake would also affect as many as 58 water wells because of changes in ground water levels.

Removing the project would eliminate many of the project facilities and one archeological site that are eligible for listing on the National Register of Historic Places. PGE has developed a draft Historic Properties Management Plan that appropriately mitigates any impacts.

The project would result in the loss of 22-MW operating project that produces an average annual generation of about 111,000 MWh. This represents about 1 percent of the capacity owned by PGE. While annual energy requirements are expected to grow in the Pacific Northwest, substantial new additions of generation are anticipated. The loss of generation would have a negligible effect on the region.

Overall, the Commission staff believes that any short-term and long-term environmental impacts and loss of generation produced by the project would be outweighed by the long-term environmental benefits of the project removal.

The additional staff-recommended environmental protection plans would add an insignificant additional cost (about \$20,000) to the cost of surrendering the project, would help lessen expected impacts, and would be worth the cost.

Therefore, staff recommends that PGE's application for surrender of license be approved, as proposed, with the additional staff recommendations.

Marmot Dam Removal Alternative

We recommend the removal of Marmot dam in one season with minimal sediment removal (alternative 1) because:

- construction under alternatives 1 and 3 would take one construction season instead of two as under alternative 2 resulting in less impacts to water quality and instream habitat by limiting construction activity (installation and removal of cofferdam, construction staging, and in-water work) to single season
- the benefits of additional sediment dredging under alternatives 2 and 3 would not outweigh the additional impacts including increases turbidity and instream disturbance
- alternative 1 would not require off-site sediment disposal as would alternative 2 and 3, which would result in truck traffic, dust, noise and up to 100 acres of land for disposal
- alternative 1 is the least expensive of the three Marmot dam removal alternatives (\$9 million less expensive than alternative 2 and \$6.7 million less expensive than alternative 3)

Amendment of License Application

Interim Fish Protection Measures

The proposed interim fish protection measures, including changes in operating levels of the canal to protect downstream-migrating juvenile salmonids and continued funding of the operation and maintenance of the existing fish ladder and fish trap, would benefit existing fish populations until removal of the project is initiated and should be included in the amended license.

Pre-dam Removal Monitoring

PGE's proposal for geomorphological and water quality baseline monitoring prior to dam removal is necessary to minimize impacts from removal activities and to determine the post-removal adjustment period and should be included in the amended license.

Continued Generation

The proposal to delay project removal and allow project operation to continue until removal of Little Sandy diversion dam in 2008 is reasonable. Keeping Marmot dam in place until 2007 is needed to sort out-of-basin hatchery stock from the wild stock until the last of the hatchery fish returns to the Sandy River in 2007. The project canals are

also needed to be in place to facilitate removal of the project to divert flows from the marmot dam construction site. Pre-dam removal studies would also take place during this period (see above section). The project would continue to generate an average of 111,000 MWh until Marmot dam is removed in 2007 and Little Sandy diversion dam is removed in 2008. Interim measures would be in place to reduce ongoing impacts to fish populations.

Extension of License Term

PGE's proposal to extend the license term to 2017, to include post-removal monitoring, may be excessive and unnecessary. The license term would not necessarily have to extend beyond removal of project facilities and site restoration. Monitoring could be a condition of the surrender order and final acceptance of the surrender by the Commission could be made contingent on satisfactory completion of the monitoring program.

8.0 CONSISTENCY WITH COMPREHENSIVE PLANS

We evaluated the extent to which the proposed project would be consistent with existing comprehensive plans for improving, developing, or conserving a waterway or waterways affected by the project.

Under Section 10(a)(2) of the FPA, federal and state agencies filed a total of 108 comprehensive plans that address various resources in Oregon.²² Of those plans, we have identified six comprehensive plans that are applicable to the Bull Run Hydroelectric Project:

- BLM. Oregon State Parks and Recreation Department. Clackamas and Multnomah Counties. 1993. Sandy Wild and Scenic River and State Scenic Waterway Management Plan. Salem, Oregon.
- BLM. 1995. Salem District Record of Decision and Resource Management Plan. Department of the Interior, Salem, Oregon. May 1995.
- ODFW. 1993. Oregon Wildlife Diversity Plan. Second Edition. ODFW, Portland, Oregon.

²² See *Revised List of Comprehensive Plans* dated June 2003 [<http://www.ferc.gov/hydro/docs/complan.pdf>].

- USFS (U.S. Forest Service). 1990. Final Environmental Impact Statement, Land and Resource Management Plan, Mount Hood National Forest. USDA, Forest Service, Pacific Northwest Region.
- USFS and BLM. 1993. Salmon National Wild and Scenic River Management Plan. Mt. Hood National Forest.
- USFS and BLM. 1994. Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl; Standards and Guidelines for Management of Habitat for Late-successional and Old Growth Forest Related Species within the Range of the Northern Spotted Owl ("Northwest Forest Plan"). USDA Forest Service and USDI Bureau of Land Management. April 1994. Portland, Oregon.

The Northwest Forest Plan includes an Aquatic Conservation Strategy (ACS) aimed at restoring and maintaining the ecological health of watersheds and aquatic ecosystems. The objectives of the ACS are to restore: the distribution, diversity, and complexity of watershed and landscape-scale features; spatial and temporal connectivity; the physical integrity of the aquatic system; water quality necessary to support healthy riparian, aquatic, and wetland ecosystems; the sediment regime; restore in-stream flows sufficient to create and restore riparian, aquatic, and wetland habitats; timing, variability, and duration of flood plain inundation and water table elevation in meadows and wetlands; the species composition and structural diversity of plant communities in riparian areas and wetlands; and habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species. Removing the project would help restore aquatic habitat and eliminate ongoing impacts consistent with the objectives of the ACS.

We conclude that the proposed actions are consistent with all the applicable state and federal comprehensive plans. USFS anticipates that the implementation of the settlement agreement would satisfy the standards and guidelines under the Mt. Hood Land and Resource Management Plan, as amended by the Northwest Forest Plan (PGE 2002f). BLM anticipates that the implementation of the settlement agreement would satisfy the standards and guidelines under the Salem District Resource Management Plan (PGE 2002f).

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Appendix A

Sandy River Endangered Species Act Fish Monitoring and Contingencies Plan

Appendix A. Sandy River ESA Fish Monitoring and Contingencies Plan.

Issue	Area Affected	Species/ Lifestage Affected and Run Timing	Monitoring	Contingency Trigger (duration/timing/ magnitude of impact)	Contingency (action to be performed)	Potential ESA Take Issues
Fish Passage: Blockage to upstream fish passage due to sediment deposition issues, either as a structural obstruction or high velocity areas over long distances. Also includes side channel problems	Reach 0 Reach 1	Spring Chinook Adults (Apr-Nov with peak in June-Sept). Winter Steelhead Adults (Nov- May with peak in Feb-Apr) Coho Adults (Sept-Dec with peak in Sept-Nov). Bull Trout ⁴	1. Monitor integrity of coffer dam during in-water work period (July-Oct) dam removal operations, prior to fall rains - if in-water work period breaching of coffer dam occurs, visual monitoring action required 5 days/week to identify any potential passage problems until fall high flows begin. Fish passage monitoring will then follow # 2-4, below. 2. From high-flow breaching of the coffer dam to Feb 15 of the following year: Monitor one day/week (additional monitoring day(s) necessary if barrier detected to determine if barrier exists for 2 days) 3. Regular monitoring (5 days/week) will occur from Feb 15 to Nov 30 in the year following dam removal to identify any potential passage problems. 4. Members of the Monitoring Implementation Team (MIT) ¹ shall participate in an initial monitoring trip to ensure monitoring methodologies are field-tested for both visual observations and passage barrier data collection. MIT members also shall occasionally participate in monitoring activities. 5. After the first year of post-dam removal Fish Passage monitoring, the MIT will refine the frequency of Fish Passage monitoring events	In-water Work Period Breaching (during Mammot Dam removal period) and Post-Dam Removal Periods 1. Complete structural blockage or other migratory barrier, as defined by ESA sub-team criteria ¹ , for over 2 days during peak migration. If visual monitoring observations by PGE (or other party) indicate potential existence of a migratory barrier, site-specific passage barrier data (see footnote 1) will be collected by PGE and recorded. 2. Complete structural or other migratory barrier as defined by ESA sub-team criteria for over 2 days during non-peak migration. If visual monitoring observations by PGE (or other party) indicate potential existence of a migratory barrier, site-specific passage barrier data (see footnote 1) will be collected by PGE and recorded.	Once a Contingency Trigger is identified via Monitoring, the run-timing of listed ESA fish species will dictate the type of Contingency response Peak Migration Period Fish Passage Problem: After two days of passage blockage, the blockage will require immediate contingency action. PGE will notify all MIT members within 12 hours, and solicit Contingency guidance. PGE will implement contingency options recommended by resource agency MIT members. However, if no resource agency input is available, PGE will select and implement a Contingency Option (see Contingency Options, below). During and after passage blockage removal activities, PGE shall report the actions taken and results of those actions to the MIT and make adjustments to implementation according to recommendations of resource agencies. This "feedback loop" provides the MIT with information to determine if the passage blockage has been successfully addressed or whether PGE must take additional passage blockage actions. Non-Peak Migration Period Fish Passage Problem: After 2 days of passage blockage, the blockage will be immediately reviewed by the MIT with a decision on whether or not a contingency action is necessary during the non-peak migration period. The MIT will consider the magnitude and circumstances of the blockage, the species/ lifestages present at the time, fish maturation, run strength, likely flow events and weather conditions, water quality, and any other environmental factors deemed relevant. If the MIT determines that a contingency action is required, the MIT will notify PGE of the requirement to alleviate the Fish Passage problem. The MIT also will recommend the action to be taken by PGE (see Contingency Options, below). During and after passage blockage removal activities, PGE shall report the actions taken and results of those actions to the MIT. This "feedback loop" provides the MIT with information to determine if the passage blockage has been successfully addressed or whether PGE must take additional passage blockage actions. Contingency Options ¹ : 1. Mechanically remove structural blockage when instream work can be accomplished safely. 2. Add instream channel complexity (i.e., anchored logs) to increase channel roughness and create velocity breaks. (Note: instream channel complexity action is a temporary, single season action, not a permanent, hardened feature). 3. Emergency salvage and transport of fish 4. Rapid deployment of a trap and haul facility	Take likely to occur from passage delay or blockage: migration delay, high turbidity, poor holding conditions, etc

Table A. continued.

Issue	Area Affected	Species/ Lifestage Affected and Run Timing	Monitoring	Contingency Trigger (duration/timing/ magnitude of impact)	Contingency (action to be performed)	Potential ESA Take Issues
	Reach 2		No regularly scheduled monitoring. Opportunistic visual observations during overflights	Any blockage to be reported to and discussed by MIT.	Unknown, as Reach 2 is inaccessible	
	Reach 3	Spring Chinook Adults (Apr-Nov with peak in June-Sept). Winter Steelhead Adults (Nov- May with peak in Feb-Apr). Coho Adults (Sept-Dec with peak in Sept-Nov). Fall Chinook Adults (Aug-Dec with peak in Oct-Nov). Bull Trout	1 During low flow periods (Aug-Oct): Monitor fish passage problems during receding hydrograph at 100 cfs increments, based on Sandy R gage above Bull Run, from ~600 cfs down to 400 cfs. One monitoring check in reach 3 per each 100 cfs increment Increases in flow over 600 cfs during Aug-Oct resets the monitoring schedule described above. 2 Any time of year: Monitor once for all fish passage problems and stranding in side channels after flows recede from each 3,000 cfs (or greater) events to lower, base levels. Monitoring to occur as water levels recede with initial visual determination of whether a blockage was created by sediment movement during 3,000 + cfs flow event.	Dry-period Breaching (during Marmot Dam removal period) and Post-Dam Removal Periods: 1 Complete structural blockage or other migratory barrier, as defined by ESA sub-team criteria¹, for over 2 days during peak migration. 2. Complete structural or other migratory barrier, as defined by ESA sub-team criteria, for over 2 days during non-peak migration. 3 Upstream blockage of side channel access, with potential to falsely attract and strand fish into the lower portion of that side channel during any migration period. 4 Actual stranding of adults or juveniles in side channels during any migration period.	Once a Contingency Trigger is identified via Monitoring, the run-timing of listed ESA fish species will dictate the type of Contingency response For structural blockage or other migratory barrier during peak migration, the same process as described above for reaches 0 and 1 "Peak Migration Period Fish Passage Problem" (above) shall occur. For structural blockage or other migratory barrier during non-peak migration, the same process as described above for reaches 0 and 1 "Non-Peak Migration Period Fish Passage Problem" (above) shall occur. For upstream blockage of side channel access, or actual stranding of adults or juveniles, the same process as described above for reaches 0 and 1 "Non-Peak Migration Period Fish Passage Problem" (above) shall occur. Contingency Options: 1. Mechanically remove side channel blockage if feasible. 2. Add instream channel complexity (i.e., anchored logs) to increase channel roughness and create velocity breaks (Note: instream channel complexity action is a temporary, single season action, not a permanent, hardened feature). 3. Emergency salvage of fish if fish become stranded in side channels 4. Rapid deployment of trap and haul facility.	

Appendix A, continued.

Issue	Area Affected	Species/ Lifestage Affected and Run Timing	Monitoring	Contingency Trigger (duration/timing/ magnitude of impact)	Contingency (action to be performed)	Potential ESA Take Issues
	Reach 4 and 5	Spring Chinook Adults (Apr-Nov with peak in June-Sept). Winter Steelhead Adults (Nov - May with peak in Feb-Apr). Coho Adults (Sept-Dec with peak in Sept-Nov) Fall Chinook Adults (Aug-Dec with peak in Oct-Nov). Bull Trout	1 During low flow periods (Aug-Oct): Monitor fish passage problems during receding hydrograph at 100 cfs increments, based on Sandy R gage above Bull Run, from ~600 cfs down to 400 cfs. One monitoring check in reaches 4 and 5 per each 100 cfs increment Increases in flow over 600 cfs during Aug-Oct resets the monitoring schedule described above 2. Any time of year. Monitor once for all fish passage problems and stranding in side channels after flows recede from each 3,000 cfs (or greater) events to lower, base levels. Monitoring to occur as water levels recede with initial visual determination of whether a blockage was created by sediment movement during 3,000 + cfs flow event.	Dry-period Breaching (during Marmot Dam removal period) and Post-Dam Removal Periods 1. Complete structural blockage or other migratory barrier, as defined by ESA sub-team criteria, for over 2 days during peak migration 2. Complete structural or other migratory barrier, as defined by ESA sub-team criteria, at non-peak migration 3. Upstream blockage of side channel access, with potential to falsely attract and strand fish into the lower portion of that side channel during any migration period. 4. Actual stranding of adults or juveniles in side channels during any migration period.	Once a Contingency Trigger is identified via Monitoring, the run-timing of listed ESA fish species will dictate the type of Contingency response. For structural blockage or other migratory barrier during peak migration, the same process as described above for reaches 0 and 1 "Peak Migration Period Fish Passage Problem" (above) shall occur. For structural blockage or other migratory barrier during non-peak migration, the same process as described above for reaches 0 and 1 "Non-Peak Migration Period Fish Passage Problem" (above) shall occur. For upstream blockage of side channel access, or actual stranding of adults or juveniles, the same process as described above for reaches 0 and 1 "Non-Peak Migration Period Fish Passage Problem" (above) shall occur. Contingency Options: 1. Mechanically remove side channel blockage if feasible. 2. Add instream channel complexity (i.e., anchored logs) to increase channel roughness and create velocity breaks (Note: instream channel complexity action is a temporary, single season action, not a permanent, hardened feature) 3. Emergency salvage of fish if fish become stranded in side channels. 4. Rapid deployment of trap and haul facility.	Reach 3 rationale concerns are main channel blockage in upper reach, and upstream blockage of a side channel. Anticipate main channel will remain passable in lower Reach 3. Side channel may cause "attractive nuisance", create stranding. As hydrograph descends, stranding potential increases
	All reaches, especially reservoir area, reaches 1 and 3	Outmigrating juvenile salmonids (Feb 15- June 30)	Covered by monitoring actions for Passage in Reaches 0-5.			Main concern in Reach 4: side channel stranding.
	Reach 0, 1 and 2 have no tributaries for anadromy					
Tributary Blockage: Sediment moving downstream will block entrances to side channels and tributaries. NOTE: side channels are addressed in						

Appendix A. continued.

Issue	Area Affected	Species/ Lifestage Affected and Run Timing	Monitoring	Contingency Trigger (duration/timing/ magnitude of impact)	Contingency (action to be performed)	Potential ESA Take Issues
Fish Passage	Reach 3 Cedar Creek, which already has passage problems at low flows				All migrating salmonids Hatchery fish (up and downstream)	Check Cedar Creek confluence with Sandy R. concurrent with reach 3 Fish Passage monitoring [above] Monitoring occurs during descending Sandy R flows [between 600 to 400 cfs in 100 cfs increments] as well as after high flow [3,000 cfs] events
	Reach 4 Bull Run River Trout Creek Gordon Huck	All salmonids (all months) Steelhead, Cutthroat, Chinook Fall Chinook, Coho, Steelhead, Cutthroat Fall Chinook, Coho, Steelhead, Cutthroat Coho	Check tributary confluences with Sandy R. concurrent with reach 3 Fish Passage monitoring [above] Monitoring occurs during descending Sandy R flows [between 600 to 400 cfs in 100 cfs increments] as well as after high flow [3,000 cfs] events.	Complete blockage, as defined by ESA sub-team criteria, of tributary access for over 2 days	Once a potential tributary passage problem is identified, the MIT will immediately be contacted. The MIT will consider the blockage, timing of next flow event, species/ lifestages present at the time, fish maturation, run strength, migration periodicity, water quality, and importance of habitat, to determine if additional response is necessary. If the MIT determines that a contingency action is required, the MIT will notify PGE of the requirement to alleviate the Tributary Blockage problem. The MIT also will recommend the action to be taken by PGE (see Contingency Options under Fish Passage, above)	Broad, shallow sheet flow or subsurface flow at tributary mouth during low Sandy River flow periods, or blockage after high-flow event
	Reach 5 Braided channels Beaver (potential habitat restoration)	All salmonids Coho/Steelhead	Check Beaver Creek confluence and braided channel areas in Sandy R. concurrent with reach 3 Fish Passage monitoring [above]. Monitoring occurs during descending Sandy R flows [between 600 to 400 cfs in 100 cfs increments] as well as after high flow [3,000 cfs] events.	Complete blockage, as defined by ESA sub-team criteria, of tributary access for over 2 days	Once a potential tributary passage problem is identified, the MIT will immediately be contacted. The MIT will consider the blockage, timing of next flow event, species/ lifestages present at the time, fish maturation, run strength, migration periodicity, water quality, and importance of habitat, to determine if additional response is necessary. If the MIT determines that a contingency action is required, the MIT will notify PGE of the requirement to alleviate the Tributary Blockage problem. The MIT also will recommend the action to be taken by PGE (see Contingency Options under Fish Passage, above)	Main concern is access to tributaries is maintained during peak migrations (both up and down stream)

Appendix A. continued.

Issue	Area Affected	Species/ Lifestage Affected and Run Timing	Monitoring	Contingency Trigger (duration/timing/ magnitude of impact)	Contingency (action to be performed)	Potential ESA Take Issues
	Reach 5	All salmonid lifestages during low flow periods	Check Sandy River delta at low flows as hydrograph drops from 600 to 400 cfs in 100 cfs increments (paged above Bull Run) and after >3,000 cfs events	Blockage, based on ESA sub-team criteria, of up and downstream fish passage from the Columbia River	Once a Sediment Deposition at Mouth of Sandy problem is identified, the MIT will immediately be contacted. The MIT will consider the blockage, timing of next flow event, species/ lifestages present at the time, fish maturation, run strength, migration periodicity, water quality, and importance of habitat, to determine if additional response is necessary. If the MIT determines that a contingency action is required, the MIT will notify PGE of the requirement to alleviate the Sediment Deposition at Mouth of Sandy problem. The MIT also will recommend the action to be taken by PGE (see Contingency Options under Fish Passage, above).	
Sediment Deposition at Mouth Of Sandy, (esp sand and during low flow periods) may prevent fish passage	Reach 1 and 2	None	None			Reach 5: sand deposition below I-84 bridge that creates an impassible sand bar during low summer/fall baseflows. Need to ensure there is a single passable mainstem channel for fish to pass.
Sediment Deposition over Spawning Beds, existing redds buried by sediment moving downstream	Reaches 3, 4, and 5	Incubating fall Chinook (Sept - Jan) Incubating winter steelhead (Apr - 15 July)	None under ESA fish requirements			
	Reaches 0, 1 and 2	All salmonids	Monitor side channel blockage as per Fish Passage monitoring, above	Identify if side channels are non-usable	Once a potential side channel problem is identified, the MIT is to consider the fish usage, blockage, timing of next flow event, migration periodicity, importance of habitat and water quality to determine course of action, if any. The MIT also will recommend the action to be taken by PGE (see Contingency Options under Fish Passage, above).	Deposition of sediments over existing mainstem Sandy River salmonids redds after Mannot Dam is removed. Deposition may cause loss of eggs/alevins. Impact believed to be limited to season following dam removal.
Loss of Mainstem Habitat for juvenile fish:	Reach 3,4,5	All salmonids	Monitor side channel blockage as per Fish Passage monitoring, above	Identify if side channels are non-usable	Once a potential side channel problem is identified, the MIT is to consider the fish usage, blockage, timing of next flow event, migration periodicity, importance of habitat and water quality to determine course of action, if any. The MIT also will recommend the action to be taken by PGE (see Contingency Options under Fish Passage, above).	Potential take issue-adverse modification. - However, passage is a greater concern in Reach 0-2

Appendix A, continued.

Issue	Area Affected	Species/ Lifestage Affected and Run Timing	Monitoring	Contingency Trigger (duration/timing/ magnitude of impact)	Contingency (action to be performed)	Potential ESA Take Issues
	0,1,3, possibly 2, 4,5	All salmonids	None	Contingency Trigger same as fish passage & habitat issues	Contingencies same as fish passage & habitat issues	Potential take issue-adverse modification Loss of habitat is the larger concern than mainstem passage in reaches 3-5
Water Quality Issue: Sedimentation	0-5; and potentially Columbia River in plume	All salmonids	As identified in the ODFQ turbidity monitoring plan.	Delay in passage into tributaries (see monitoring action under Tributary Blockage issue, above)	Ensure tributaries are not blocked for fish so they can move into tributaries to avoid turbid conditions (linked to the tributary passage monitoring and contingencies)	Passage blockage, loss of redds
Turbidity and/or TSS: post-construction						Potential ESA take due to turbidity/total suspended sediments

¹ ESA Sub-team Criteria identifying potential blockages in the mainstem:

Length: A passage barrier exists if:

- Length of blockage is greater than 300' and velocity greater than 2 ft/sec
- Length of blockage is greater than 200', less than 300', and velocity greater than 3 ft/sec
- Length of blockage is greater than 150', less than 200', and velocity greater than 4 ft/sec
- Length of blockage is greater than 100', less than 150', and velocity greater than 5 ft/sec
- Length of blockage is greater than 50', less than 100', and velocity greater than 6 ft/sec
- Length of blockage is greater than 20', less than 50', and velocity greater than 8 ft/sec
- Length of blockage is less than 20' and velocity greater than 11 ft/sec

Depth: Migratory channel must have at least a 10-inch-deep thalweg (deepest portion of cross section) to be considered passable

Height: A passage barrier exists if:

- Jump pool shallower than jump height
- Jump height is greater than 4'

² An ESA Monitoring Implementation Team (MIT), as described in Section 7.3 of the Decommissioning Plan, would be established to oversee the Sandy River ESA Fish Monitoring and Contingencies Plan (ESA Fish Plan)

³ Mechanical Removal, Channel Complexity Enhancement, Emergency salvage, and Trap and Haul are described in Section 4.6 of the Decommissioning Plan

⁴ Bull trout will also be protected via this ESA monitoring and contingencies plan. Bull trout are not known to currently reside in the Sandy River Basin, but are occasional migrants into the Sandy River Basin from other Columbia River tributaries

Appendix B

Coarse Sediment Deposition Thickness Figures

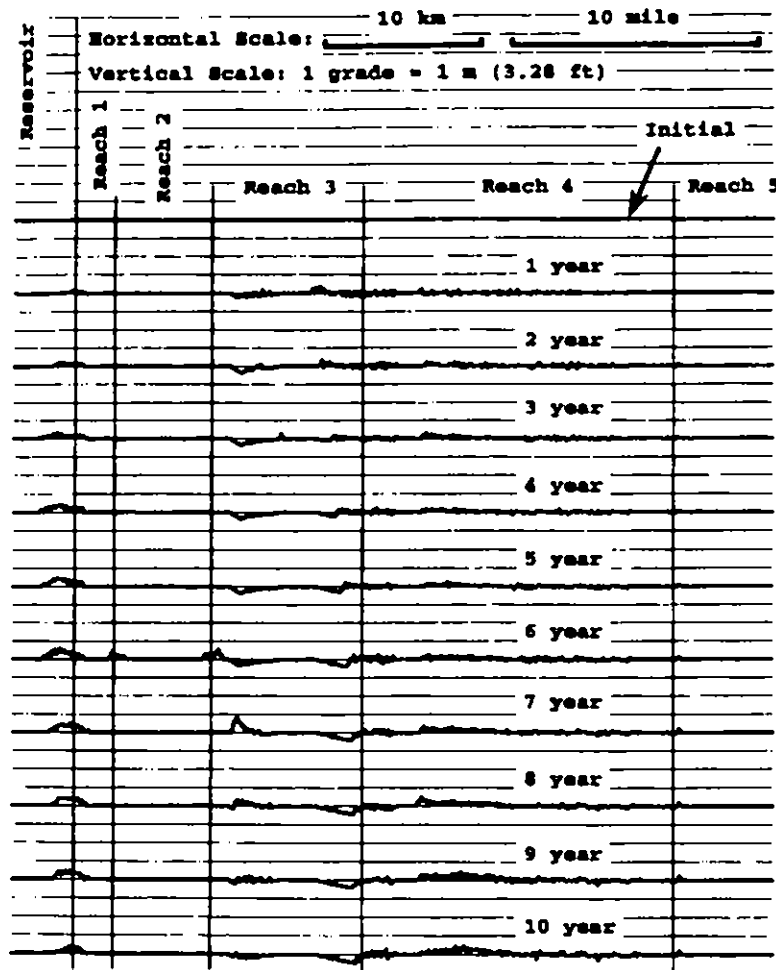


Figure B-1. Coarse Sediment Deposition Thickness under Reference (Background) Conditions.

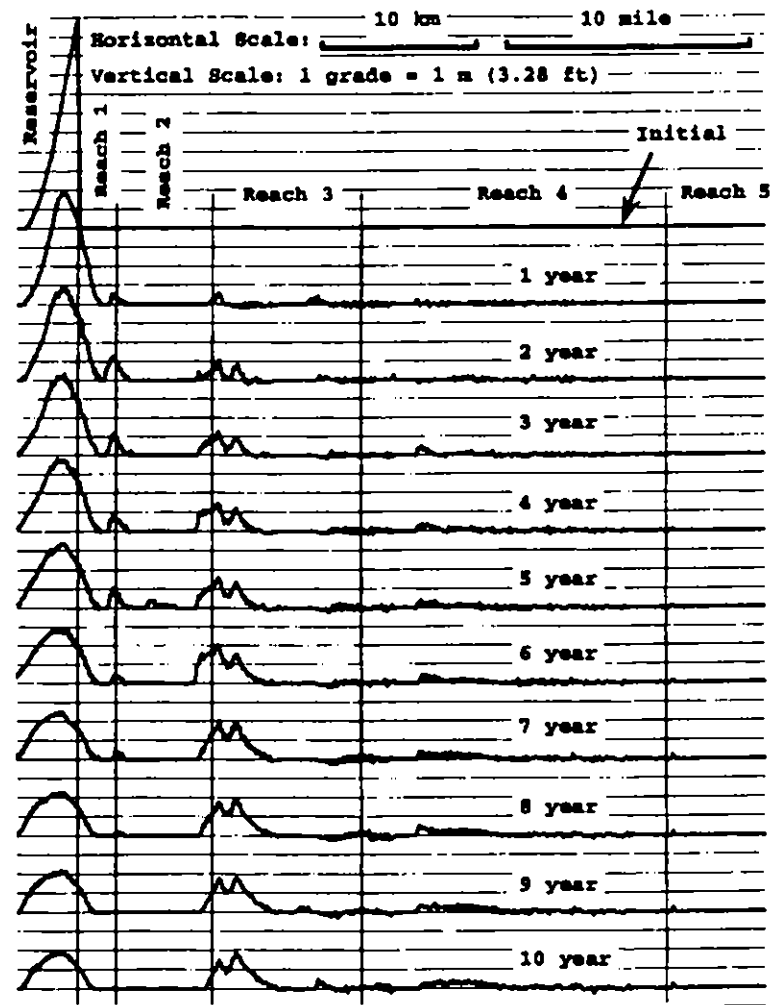


Figure B-2. Coarse Sediment Deposition Thickness for Alternative 1 (Minimal Dredging).

B-1

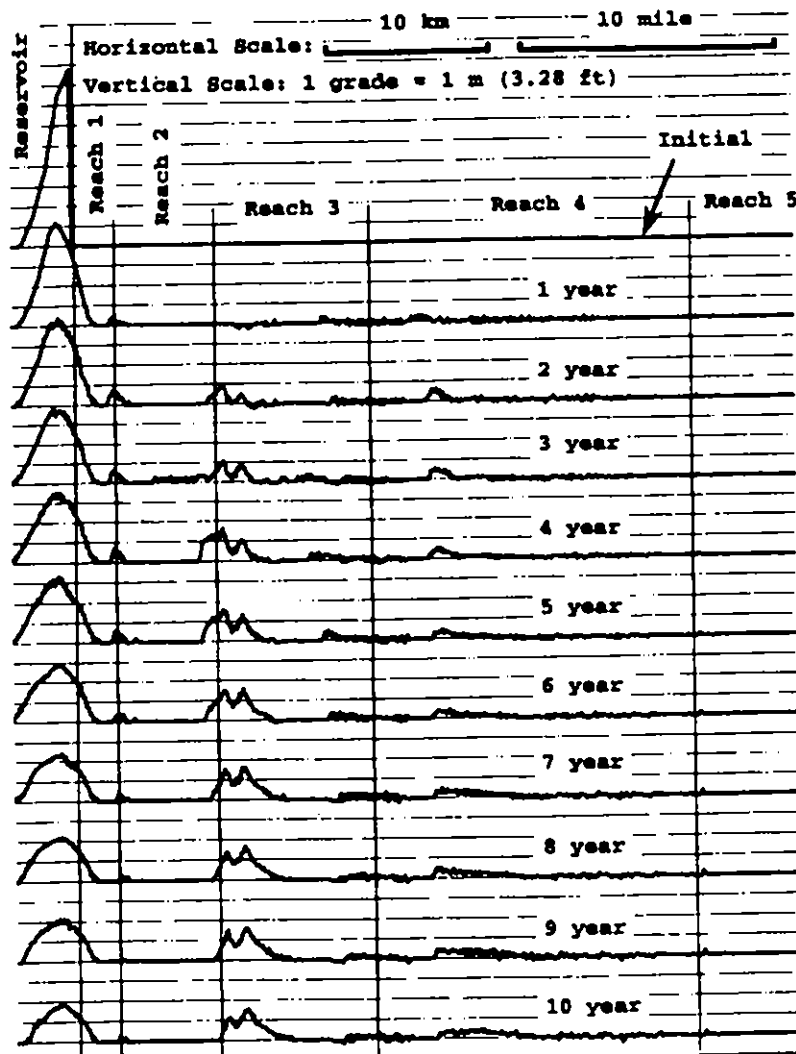


Figure B-3. Coarse Sediment Deposition Thickness for 125,000 Cubic Yards Of Dredging Prior to Dam Removal.

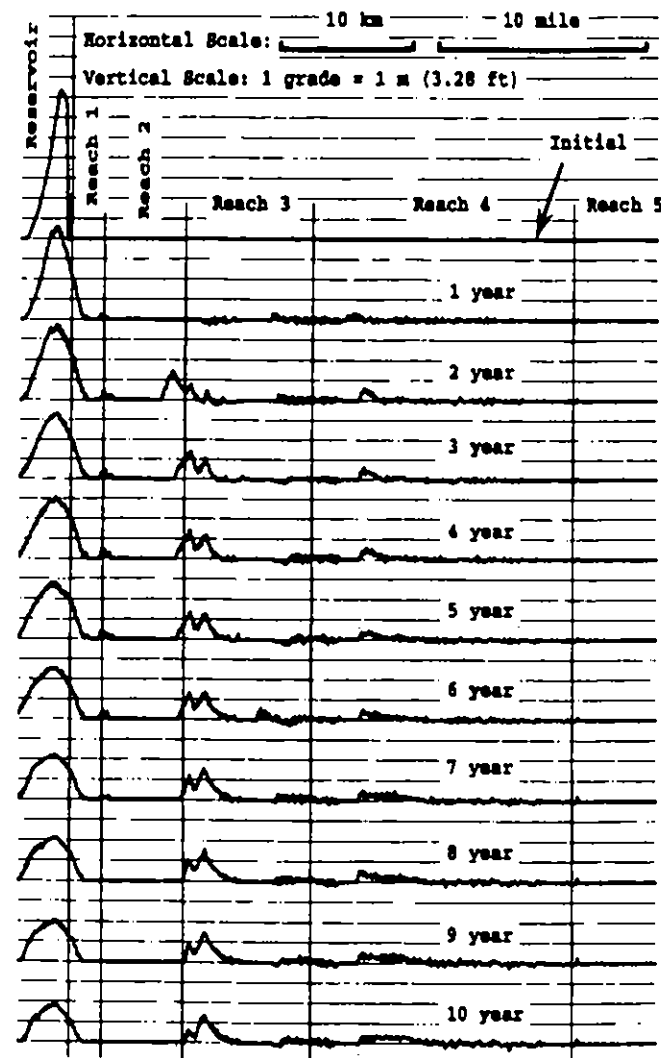


Figure B-4. Coarse Sediment Deposition Thickness for 300,000 Cubic Yards Of Dredging Prior to Dam Removal.

Appendix C

Evaluation of Water Wells Potentially Affected by Removal of Roslyn Lake based on Well Log Reports

Well Log	Township/ Range/ Section	Owner	Depth (feet)	Yield (gallons/ minute)	Screening Criteria			Well Likely Affected
					Hydrologic boundary	Hydro- geology	Depth	
CLAC 51901	2S-4E-1	Meacher, Diana	130	8	Y	Y	Y	Y
CLAC 52508	2S-4E-1	Shulcr, Cecil			U	U	U	U
CLAC 5766	2S-4E-12	Welden, Richard	65	7	Y	Y	Y	Y
CLAC 5767	2S-4E-12	Parsley, E L	220	18	U	Y	Y	U
CLAC 5768	2S-4E-12	Wood, M W	206	20	U	Y	Y	U
CLAC 6698	2S-5E-7	Tolle, Bryon	35	15	U	U	U	U
CLAC 6702	2S-5E-7	Shaver, Clyde R	61	20	Y	U	U	U
CLAC 6710	2S-5E-7	Vanende, Paul	60	55	U	U	U	U
CLAC 6711	2S-5E-7	Pearson, C A	136	20	U	Y	Y	U
CLAC 6713	2S-5E-7	Hagadoin, R H	55	5	Y	Y	Y	Y
CLAC 6715	2S-5E-7	Trickle, Wayne	110	7	Y	U	U	U
CLAC 6717	2S-5E-7	Dickman, Glen	46	20	U	Y	Y	U
CLAC 6719	2S-5E-7	Calhoun, Ronald W	60	50	Y	Y	Y	Y
CLAC 6724	2S-5E-7	Klingler, David C	63		Y	U	U	U
CLAC 6727	2S-5E-7	Knoll, James	50	25	Y	Y	Y	Y
CLAC 52837	2S-5E-7	Caudell, Demi			Y	U	U	U
CLAC 53307	2S-5E-7	Asch, Tom	199	25	Y	Y	Y	Y
CLAC 176	2S-5E-5	Kitchen, William C	109	40	Y	Y	Y	Y
CLAC 6672	2S-5E-5	Heckel, Ron	240	20	Y	U	U	U
CLAC 6677	2S-5E-5	Dodson, John	70	10	Y	Y	Y	Y