Kachess Drought Relief Pumping Plant and Keechelus Reservoir-to-Kachess Reservoir Conveyance

DRAFT Environmental Impact Statement

KITTITAS AND YAKIMA COUNTIES, WASHINGTON

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office
Yakima, Washington

State of Washington
Department of Ecology
Office of Columbia River
Yakima, Washington
Ecology Publication Number: 15-12-001

January 2015

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The mission of the Department of Ecology is to protect, preserve and enhance Washington's environment, and promote the wise management of our air, land and water for the benefit of current and future generations.

United States Department of the Interior
BUREAU OF RECLAMATION
Columbia-Cascades Area Office
1917 Marsh Road
Yakima, Washington 98901-2058

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To: Interested Individuals, Organizations, and Agencies

Subject: Kachess Drought Relief Pumping Plant and Keechelus-to-Kachess Conveyance (KDRPP/KKC) Projects Draft Environmental Impact Statement, Kittitas and Yakima Counties, Washington

Dear Ladies and Gentlemen:

Enclosed for your review and comment is the Draft Environmental Impact Statement (EIS) for the proposed Kachess Drought Relief Pumping Plant (KDRPP) and Keechelus Reservoir-to-Kachess Reservoir Conveyance (KKC) projects. These projects are components of the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan). This Draft EIS has been prepared jointly by the Bureau of Reclamation and the Washington State Department of Ecology, Office of Columbia River.

This Draft EIS evaluates a No Action Alternative and five action alternatives to restore and enhance instream flows and aquatic habitat for fish, including enhancements for bull trout; improve water supply reliability during drought years; improve the ability of water managers to respond and adapt to potential effects of climate change; and contribute to the vitality of the regional economy and riverine environment in the Yakima River Basin. The six alternatives are:

- *Alternative 1 – No Action*
- *Alternative 2A – KDRPP East Shore Pumping Plant*
- *Alternative 2B – KDRPP South Pumping Plant*
- *Alternative 3A – KKC North Tunnel Alignment*
- *Alternative 3B – KKC South Tunnel Alignment*
- *Alternative 4 – Combined KDRPP and KKC*

This Draft EIS was prepared in compliance with the National Environmental Policy Act (NEPA), Public Law 91-190, and the State Environmental Policy Act (SEPA), Chapter 43.21C RCW, and the SEPA Rules (Chapter 197-11 WAC). A joint NEPA and SEPA scoping process was held from October 30, 2013, to December 16, 2013.

For this Draft EIS, comments may be submitted orally, electronically, or by regular mail. Oral comments will be accepted at both of the public meetings. The meetings will be from 4-7 p.m. on the dates and locations listed below:

February 3, 2015 Hal Holmes Center 209 N. Ruby Street Ellensburg, WA 98926	February 5, 2015 U.S. Forest Service Cle Elum Ranger District 803 W. 2nd Street Cle Elum, WA 98922

Requests to provide comments orally at the public meetings will be handled on a first-come, first-served basis. Comments will be transcribed by a court reporter. In the interest of available time, each speaker will be asked to limit oral comments to 5 minutes. Longer comments should be summarized and submitted in writing either at the public meeting or identified as meeting comments and sent to Ms. Candace McKinley, Environmental Program Manager, no later than March 10, 2015, at the address below.

The public meeting facilities are physically accessible. Individuals who need accessibility accommodations, including sign language interpreters or other auxiliary aids, may contact Ms. McKinley. Requests should be made as early as possible to allow sufficient time to arrange for accommodation.

Comments may also be submitted electronically, by telephone, by facsimile, or by mail to Ms. McKinley. Comments on this document must be postmarked by March 10, 2015, to ensure inclusion into the Final EIS. Before including your name, address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment—including your personal identifying information—may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

For further information regarding this document or to submit comments, please contact:

Ms. Candace McKinley
Environmental Program Manager
Bureau of Reclamation
Columbia-Cascades Area Office
1917 Marsh Road
Yakima, WA 98901-2058
Phone: 509-575-5848, ext. 603
Fax: 509-454-5650
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Those wishing to obtain the Draft EIS in the form of a printed document or on compact disk (CD-ROM), or an Executive Summary of the Draft EIS, may contact Ms. McKinley at the address or phone number given above.

The Draft EIS is available for viewing on the internet at http://www.usbr.gov/pn/programs/eis/kdrpp/index.html and http://www.usbr.gov/pn/programs/eis/kkc/index.html.

Additional information regarding the Integrated Plan may be found at http://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html.

Sincerely,

Dawn Wiedmeier
Area Manager
Columbia-Cascades Area Office
Bureau of Reclamation
1917 Marsh Road
Yakima, Washington 98901-2058

Derek I. Sandison, Director
Office of Columbia River
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15 W. Yakima Ave., Ste. 200
Yakima, Washington 98902

Enclosure

Draft Environmental Impact Statement
Kachess Drought Relief Pumping Plant and
Keechelus Reservoir-to-Kachess Reservoir Conveyance
Kittitas County and Yakima County, Washington

Joint Lead Agencies:	**For further information contact**:
U.S. Department of the Interior Bureau of Reclamation	Ms. Candace McKinley Environmental Program Manager Columbia-Cascades Area Office 1917 Marsh Road Yakima, Washington 98901-2058 509-575-5848, ext. 603
State of Washington Department of Ecology	Mr. Derek I. Sandison Director, Office of Columbia River 15 W. Yakima Ave, Suite 200 Yakima, Washington 98902-3452 509-457-7120

Cooperating Governments and Agencies:

Confederated Tribes and Bands of the Yakama Nation
U.S. Department of Agriculture, U.S. Forest Service
U.S. Department of Energy, Bonneville Power Administration

This Draft Environmental Impact Statement (DEIS) for the Kachess Drought Relief Pumping Plant (KDRPP) and Keechelus Reservoir-to-Kachess Reservoir Conveyance (KKC) was prepared jointly by the Bureau of Reclamation and Washington State Department of Ecology. These projects are part of the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan). This DEIS evaluates a No Action Alternative and five action alternatives: Alternative 2A – KDRPP East Shore Pumping Plant; Alternative 2B – KDRPP South Pumping Plant; Alternative 3A – KKC North Tunnel Alignment; Alternative 3B – KKC South Tunnel Alignment; and Alternative 4 – Combined KDRPP and KKC.

This DEIS was prepared in compliance with the National Environmental Policy Act (NEPA) 42 USC 4371 et seq. and the State of Washington Environmental Policy Act (SEPA), Chapter 43.21C RCW, and the SEPA Rules (Chapter 197-11 WAC).

SEPA FACT SHEET

Brief Description of Proposal:

The Bureau of Reclamation and the Washington State Department of Ecology have jointly prepared this Draft Environmental Impact Statement (DEIS) on the Kachess Drought Relief Pumping Plant (KDRPP) and Keechelus Reservoir-to-Kachess Reservoir Conveyance (KKC). This document was prepared in compliance with the National Environmental Policy Act (NEPA) and Washington State Environmental Policy Act (SEPA). Ecology is the SEPA lead agency for the proposal.

The action alternatives examine constructing and operating a pumping plant to access up to 200,000 acre-feet of water in Kachess Reservoir during drought years, constructing and operating a gravity flow tunnel from Keechelus Reservoir to Kachess Reservoir, and constructing several projects to enhance the resiliency of bull trout populations in the Kachess and Keechelus watersheds. These projects are part of the Yakima Basin Integrated Water Resources Management Plan (Integrated Plan).

Proponents and Contacts:

U.S. Department of the Interior, Bureau of Reclamation

Contact: Ms. Candace McKinley
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Columbia-Cascades Area Office
1917 Marsh Road
Yakima, Washington 98901-2058
509-575-5848, ext. 603

State of Washington, Department of Ecology

Contact: Mr. Derek I. Sandison
SEPA Responsible Official
Director, Office of Columbia River
15 W. Yakima Ave, Suite 200
Yakima, Washington 98902-3452
509-457-7120

Permits, Licenses, and Approvals Required for Proposal:

To implement any component of the action alternative, the lead agency would need to apply for any required permits and comply with various laws, regulations, and Executive Orders. The following are those that are likely to apply:

- National Environmental Policy Act
- Endangered Species Act
- Magnusson-Stevens Fishery Conservation and Management Act
- Fish and Wildlife Coordination Act
- Secretary's Native American Trust Responsibilities
- National Historic Preservation Act
- Native American Graves Protection and Repatriation Act
- Executive Order 11988: Floodplain Management
- Executive Order 11990: Protection of Wetlands
- Executive Order 12898: Environmental Justice
- Executive Order 13007: Indian Sacred Sites
- Executive Order 13175: Consultation and Coordination with Indian Tribal Governments
- Clean Water Act
- State Environmental Policy Act
- Dam Safety Permit
- Hydraulic Project Approval
- Governor's Executive Order 05-05

Additionally, Reclamation and Ecology would coordinate with Kittitas County and Yakima County on the applicability of local regulations, including critical areas regulations and the Shoreline Management Program.

Authors and Contributors:

A list of authors and contributors is provided in a section that follows Chapter 5.

Date of Issue:

January 9, 2015

Public Comment Period:

The DEIS will be available for a 60-day public comment period. Comments must be received or postmarked by 5 p.m. PST on March 10, 2015, and may be submitted orally, in writing via regular mail, by facsimile, or by email to:

Ms. Candace McKinley
Environmental Program Manager
Columbia-Cascades Area Office
1917 Marsh Road
Yakima, Washington 98901-2058
Phone: 509-575-5848, ext. 603

Fax: 509-454-5650
Email: kkbt@usbr.gov

Public Meetings:

Reclamation and Ecology will conduct two public meetings to receive comments on the DEIS. The meetings will be held from 4-7 p.m. on the following dates and times and at the following locations:

1. Tuesday, February 3, 2015, Hal Holmes Community Center, 209 N. Ruby Street, Ellensburg, Washington 98926;

2. Thursday, February 5, 2015, U.S. Forest Service, Cle Elum Ranger District, Tom Craven Conference Room, 803 W 2nd Street, Cle Elum, Washington 98922

Timing of Additional Environmental Review:
Reclamation and Ecology anticipate releasing the Final EIS on the Kachess Drought Relief Pumping Plant and Keechelus Reservoir-to-Kachess Reservoir Conveyance in June 2015.

Document Availability:

The DEIS can be viewed online at:
http://www.usbr.gov/pn/programs/eis/kdrpp/index.html
and http://www.usbr.gov/pn/programs/eis/kkc/index.html
The document may be obtained in hard copy or CD by written request to the SEPA Responsible Official listed above, or by calling 509-575-5848, ext. 603. To ask about the availability of this document in a format for the visually impaired, call the Office of Columbia River at 509-662-0516. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Location of Background Materials:

Background materials used in the preparation of this DEIS are available online at:

Kachess Drought Relief Pumping Plant
http://www.usbr.gov/pn/programs/eis/kdrpp/index.html

Keechelus Reservoir-to-Kachess Reservoir Conveyance
http://www.usbr.gov/pn/programs/eis/kkc/index.html

Additional information about the Yakima River Basin Integrated Water Resource Management Plan is available at:

http://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html.

RECLAMATION
Managing Water in the West

Kachess Drought Relief Pumping Plant and Keechelus-to-Kachess Conveyance Projects

DEPARTMENT OF ECOLOGY
State of Washington

ACRONYMS AND ABBREVIATIONS

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AASHTO	American Association of State Highway and Transportation Officials
APE	Area of Potential Effects
BA	biological assessment
BIA	Bureau of Indian Affairs
bgs	below ground surface
BLM	Bureau of Land Management
BMPs	best management practices
BNSF	Burlington Northern Santa Fe
BPA	Bonneville Power Administration
BTE	Bull Trout Enhancement
C	Celsius
CAO	Critical Areas Ordinance
CAR	Coordination Act Report
CEAs	connectivity emphasis areas
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_4	methane
CIG	Climate Impact Group
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
Colville Confederated Tribes	Confederated Tribes of the Colville Reservation
Corps	U.S. Army Corps of Engineers
CRMP	Cultural Resources Management Plan
CSZ	Cascadia Subduction Zone

CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CWA	Clean Water Act
cy	cubic yards
DAHP	Department of Archaeology and Historic Preservation
DART	Data Access in Real Time
dB	decibel
dBA	A-weighted decibels
DDE	Dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DEIS	Draft Environmental Impact Statement
DNR	Department of Natural Resources
DO	dissolved oxygen
DPS	distinct population segment
DS	determination of significance
EA	environmental assessment
Ecology	Washington State Department of Ecology
EDNA	Environmental Designation for Noise Abatement
EIS	Environmental Impact Statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
FR	Federal Register
FWCA	Fish and Wildlife Coordination Act
General permit	State General Permit for Storm Water Discharges Associated with Construction Activity
g	gravity
GHG	greenhouse gas
GIS	geographic information system

gpm	gallons per minute
I-90	Interstate-90
IMPLAN	Impact Analysis for PLANning model
Integrated Plan	Yakima River Basin Integrated Water Resource Management Plan
Integrated Plan PEIS	*Yakima River Basin Integrated Water Resource Management Plan Final Programmatic Environmental Impact Statement*
IO	input-output
ITA	Indian Trust Asset
kaf	thousand acre-feet
KCRS	Kittitas County Road Standards
KCT	Kittitas Conservation Trust
KDRPP	Kachess Drought Relief Pumping Plant
kg/gal	kilograms per gallon
KID	Kennewick Irrigation District
KKC	Keechelus to Kachess Conveyance
KRD	Kittitas Reclamation District
kV	kilovolt
L_{max}	average maximum noise level
LWD	large woody debris
M	Richter magnitude
MCR	Middle Columbia River
mg/L	milligrams per liter
mg/m^3	milligrams per meter cubed
Milestone	Water Supply Facility Permit and Funding Milestone
MMS	moment magnitude
MOA	Memorandum of Agreement
MOCA	Managed Owl Conservation Area
µg/L	Microgram per liter
µg/m^3	micrograms per cubic meter
MVA	megavolt ampere

N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
N/E	not expected
NEHRPA	National Earthquake Hazards Reduction Program Act
NEPA	National Environmental Policy Act
NF	National Forest road
NHPA	National Historic Preservation Act
NIDCD	National Institute on Deafness and Other Communication Disorders
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NO_X	nitrogen oxide
NPDES	National Pollutant Discharge Elimination System
NPCC	Northwest Power and Conservation Council
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
O_3	ozone
OMR&P	construction, operations, maintenance, replacement, and power
OSS	on-site sewer systems
PCBs	polychlorinated biphenyls
PCDDs/PCDFs	polychlorinated dioxins and furans
PEIS	Programmatic Environmental Impact Statement
PHA	peak horizontal ground acceleration
PHS	Priority Habitats and Species
PM	particulate matter
$PM_{2.5}$	particulate matter less than 2.5 microns
PM_{10}	particulate matter less than 10 microns
ppm	parts per million
PPV	peak particle velocity

PSE	Puget Sound Energy
PSHA	probabilistic seismic hazard analysis
RCW	Revised Code of Washington
Reclamation	Bureau of Reclamation
RID	Roza Irrigation District
RM	river mile
RV	recreational vehicle
SEPA	State Environmental Policy Act
Service	U.S. Fish and Wildlife Service
SHPO	State Historic Preservation Officer
SILs	scenic integrity levels
SIP	State Implementation Plan
SMP	Shoreline Master Program
SOAC	System Operations Advisory Committee
SPAMA	Snoqualmie Pass Adaptive Management Area
Storage Study	Yakima River Basin Water Storage Feasibility Study
SWPPP	stormwater pollution prevention plan
TBM	tunnel boring machine
TCF	Teanaway Community Forest
TCP	Traditional Cultural Property
TDG	total dissolved gases
TMDL	total maximum daily load
TPH	total petroleum hydrocarbons
TWSA	total water supply available
USC	U.S. Code
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
UST	Underground storage tank

VQO	Visual Quality Objective
WAC	Washington Administrative Code
WARM plan	Wetlands and Aquatic Resources Mitigation Plan
WDFW	Washington Department of Fish and Wildlife
WIP	Wapato Irrigation Project
WQI	water quality improvement
WRIA	Watershed Resource Inventory Area
WSDF	Washington State Department of Fisheries
WSDOH	Washington State Department of Health
WSDOT	Washington State Department of Transportation
Yakama Nation	Confederated Tribes and Bands of the Yakama Nation
YBTAP	Yakima Bull Trout Action Plan
YCIP	Yakama Nation Cultural Resources Program
YKFP	Yakima/Klickitat Fisheries Project
YRBWEP	Yakima River Basin Water Enhancement Project

Contents

MISSION STATEMENT
COVER LETTER
JOINT LEAD AGENCIES
SEPA FACT SHEET
FRONTISPIECE
ACRONYMS AND ABBREVIATIONS
EXECUTIVE SUMMARY

TABLE OF CONTENTS

Tables

Figures

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Introduction

The U.S. Department of the Interior Bureau of Reclamation and the Washington State Department of Ecology have prepared this Draft Environmental Impact Statement (DEIS) to evaluate the potential environmental effects of implementing two similar and closely related projects in the Yakima River basin in central Washington State:

- Kachess Drought Relief Pumping Plant (KDRPP)
- Keechelus Reservoir-to-Kachess Reservoir Conveyance (KKC)

Reclamation and Ecology are proposing these two projects as well as enhancements to improve the abundance and resiliency of bull trout populations in the basin as part of implementation of the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan) (Reclamation and Ecology, 2011h). The Integrated Plan is a comprehensive program of solutions developed to restore ecological functions in the Yakima River system and to provide more reliable and sustainable water resources for the health of the riverine environment and for agricultural, municipal, and domestic needs.

As joint lead agencies, Reclamation and Ecology have prepared this DEIS to meet requirements of both the National Environmental Policy Act (NEPA) and State Environmental Policy Act (SEPA). The Yakama Nation, U.S. Fish and Wildlife Service (Service), U.S. Forest Service (USFS), and Bonneville Power Administrative (BPA) are cooperating agencies in preparation of the DEIS in accordance with 40 CFR Section 1508.5. Under NEPA, a cooperating agency is any Federal agency, other than the lead agency, that has jurisdiction by law or special expertise with respect to any environmental impact involved in an action requiring an environmental impact statement. In addition, a State or local agency of similar qualifications or an Indian Tribe may by agreement with the lead agency become a cooperating agency.

Background of the Proposed Action

Reclamation's mission is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Ecology's mission is to protect, preserve and enhance the State of Washington's environment for current and future generations. Consistent with its mission, Ecology is has been directed by the State legislature to implement actions that provide concurrent benefits for instream and out-of stream uses for the Yakima River basin.

In June 2009, Ecology and Reclamation brought representatives from the Yakama Nation, irrigation districts, environmental organizations, and Federal, State, county, and city governments together to form the Yakima River Basin Water Enhancement Project (YRBWEP) Workgroup to help develop a consensus-based solution to the basin's water problems. Over the next 18 months, the group developed the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan) (Reclamation and Ecology, 2011h)[1].

The Plan includes the following seven elements:

- Reservoir Fish Passage
- Structural and Operational Changes
- Surface Water Storage
- Groundwater Storage
- Habitat/Watershed Protection and Enhancement
- Enhanced Water Conservation
- Market Reallocation

Reclamation and Ecology prepared the program-level *Yakima River Basin Integrated Water Resource Management Plan Programmatic EIS* (Integrated Plan PEIS) to determine the effects of implementing the Integrated Plan (Reclamation and Ecology, 2012)[2]. The Integrated Plan PEIS supports the conclusion that the current water resources infrastructure, programs, and policies in the Yakima River basin are not capable of consistently meeting the demands for fish and wildlife, irrigation, and municipal water supply (Reclamation and Ecology, 2012).

The Selected Alternative identified in Reclamation's Integrated Plan PEIS Record of Decision (Integrated Plan ROD) includes seven elements, each containing distinct actions, that collectively provide a comprehensive approach to water management in the Yakima River basin and meet the need to restore ecological functions and provide more reliable and sustainable water resources for the health of the riverine environment and for agricultural, municipal, and domestic needs (Reclamation, 2013). The KDRPP and KKC, along with enhancements for bull trout populations in the basin, are identified in the Integrated Plan ROD as necessary components of the Integrated Plan that contribute to achieving the Plan's overall goals.

[1] The following websites contain information about implementation of the Integrated Plan:

- http://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html
- http://www.ecy.wa.gov/programs/wr/cwp/YBIP.html.

[2] Available online at http://www.usbr.gov/pn/programs/yrbwep/reports/FPEIS/fpeis.pdf

Proposed Action

Reclamation's Proposed Action is to construct, operate, and maintain one or both of two closely related water resource projects in the upper Yakima River basin pending congressional authorization. Reclamation and Ecology are considering how these two parts of the Proposed Action, alone or in combination, contribute to restoring ecological functions and providing more reliable and sustainable water resources for the health of the riverine environment and for agricultural, municipal, and domestic needs. The two projects are so closely related in overlapping geography, concurrent timing, interrelated operations, cumulative impacts, and interdependence through the Integrated Plan ROD to be considered interconnected parts of a single course of action that should be evaluated in a single EIS (40 CFR 1502.4 and 40 CFR 1508.25). These relationships are detailed in Section 1.5 and Chapter 2 of this DEIS. The two projects being considered under the Proposed Action are described briefly below as:

- Kachess Reservoir Drought Relief Pumping Plant (KDRPP). Deliver up to an additional 200,000 acre-feet of water from Kachess Reservoir during drought years by installing a new deeper outlet works and pumping system to access existing stored water that cannot currently be accessed. Implement an integrated package of aquatic habitat enhancements and assessments focused on improving the abundance and resiliency of bull trout populations in the Yakima River basin.
- Keechelus Reservoir-to-Kachess Reservoir Conveyance (KKC). Augment flows into Kachess Reservoir and reduce flows in the Yakima River downstream from Keechelus Reservoir to Lake Easton[3] by transferring water from Keechelus Reservoir to Kachess Reservoir via a new tunnel. Implement an integrated package of aquatic habitat enhancements and assessments focused on improving the abundance and resiliency of bull trout populations in the Yakima River basin.

Purpose and Need for the Action

The purpose of the Proposed Action is to fulfill elements of the Integrated Plan ROD signed by Reclamation on July 9, 2013 to help restore ecological functions and provide more reliable and sustainable water resources for the health of the riverine environment and for agricultural, municipal, and domestic needs. The two projects being considered under the Proposed Action respond to specific conditions in the Yakima River basin that adversely affect and are affected by Reclamation's facilities and operations. Those conditions are identified here as the need associated with each of the two projects.

[3] Lake Easton is a reservoir on the Yakima River created by the Easton Diversion Dam, which supplies the Kittitas Reclamation District. The Yakima River flows into Lake Easton from the southwest and the Kachess River from the northwest.

Needs related to KDRPP:

- Demand for irrigation water by existing users in the Yakima River basin exceeds supply in drought years, which can lead to substantial prorationing of water deliveries and economic losses to farmers[4].
- The productivity and function of aquatic habitat conditions for bull trout in tributaries above Keechelus and Kachess reservoirs, as well as throughout the Yakima River basin, is not of consistent quality, and in areas is substantially degraded. In addition, passage within these tributaries is in some cases impaired or blocked.

Needs related to KKC:

- Runoff from the Keechelus watershed in a typical year is greater than can be contained in the reservoir for release when most needed for instream, agricultural, municipal, and domestic uses.
- Current operations at Keechelus Dam result in high flows in the upper Yakima River during the irrigation season that impair rearing habitat for steelhead and spring Chinook upstream of Lake Easton.
- The productivity and function of aquatic habitat conditions for bull trout in tributaries above Keechelus and Kachess reservoirs, as well as throughout the Yakima River basin, is not of consistent quality, and in areas is substantially degraded. In addition, passage within these tributaries is in some cases impaired or blocked.

The objectives of each of the two projects are identified below followed by a discussion of the conditions that give rise to the identified needs and objectives.

The objectives of KDRPP are to:

- Access stored water in Kachess Reservoir that is currently unavailable in order to improve water supply during periods of drought, with a goal of approaching not less than 70 percent of proratable water rights whenever feasible[5].
- Implement the Bull Trout Enhancement (BTE) package of aquatic habitat enhancements, and accomplish assessments of current conditions and limiting factors for bull trout populations in the Yakima River basin to improve the effectiveness of future enhancement actions.

[4] Concerns regarding economic loss are discussed in the Integrated Plan FEIS in Section 1.3, Purpose and Need for the Action, on pages 1-5 and 1-6.

[5] The basis for this threshold for prorationing is discussed in the Integrated Plan FEIS in Section 1.3, Purpose and Need for the Action, on pages 1-5 and 1-6.

A substantial portion of the water stored in Kachess Reservoir is below the existing reservoir outlet. Thus, this stored water is not accessible under existing conditions due to the physical configuration of the dam. If made accessible, this water could be utilized to increase water supply during periods of drought and provide greater flexibility to deliver water to meet Reclamation’s contractual obligations.

Regarding bull trout, the Service listed the Columbia River Basin Distinct Population Segment (DPS) of bull trout as threatened under the Endangered Species Act (ESA) in June 1998. The Service identified 12 subpopulations of bull trout in the Yakima River basin and designated critical habitat in a number of reaches of the Yakima River and tributaries (Reclamation and Ecology, 2014b). As an outcome of the Integrated Plan, consensus has emerged among the Yakama Nation and resource agencies with jurisdictions around an integrated package of aquatic habitat enhancements and assessments focused on improving the abundance and resiliency of bull trout populations in the Yakima River basin. The package of enhancements and assessments is referred to as Bull Trout Enhancement (BTE). The existing conditions in the basin that contributed to the listing of bull trout and the uncertainties of climate change have created an imperative for implementing affirmative steps as identified in the BTE. These conditions related to bull trout and the BTE are the same for KDRPP and KKC.

The objectives of KKC are to:

- Capture excess runoff from the Keechelus watershed
- Improve capabilities for refilling Kachess Reservoir during and following dry and drought years
- Reduce high flows from Keechelus Dam in the upper Yakima River during irrigation season to improve rearing habitat for steelhead and spring Chinook upstream of Lake Easton
- Implement the BTE package of aquatic habitat enhancements, and accomplish assessments of current conditions and limiting factors for bull trout populations in the Yakima River basin to improve the effectiveness of future enhancement actions.

The storage capacity of Kachess Reservoir is greater than the runoff in the Kachess watershed. Because of this, Kachess Reservoir does not refill in some years, especially after droughts, creating a need for additional inflow to the reservoir. On the other hand, total available runoff in the Keechelus watershed is greater than the storage capacity of Keechelus Reservoir. Consequently, this water is released down-river during the spring runoff period and is not utilized for total water supply available (TWSA) or targeted for fish benefits.

TWSA is defined as:

> *That amount of water available in any year from natural flow of the Yakima River, and its tributaries, from storage in the various Government reservoirs on the Yakima River watershed and from other sources, to supply the contract obligations of the United States to the Yakima River and its tributaries* (Civil Action No. 21 (1945 Consent Decree) Article 4, 1st Para.).

During the irrigation season, releases of stored water from Keechelus Reservoir create undesirably high flows in the Keechelus reach of the Yakima River that affect rearing habitat for steelhead and spring Chinook. As part of Reclamation's operation of the Yakima Project, these releases are necessary to meet contractual obligations to various water users. An alternative means to convey water stored in Keechelus Reservoir to points of diversion farther down the system would enable Reclamation to reduce high flows in the Yakima River and improve fish habitat while meeting contractual obligations.

Reclamation's Federal actions would be to construct, operate, and maintain one of the alternatives evaluated in this EIS. These Federal actions that require review under NEPA, and are the focus of this EIS. Reclamation's decisions that will rely upon the analysis presented in this EIS and supporting documents are:

- Determination that the feasibility of alternatives to provide additional water for irrigation needs and improve habitat below Keechelus Dam and evaluation of those alternatives under NEPA is complete.
- Determination that Reclamation will or will not pursue a recommendation for congressional action to authorize or fund the implementation of an alternative or combination of alternatives.
- If Reclamation decides to pursue a recommendation for congressional action for authorization or funding, which alternative or combination of alternatives will be recommended.

Ecology's State actions will be to participate financially, issue permits as required, and issue water rights as necessary for one of the alternatives evaluated in this EIS. These State actions require review under SEPA in this EIS.

Alternatives

Alternative 1 – No Action

The No Action Alternative represents the most likely future in the absence of implementing any of the proposals that are part of the Proposed Action. The No Action Alternative forms the baseline for comparison of potential impacts of the Proposed Action and its alternatives. Under *Alternative 1 – No Action*, Reclamation and Ecology would not implement the Proposed Action. Reclamation would continue to manage water supply provided by Kachess and Keechelus reservoirs consistent with current operational practices and constraints. The current operations served as the basis for analyzing impacts of the Proposed Action.

For the purpose of this DEIS, Reclamation and Ecology consider the *Alternative 1 – No Action* to include the following:

- Planned and designed projects
- Authorized projects that have identified funding for implementation
- Projects scheduled for implementation

The following projects meet the criteria for No Action.

YRBWEP Phase II

The Yakima River Basin Water Enhancement Project Act of 1994, commonly referred to as YRBWEP Phase II, provides for a water conservation program with joint Federal and State funding coupled with local matches. The program provides economic incentives to implement structural and nonstructural water conservation measures. As required by YRBWEP Phase II, a Conservation Advisory Group and Reclamation completed a *Basin Conservation Plan* in 1998, and implementation of conservation measures identified in the plan is ongoing (Yakima River Basin Conservation Advisory Group, 1998). *Alternative 1 – No Action* includes those conservation measures currently being implemented. The *Basin Conservation Plan* also includes limited provisions to acquire land and water rights on a permanent and temporary basis to improve instream flows.

On-going YRBWEP Phase II projects that fit the criteria in Section 2.3.2 are:

- Roza Irrigation District Reregulation Reservoir which will conserve 8,584 acre-feet annually when construction is completed and it is operational in 2016.
- Sunnyside Division Board of Control Phase IIB Enclosed Lateral Improvement Projects which will conserve 6,461 acre-feet annually when construction is completed and it is operational in 2032.

WSDOT I-90 Snoqualmie Pass East Phase 2A

Another project that meets the no action criteria is the Washington State Department of Transportation’s (WSDOT) I-90 - Snoqualmie Pass East Phase 2A - Keechelus Dam Vicinity to the Stampede Pass Interchange project. As part of this project, WSDOT and the Federal Highway Administration (FHWA) will replace a 2.1-mile section (milepost 59.9 to 62.0) of existing interstate highway with a new six-lane highway, add a new chain-up area, stabilize rock slopes, remove and reclaim the Price Noble Creek Rest Area and sno park, and construct a wildlife over-crossing near Price Noble Creek. Construction is scheduled to begin in spring 2015 with completion planned for fall 2019. WSDOT evaluated the impacts of this project in the *I-90 - Snoqualmie Pass East Final EIS and Section 4(f) Evaluation* (WSDOT, 2008).

Alternative 2A – KDRPP East Shore Pumping Plant

KDRPP East Shore Pumping Plant Facilities

KDRPP consists of a series of facilities to pump water from Kachess Reservoir and convey it to the Kachess River, which discharges to the Yakima River at Lake Easton. KDRPP would allow the reservoir to be drawn down to about elevation 2,110, approximately 80 feet lower than the current outlet and 152 feet below full pool by using a pumping plant. This would allow access to up to an additional 200,000 acre-feet of water that is currently stored in the reservoir below the elevation of the existing outlet (elevation 2,192.75).

The pumping plant would be used to deliver up to 200,000 acre-feet of water during drought years to downstream Yakima Project irrigation districts, including Kittitas Reclamation District (KRD), Roza Irrigation District (RID), and the Wapato Irrigation Project (WIP)[6]. Reclamation and Ecology define a drought year as a year when water supply falls below 70 percent of proratable water rights. KDRPP would enable delivery of enough water to contribute to increasing prorationing up to 70 percent. As described in Section 1.3 of the Integrated Plan PEIS, 70 percent would provide a water supply sufficient to prevent severe economic losses to proratable water rights users (Reclamation and Ecology, 2012).

Reclamation would use the pumping plant during drought years and could possibly use it in following years as the reservoir is refilling to a level above the existing gravity outlet. This would result in the reservoir being drawn down to the gravity outlet level (elevation 2,110) by about August in drought years. KDRPP would deliver water stored in Kachess Reservoir throughout the remainder of the water year and until the reservoir refills above the gravity outlet level. At the proposed rate of 1,000 cfs, it would take about 101 days to pump the entire 200,000 acre-feet of stored water that is below the elevation of the existing outlet. Section 4.3 includes information about expected reservoir levels under operation of KDRPP.

Alternative 2A – KDRPP East Shore Pumping Plant includes a mostly underground pumping plant located on the east shore of Kachess Reservoir (Figure ES-1). The pumping plant would receive water via a tunnel from an intake located on the floor of the reservoir.

[6] Kennewick Irrigation District is also considering participating in the KDRPP proposal.

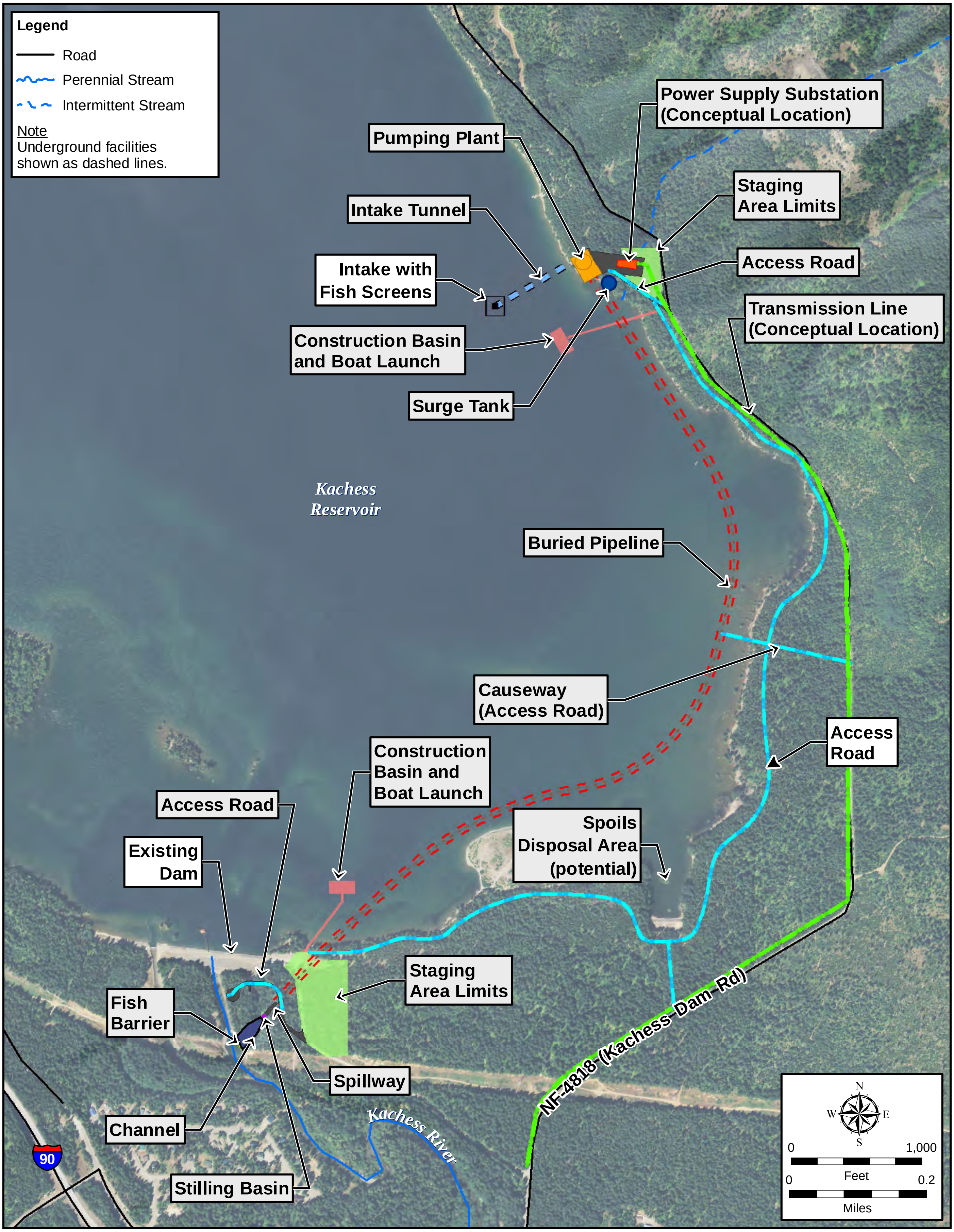

Figure ES-1. ***Alternative 2A – KDRPP East Shore Pumping Plant*** **Overview**

A pipeline located on the reservoir bed would convey water from the pumping plant to a spillway and discharge structure located just downstream from the existing Kachess Dam outlet channel, where it would be released to the Kachess River. The pumping plant would require power which would be supplied via a connection with an existing Puget Sound Energy substation in Easton.

Bull Trout Enhancement

Reclamation and Ecology are developing a Memorandum of Understanding (MOU) with the Service, National Marine Fisheries Service (NMFS), USFS, Washington Department of Fish and Wildlife (WDFW), and the Yakama Nation to implement bull trout enhancement (BTE) to enhance the resiliency of bull trout populations in the Yakima River basin. The BTE is included as a component of all the action alternatives evaluated in this DEIS. The BTE includes actions to enhance bull trout habitat as well as assessments of future efforts to enhance bull trout populations. This DEIS evaluates proposed stream channel and floodplain restoration at Gold Creek and stream passage improvement at Cold Creek. Both creeks are tributaries of Keechelus Reservoir.

The BTE includes habitat restoration and enhancement actions at Gold Creek and Cold Creek, studies of improved bull trout passage for Kachess Reservoir tributaries (Kachess River and Box Canyon Creek), studies of fish passage improvements on the South Fork Tieton River, and assessments of bull trout population enhancements and nutrient enhancement in Kachess and Keechelus reservoirs. This DEIS evaluates the impacts of the actions proposed at Gold and Cold creeks (Figure ES-2). If the studies and assessments of the other BTE actions recommend implementation of specific actions, Reclamation and Ecology would undertake additional NEPA and SEPA analysis and obtain regulatory approvals, including ESA consultation.

Habitat restoration and enhancement to address dewatering of Gold Creek include:

- Improving the stream channel
- Reconfiguring Gold Creek Pond and regarding berms surrounding the pond to reduce stream dewatering
- Filling Heli’s Pond and its outlet channel

Reclamation and Ecology would partner with the USFS to replace the bridge on USFS Road NF-4832 to restore the Gold Creek floodplain, a project for which the USFS has already prepared a NEPA Environmental Assessment (EA) and Finding of No Significant Impact (USFS, 2011a and 2011d). The new Gold Creek USFS Bridge would span the floodplain of Gold Creek (approximately 725 feet wide) and would provide the following benefits: improved hydrologic connectivity, lower stream velocities, improved channel migration, floodplain restoration, restored capacity for sediment transport, reduced sediment and temperature, and improved groundwater flow.

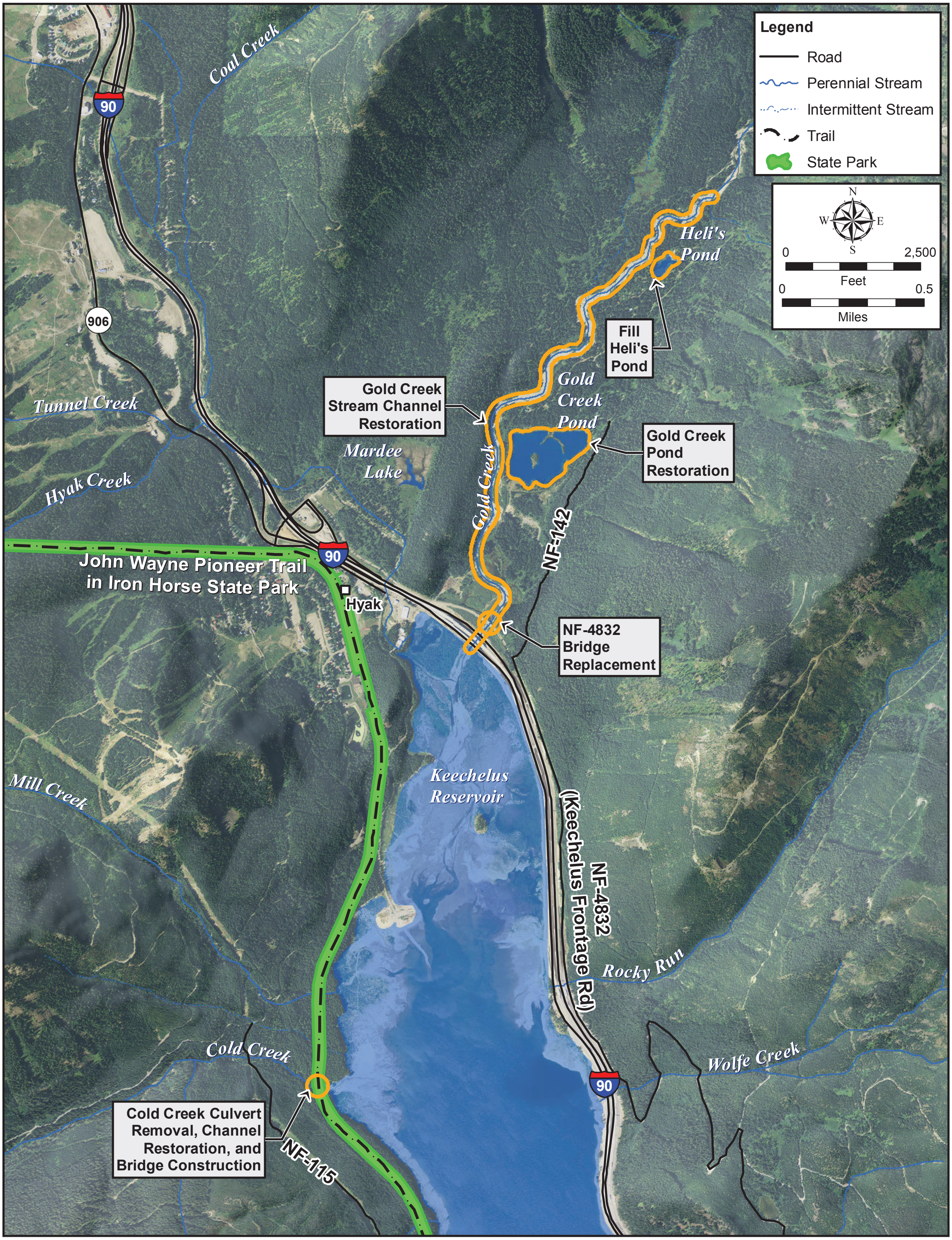

Figure ES-2. Bull Trout Enhancement Area at Gold Creek and Cold Creek

At Cold Creek, Reclamation and Ecology would remove the existing passage barrier at the mouth of the creek to allow bull trout access to the stream. The project would include excavating the John Way Pioneer Trail to remove the existing concrete culvert and building a new bridge to accommodate the trail. The project would include regrading the stream and habitat restoration.

Mitigation

Reclamation and Ecology would provide mitigation for impacts associated with *Alternative 2A – KDRPP East Shore Pumping Plant.* Specific mitigation measures are described in Chapter 4 at the end of each resource section. Reclamation and Ecology would also comply with the environmental commitments for the Proposed Action as described below.

Alternative 2B – KDRPP South Pumping Plant

KDRPP South Pumping Plant Facilities

Alternative 2B – KDRPP South Pumping Plant Alternative is similar to *Alternative 2A* except that the intake and pumping plant would be located at the south end of the reservoir downstream from Kachess Dam and adjacent to the Kachess River (Figure ES-3). The proposed south pumping plant would be adjacent to the existing outlet works discharge pool, just downstream from the existing Kachess Dam outlet channel, where the water would be released to the Kachess River. Thus a pipeline between the pumping plant and outlet works would not be needed.

Bull Trout Enhancement

The BTE projects would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant.*

Mitigation

Reclamation and Ecology would provide mitigation for impacts associated with *Alternative 2B – KDRPP South Pumping Plant.* Specific mitigation measures are described in Chapter 4 at the end of each resource section. Reclamation and Ecology would also comply with the environmental commitments for the Proposed Action as described below.

Alternative 3A – KKC North Tunnel Alignment

KKC North Tunnel Alignment Facilities

KKC consists of an underground tunnel to convey water from Keechelus Reservoir to Kachess Reservoir. This would allow Reclamation to reduce flows in the upper Yakima River, thereby improving rearing habitat for steelhead and spring Chinook, and improving the ability to refill Kachess Reservoir following drought years. The proposed conveyance extends east from the Keechelus Dam outlet and discharges on the west shore of Kachess Reservoir.

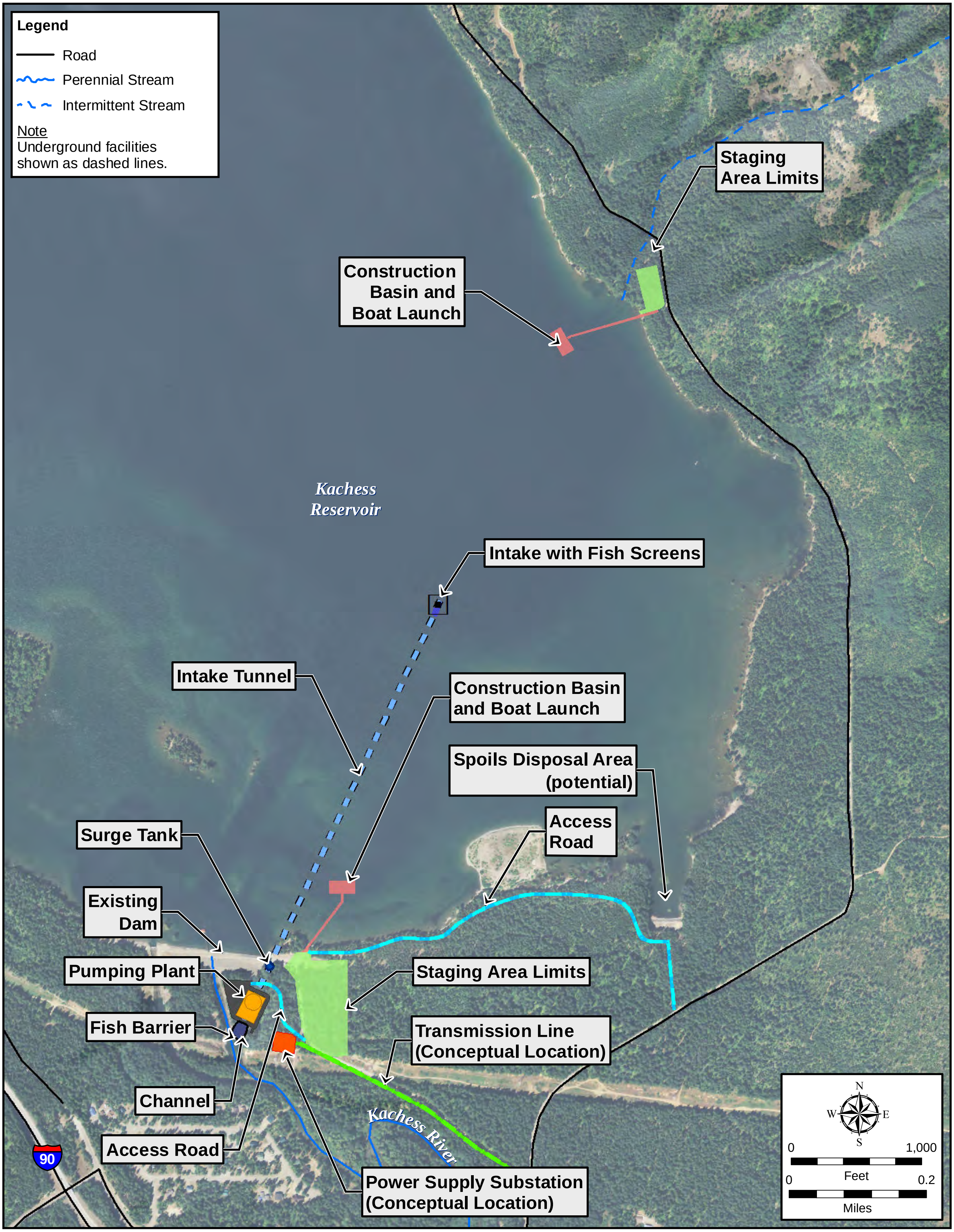

Figure ES-3. ***Alternative 2B – KDRPP South Pumping Plant*** **Overview**

Reclamation would operate KKC by diverting water by gravity flow from the Yakima River downstream of Keechelus Reservoir to the Kachess Reservoir. Reclamation would transfer flows in all years when Keechelus Reservoir is above its target pool elevation and Kachess Reservoir is below target pool elevation. Under existing conditions, flows released from Keechelus Reservoir are too high in summer months to provide habitat for anadromous fish. This proposal would reduce flows in July and August and provide a more gradual reduction in flows until September.

This DEIS evaluates two alternatives for KKC: *Alternative 3A – KKC North Tunnel Alignment* and *Alternative 3B – KKC South Tunnel Alignment*. The alternatives primarily differ in how the tunnel and portals are configured. Reclamation would operate KKC the same, regardless of the location of the facilities.

The *Alternative 3A – KKC North Tunnel Alignment* extends east from the Keechelus Dam area to an outlet on the west shore of Kachess Reservoir (Figure ES-4). The tunnel is a single segment tunnel that would be excavated upgradient from a portal at Kachess Reservoir. The tunnel design evaluated in this DEIS curves slightly to the south to avoid a rock formation that would require deep excavation to install the tunnel. Additional geotechnical information (expected spring 2015) would be considered in selecting the tunnel route. This DEIS assumes the curved tunnel alignment because it represents a worst-case scenario for environmental analysis. All of the facilities would be same regardless of whether the curved or straight tunnel alignment is selected.

Bull Trout Enhancement

The BTE projects would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant.*

Mitigation

Reclamation and Ecology would provide mitigation for impacts associated with *Alternative 3A – KKC North Tunnel Alignment.* Specific mitigation measures are described in Chapter 4 at the end of each resource section. Reclamation and Ecology would also comply with the environmental commitments for the Proposed Action as described below.

Alternative 3B – KKC South Tunnel Alignment

KKC South Tunnel Alignment Facilities

Alternative 3B – KKC South Tunnel Alignment is similar to *Alternative 3A – KKC North Tunnel Alignment.* All of the facilities located in the Keechelus Dam area would be the same as proposed for *Alternative 3A – KKC North Tunnel Alignment* (Sections 2.6.1.1 through 2.6.1.4). The tunnel would start at the Keechelus Reservoir portal, but would be located further south than for *Alternative 3A*, discharging into Kachess Reservoir at the Kachess Reservoir portal just to the south of the portal proposed for *Alternative 3A* (Figure ES-5). In order to reduce truck traffic on Kachess Lake Road and eliminate the need to relocate that road, the access portal for construction would be located near the I-90 Exit 62 Stampede Pass interchange. Construction from this portal would be done in two segments, one extending northwest to the Keechelus portal and one extending northeast to the Kachess Reservoir outlet. *Alternative 3B* also includes the BTE activities identified in *Alternative 2A*, Section 2.4.5.

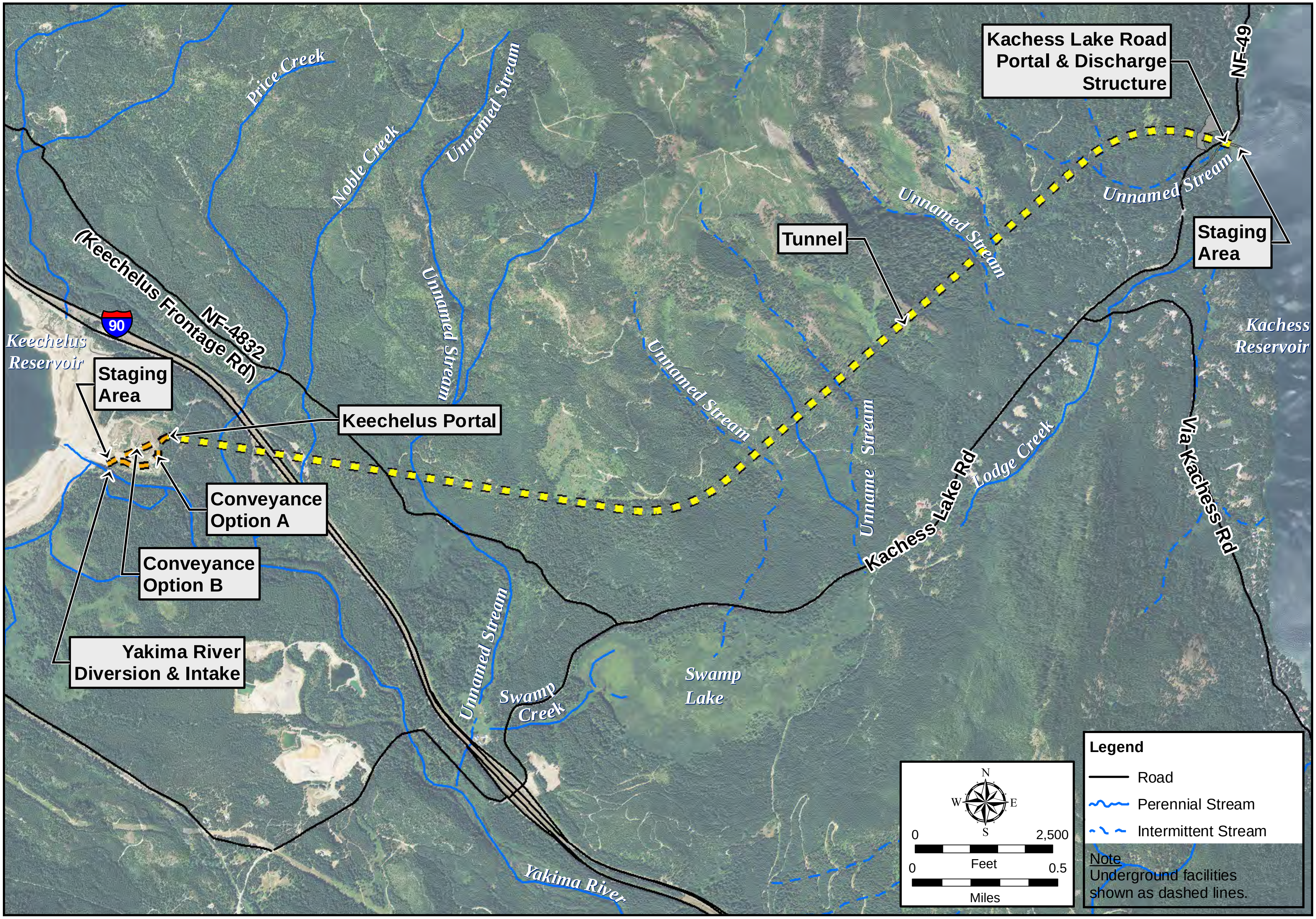

Figure ES-4. ***Alternative 3A – KKC North Tunnel Alignment*** **Overview**

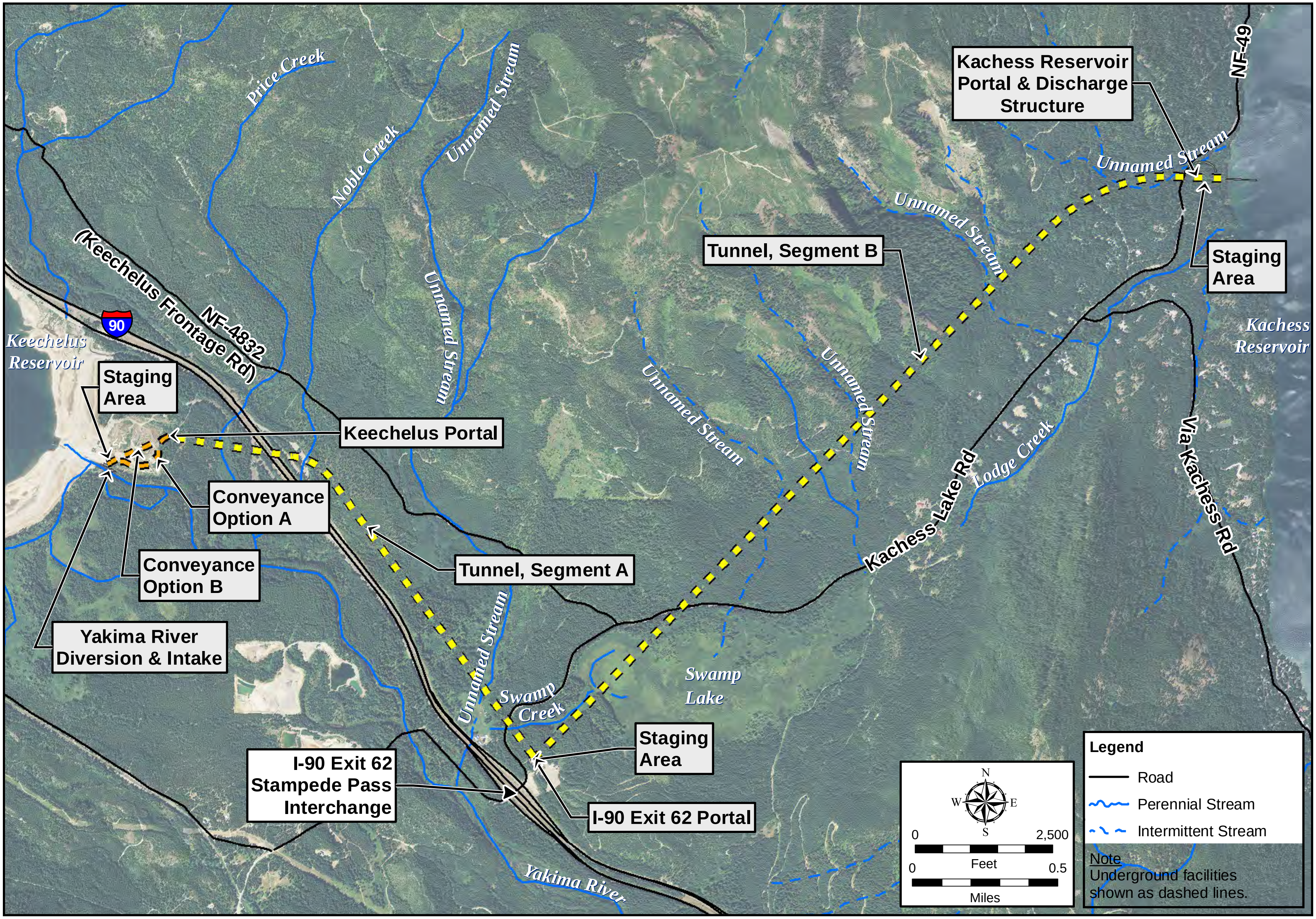

Figure ES-5. ***Alternative 3B – KKC South Tunnel Alignment*** **Overview**

Bull Trout Enhancement

The BTE projects would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant.*

Mitigation

Reclamation and Ecology would provide mitigation for impacts associated with *Alternative 3B – KKC South Tunnel Alignment.* Specific mitigation measures are described in Chapter 4 at the end of each resource section. Reclamation and Ecology would also comply with the environmental commitments for the Proposed Action as described below.

Alternative 4 – Combined KDRPP and KKC

Combined KDRPP and KKC Facilities

Under *Alternative 4 – Combined KDRPP and KKC*, Reclamation and Ecology would implement the KDRPP and KKC together to provide more flexible water management. In addition to allowing Reclamation to reduce artificially high flows in the Keechelus Reach, combined operation of KDRPP and KKC would speed up refill of Kachess Reservoir after it has been drawn down in drought years under KDRPP. The facilities and construction processes for each component would be the same as described for *Alternatives 2A* or *3B* and *Alternatives 3A* or *3B* and Reclamation and Ecology.

Bull Trout Enhancement

The BTE projects would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant.*

Mitigation

Reclamation and Ecology would provide mitigation for impacts associated with *Alternative 4 –Combined KDRPP and KKC.* Specific mitigation measures are described in Chapter 4 at the end of each resource section. Reclamation and Ecology would also comply with the environmental commitments for the Proposed Action as described below.

Summary of Environmental Consequences

Chapter 4 of the DEIS describes the environmental consequences of the alternatives, including the No Action Alternative as well as mitigation measures for potential impacts. Table ES-1 provides a summary of impacts and benefits associated with the No Action and four action alternatives.

All of the action alternatives include major construction impacts including increased dust, vehicle emissions, noise, and traffic on local roadways and I-90. Construction, including removal of vegetation, would temporarily disrupt fish and wildlife, including Endangered Species Act listed bull trout and northern spotted owl. Construction at Kachess Reservoir and Gold and Cold creeks would temporarily disrupt the usability and quality of recreation. Construction could also damage or alter identified National Register of Historic Places sites.

KDRPP (*Alternatives 2A* and *2B*) would increase water supply to proratable irrigation districts from 19 to 23 percent and bring the supply close to the 70 percent of entitlements goal. KDRPP would lower the level of Kachess Reservoir by up to 80 feet, which would impact fish access to reservoir tributaries and the upper Kachess basin. Lower reservoir levels would increase slope stability risks on the reservoir rim and could impact water quality by increasing water temperature and decreasing dissolved oxygen. Lower reservoir levels could also cause lower groundwater levels, negatively impacting water supply for residents. The reservoir drawdown would negatively impact visual quality and recreation by exposing a large area of reservoir bed and making the existing boat launches unusable. Stream restoration at Gold and Cold creeks would alter the character or recreation at Gold Creek Pond and the Cold Creek segment of the John Wayne Pioneer Trail.

KKC (*Alternatives 3A* and *3B*) would reduce artificially high flows in the Keechelus Reach of the Yakima River, improving habitat for anadromous fish. KKC would cause a minimal increase in water supply for proratable irrigation districts. Fluctuations in water levels in Kachess Reservoir would reduce connectivity between the reservoir and tributary habitats. Transferring water from Keechelus Reservoir to Kachess Reservoir could introduce contaminants such as PCBs to Kachess Reservoir.

Combined operation of KDRPP and KKC (*Alternative 4*) would have the same impacts as the individual projects, but would provide a greater benefit to proratable water supply than KDRPP alone and KKC would help refill Kachess Reservoir more rapidly following operation of KDRPP.

Under all action alternatives, the BTE would improve habitat for bull trout, other fish, and wildlife in the Gold and Cold creek areas. Improvements would increase streamflows, improve fish passage, and provide a surface water connection between the creeks and Keechelus Reservoir.

Table ES-1. Summary Comparison of Impacts

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Earth					
Shoreline erosion, if any and seismic hazards would continue as under existing conditions.	<u>Construction</u>: Erosion during construction and seismic and slope stability risks not significant impacts. <u>Operation</u>: Increased risk of slope stability on the reservoir rim. Long-term erosion not significant.	Same as *Alternative 2A*.	<u>Construction</u>: Erosion during construction and seismic and slope stability risks not significant impacts. <u>Operation</u>: Long-term erosion not significant.	Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.
Surface Water Resources					
There would be a continued inadequacy of water supply for proratable irrigators in drought years. Summer streamflows in the Keechelus Reach would remain artificially high. When Keechelus Reservoir level falls below elevation 2,466, tributary access for bull trout would be adversely impacted for approximately 115 days in 81 percent of years. This would be a significant impact to fish passage. The pool elevation would remain within the current operating range of the reservoir.	<u>Construction</u>: Construction would not affect water resources. <u>Operation</u>: Water supply to proratable water users would be improved significantly by 19 to 23 percent in drought years, raising the proration to about 64 percent of entitlement. In multiple drought years, the improvement would be less. Keechelus Reservoir would be operated to help Kachess Reservoir refill following a drought. This would result in a slightly lower mean Keechelus Reservoir pool level, with a maximum reservoir drawdown of 15 feet in late summer. When Keechelus Reservoir level falls below elevation 2,466, bull trout access to tributaries is adversely impacted. This would at the same frequency as the No Action, but for a longer duration. However, the pool elevation would remain within the current operating range of the reservoir and would not significantly affect Keechelus Reservoir operations. Kachess Reservoir would be drawn down by as much as 80 feet below existing low pool conditions and take 2 to 5 years following a drought to refill. The drawdown of Kachess Reservoir would increase the occurrence and duration of reservoir pool levels below elevation 2,220. Below that elevation, fish cannot pass between the Kachess and Little Kachess basins, significantly impacting fish passage. Relative to *Alternative 1*, this would occur 5 percent more often and the duration would increase by 56 days during those years. The drawdown of Kachess Reservoir would increase the duration of reservoir levels below elevation 2,226—the level at which access for bull trout to tributary streams is significantly impacted. Frequency would be the same as *Alternative 1*, but duration would increase by 44 days (from means of 109 to 153) during those years.	Same as *Alternative 2A*.	<u>Construction</u>: There would be no impacts from construction. <u>Operation</u>: *Alternative 3A* would yield a minimal improvement in water supply to proratable users in drought years, but not enough to be significant. During post-drought years, Keechelus Reservoir maximum pool elevations would be lower and minimum elevations higher. Keechelus Reservoir levels would fall below 2,466 in 10 percent fewer years than *Alternative 1* and for 15 fewer days during those years. This would be a significant benefit to fish passage. The pool elevation would remain within the current operating range of the reservoir, and would not significantly affect Keechelus Reservoir operations. Summer streamflows in the Keechelus Reach would be reduced by 400 cfs, greatly improving fish habitat conditions. Streamflow changes in other Yakima River reaches would not have significant effects because flow would remain within current operating ranges. Streamflow in the Kachess River would change, but would fall within current operating ranges; thus no significant effect would result. The BTE would improve streamflow in Gold and Cold creeks during late summer and fall, when Keechelus Reservoir water levels are at their lowest. The BTE would provide a surface water connection from the streams to the reservoir pools, providing better seasonal passage conditions for bull trout and significantly benefiting fish passage.	Same as *Alternative 3A*.	<u>Construction</u>: Construction would not affect water resources. <u>Operation:</u> Proratable water supply would be increase to about 66 percent of entitlement during single drought years. In multiple drought years, the improvement would be less. Keechelus Reservoir would be operated to help Kachess Reservoir refill following a drought. This would result in a slightly lower mean Keechelus Reservoir pool level, with a maximum reservoir drawdown of 15 feet in late summer. Keechelus Reservoir level would fall below elevation 2,466 approximately 130 days in 74 percent of years, significantly adversely impacting tributary access for bull trout. The pool elevation would remain within the current operating range of the reservoir and would not significantly affect Keechelus Reservoir operations. Kachess Reservoir would be drawn down by as much as 80 feet below existing low pool conditions. It would take 2 to 5 years following a drought for Kachess Reservoir to refill to normal operating levels. The drawdown of Kachess Reservoir would increase the occurrence and duration of reservoir pool levels below elevation 2,220. Below that elevation, fish cannot pass between the Kachess and Little Kachess basins, significantly impacting fish passage. Relative to *Alternative 1*, this would occur 5 percent more often and the duration would increase by 56 days during those years. The drawdown of Kachess Reservoir would increase the duration of reservoir levels below elevation 2,226—the level at which access for bull trout to tributary streams is significantly impacted. Frequency would be the same as *Alternative 1*, but duration would increase by 44 days during those years.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
	Streamflow changes in Yakima River reaches would not have significant effects because flow would remain within current operating ranges. Streamflow in the Kachess River would change, but would be within current ranges; thus would not be significant. The BTE would improve streamflow in Gold and Cold creeks during late summer and fall, when Keechelus Reservoir water levels are at their lowest. The BTE would provide a surface water connection from the streams to the reservoir pools, providing better seasonal passage conditions for bull trout and significantly benefiting fish passage.				Summer streamflows in the Keechelus Reach would be reduced by 400 cfs, significantly improving habitat conditions for fish. Streamflow changes in other Yakima River reaches and the Kachess River would be within current operating ranges.
Surface Water Quality					
No changes would occur to current reservoir operations, reservoir levels, or streamflows that would affect water quality. If a severe long-term drought occurs, or conditions worsen because of climate change, water levels in reservoirs could significantly drop and, with warmer air temperatures, affect long-term water quality conditions for such parameters as DO and water temperature.	<u>Construction</u>: During construction, oil, grease, total petroleum hydrocarbons, suspended sediment, nutrients, and construction wastewater could enter receiving water. With BMPs the potential for contamination would be minimized. <u>Operation</u>: Lower reservoir pool levels during drought and post-drought recovery periods could cause turbidity, temperature, and DO in the Kachess Reservoir to be out of compliance with State surface water quality standards. No long-term significant impacts would be expected because suspended material would be localized and settle out as the reservoir bed stabilizes. After a drought and its recovery, the potential for water heating and depressed DO concentrations would diminish. If a severe long-term drought occurs or conditions worsen because of climate change, water levels in the reservoir could drop significantly, affecting DO and water temperatures resulting in potentially significant impacts. Exceedance of the State standard for temperature and turbidity may occur at the outlet to Kachess River during extended drought and drought recovery. No long-term water quality impacts are expected from the BTE. Stream restoration may help to lower peak water temperatures and improve DO conditions by improving the depth and flow conditions in Gold Creek.	Same as *Alternative 2A*.	<u>Construction</u>: Same as *Alternative 2A*. <u>Operation</u>: Operations would not cause an increase in sedimentation, turbidity, temperature, nutrients, fecal coliform bacteria, or TDG, or a decrease in DO. If a severe long-term drought occurs or conditions worsen because of climate change, water levels in the reservoirs could drop, affecting long-term water quality conditions in Kachess Reservoir for DO and temperature. Water quality in Kachess Reservoir could be modified by the introduction of contaminants from Keechelus Reservoir inflow. No long-term water quality impacts are expected from operation of the BTE following construction. Stream restoration may help to lower peak water temperatures and improve DO conditions by improving the depth and flow conditions in Gold Creek.	Same as *Alternative 3A*.	<u>Construction</u>: Same as *Alternatives 2A* and *3A*. <u>Operation</u>: During nondrought conditions, water quality impacts would be similar to those described for *Alternative 3A*. During drought and drought recovery years, water quality impacts on Kachess Reservoir and Kachess River due to lower Kachess Reservoir pool levels would be similar to those described for *Alternative 2A*. Water quality impacts on the Keechelus Reach of the Yakima River would be similar to those described for *Alternative 3A*. During drought recovery, Keechelus Reservoir pool elevations may be lower than existing conditions, potentially resulting in more surface heating during the summer months as the reservoir pool level recovers. No long-term water quality impacts are expected from operation of the BTE following construction. Stream restoration may help to lower peak water temperatures and improve DO conditions by improving the depth and flow conditions in Gold Creek.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Groundwater					
Impacts to groundwater would be the same as under existing conditions.	Construction: Groundwater levels and wells would not be impacted. Inadvertent spills may affect groundwater quality but would be minimized by utilizing BMPs. Operation: Operation may result in decreased groundwater levels in aquifers adjacent to the reservoirs, potentially decreasing the water supply to wetlands, springs, streams, or wells.	Same as *Alternative 2A*.	Construction: There may be temporary impacts to groundwater levels or wells from dewatering. Inadvertent spills may affect groundwater quality but would be minimized by utilizing BMPs. Operation: Operation would not impact groundwater contributions to streams, springs, wetlands or wells.	Same as *Alternative 3A*.	Same as *Alternative 2A* and *3A*.
Fish					
Existing passage problems in the reservoirs would continue. Artificially high streamflows in the Keechelus Reach would continue to provide unsuitable habitat for anadromous fish. Climate change may influence prey availability, decrease habitat complexity and connectivity, increase river and reservoir temperatures, and may lead to less operational flexibility to meet instream flow requirements.	Construction: Construction would reduce shoreline vegetation adjacent to Kachess Reservoir. Temporary increases in turbidity would occur during construction. During construction, increased noise levels may disturb fish. Blasting may be required, thus noise levels could be significant. Operation: *Water temperature* – Reduction in Kachess Reservoir minimum pool elevation may increase water temperatures in Kachess Reservoir. *Turbidity* - Reduction in Kachess Reservoir minimum pool elevation would expose the lower reservoir bed to wave action and increase turbidity. *Food based prey* - Available prey would be reduced in both reservoirs. *Habitat complexity* - Reduction in Kachess Reservoir minimum elevation and lower Keechelus Reservoir levels after drought years would reduce shoreline vegetation and habitat complexity. Lower reservoir levels after drought years would reduce shoreline vegetation and habitat complexity within Keechelus Reservoir. *Habitat connectivity* - Reduction in Kachess Reservoir minimum pool elevation would reduce connectivity between reservoir habitats as well as between reservoir and tributary habitats. Lower Keechelus Reservoir levels after drought years would reduce connectivity between reservoir and tributary habitats. The BTE would increase habitat connectivity between reservoir and tributary habitat in Keechelus Reservoir. *Entrainment* - Increased risk of entraining resident fishes with small larval stages in the new intake in Kachess Reservoir.	Construction: Same as *Alternative 2A*, but noise disturbance would be less than *Alternative 2A*. Operation: Impacts to temperature, food based prey, habitat connectivity, and entrainment would be the same as *Alternative 2A*. *Habitat complexity* – Impacts the same as *Alternative 2A*, but the footprint of *Alternative 2B* is smaller.	Construction: During construction increased noise levels and turbidity may disturb fish. Operation: *Food based prey* - Available prey would be reduced in Kachess Reservoir, but would increase within Keechelus Reservoir. *Habitat complexity* - Greater fluctuations in Kachess Reservoir level would reduce shoreline vegetation and habitat complexity. Smaller fluctuations in Keechelus Reservoir level would increase shoreline vegetation and habitat complexity. *Habitat connectivity* - Lower reservoir levels would reduce connectivity between reservoir and tributary habitats in Kachess Reservoir. Reduced frequency and duration of passage impediments would increase connectivity between reservoir and tributary habitats in Keechelus Reservoir. The BTE would increase habitat connectivity between reservoir and tributary habitat in Keechelus Reservoir. *River flow* - Summer instream flows in the Yakima River would meet targets in most years and increase salmon production and resident fish habitat in the Keechelus Reach. *Transmission of disease or invasive species* - The conveyance of water would increase the risk of transmitting diseases and exotic species to Kachess Reservoir.	Same as *Alternative 3A*.	Construction: Same as *Alternatives 2A* and *3A*. Operation: *Temperature* – Reduction in Kachess Reservoir minimum pool elevation may increase water temperatures in Kachess Reservoir. Following drought years, reductions in Keechelus Reservoir pool elevation may increase water temperatures in Keechelus Reservoir. *Turbidly* – Reduction in Kachess Reservoir minimum pool elevation would expose the lower reservoir bed to wave action and increase turbidity. *Food based prey* - Available prey would be reduced in Kachess Reservoir but only available zooplankton prey would be reduced within Keechelus Reservoir. Impacts to habitat complexity, connectivity and entrainment would be the same as *Alternative 2A*. Impacts to nutrients and river flow, as well as impacts from transmission of disease or invasive species would be the same as *Alternative 3A*.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Vegetation and Wetlands					
There would result in a net benefit to wetlands and vegetation in the extended study area, associated with proposed mitigation for the I-90 Phase 2A project.	Construction: Temporary loss of riparian and upland vegetation would not be significant. Operation: Prolonged drawdown of Kachess Reservoir may result in establishment of invasive species and changes to wetland hydrology and vegetation communities during drought years. This would not be significant with the implementation of invasive species control and wetland mitigation. There would be a permanent loss of less than 1 acre of wetland, which would be mitigated to ensure no net loss. Permanent loss of riparian and upland vegetation would not be significant. The BTE would benefit up to 30 acres of wetlands in the Gold Creek drainage.	Same as *Alternative 2A*.	Construction: Temporary loss of riparian and upland vegetation would not be significant. There may be temporary impacts to wetlands from dewatering. Operation: No net loss of wetlands. Permanent loss of riparian and upland vegetation would not be significant. The BTE would have a beneficial impact on up to 30 acres of wetlands in the Gold Creek drainage.	Construction: Same as *Alternative 2A*. Operation: Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.
Wildlife					
Wildlife conditions would remain similar to existing conditions, but wildlife would benefit from the ongoing wildlife connectivity improvements of the I-90 Phase 2A project.	Construction: Impacts to habitat are significant for localized species with small home ranges and not significant for transient species that occupy the larger watershed. Permanent habitat loss would be 18 acres. Disturbances to wildlife from construction activities or noise are considered significant. Impacts from the BTE would be positive or negative depending on the species. Operation: Disturbance from noise, light or human activities are not significant.	Construction: Same as *Alternative 2A*, except habitat loss would be 8 acres. Operation: Same as *Alternative 2A*.	Construction: Same as *Alternative 2A*, except habitat loss would be 4 acres. Operation: Same as *Alternative 2A*.	Construction: Same as *Alternative 2A*, except habitat loss would be 1.5 acres. Operation: Same as *Alternative 2A*.	Construction: Same as *Alternative 2A* and *3A*, except habitat loss would be 8 to 22 acres, depending on which combination of KDRPP and KCC is chosen. Operation: Same as *Alternative 2A*.
Threatened and Endangered Species					
Habitat conditions would be similar to existing conditions. Climate change could exacerbate existing negative bull trout habitat conditions as well as limit Reclamation's flexibility to meet instream flow requirements for bull trout and MCR steelhead. Habitat connectivity improvements associated with the I-90 Phase 2A project would improve conditions for bull trout and northern spotted owl.	Construction: There would be significant loss of habitat that supports the northern spotted owl. *Alternative 2A* would have the largest area of vegetation removal. Increased noise is not expected to result in harm or injury to northern spotted owl; however, it may cause disturbance behaviors. Turbidity from construction may negatively impact bull trout and MCR steelhead. Operation: The BTE would improve habitat for bull trout. There would be no other operational impacts on threatened and endangered species.	Same as *Alternative 2A*, except vegetation loss and noise impacts would be less.	Same as *Alternative 2A*, except vegetation loss and noise impacts would be less than *Alternatives 2A* and *2B*.	Same as *Alternative 2A*, except vegetation loss and noise impacts would be less than *Alternatives 2A*, *2B*, and *3A*.	Same as *Alternative 2A* and *3A*.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Visual Quality					
There would be no changes to visual quality.	Construction: There would be no significant impacts from construction. Operation: Kachess Reservoir drawdowns during drought years would have significant impacts due to changes in overall landscape character and desirability from a recreation perspective. The drawdown would potentially conflict with scenic integrity and visual quality objectives. The east shore pumping plant would have a significant impact because it would substantially contrast with and interrupt the visual character and integrity of the landscape.	Construction: There would be no impacts from construction. Operation: Kachess Reservoir drawdowns during drought years would have significant impacts due to changes in overall landscape character and desirability for recreation. The drawdown would potentially conflict with scenic integrity and visual quality objectives. New facilities would not contrast with or interrupt the visual character and integrity of the landscape.	Construction: There would be no significant impacts from construction. Operation: New facilities would not contrast with or interrupt the visual character and integrity of the landscape.	Same as *Alternative 3A*.	Same as *Alternative 2A*, *2B*, *3A*, or *3B* depending on which combination of KDRPP and KKC is chosen.
Air Quality					
Impacts to air quality would not increase over existing conditions.	Construction: Construction would result in increased emissions and fugitive dust throughout construction, but would not be significant. Operation: Emissions and fugitive dust would not have a significant impact on sensitive receptors.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternatives 2A* and *3A*.
Climate Change					
There would be no significant production of GHGs. Climate change could adversely impact operation of the reservoirs because of changes in runoff timing and volume.	Construction: There would be no significant production of GHGs. Operation: There would be no significant production of GHGs. Climate change predictions indicate that Reclamation would need to increase operation of KDRPP. This is not considered a significant impact because KDRPP would still contribute to increasing water supply. The effects of climate change would decrease winter, spring, and fall attainment of instream flow targets. Summer attainment of instream flow targets in the Keechelus Reach of the Yakima River would be improved by the effects of climate change. These impacts are not considered significant. Climate change effects could offset some of the potential benefits of the BTE, but also increase the need for the BTE.	Same as *Alternative 2A*.	Construction: There would be no significant production of GHGs. Operation: Same as *Alternative 2A*, except summer attainment of instream flow targets would be unchanged.	Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Noise					
There would be no increase in noise over existing conditions.	Construction: Construction would result in increased noise throughout the construction period. Impacts are not considered significant because noise would remain below Class A noise levels at existing noise sensitive receptors. Ground-borne vibration could be an occasional nuisance during construction hours, but would not be significant. Operation: There would be no noise impacts from operation.	Same as *Alternative 2A*.	Construction: Construction would result in increased noise throughout the construction period. Noise levels could potentially exceed maximum permissible levels, but noise would be intermittent and well below the pain threshold levels that affect human health. Ground-borne vibration could be an occasional nuisance during construction hours, but impacts would not be significant. Operation: No noise impacts are anticipated.	Same as *Alternative 2A*.	Same as *Alternatives 2A* and *3A*.
Recreation					
Similar to existing conditions. Continued increased demand, boat launches would remain inaccessible at certain times of the year and climate change may negatively affect opportunities. Construction of I-90 Phase 2A would temporarily impact recreation.	Construction: Construction would impact usability and quality of recreation at adjacent undeveloped recreation sites, but the impacts would be minor as the majority of the reservoir shore would remain available. Construction for the BTE would impact recreation at the Gold Creek Pond Picnic Area and John Wayne Pioneer Trail. Operation: Impacts from reservoir drawdown would be significant because the boat launch at Kachess Campground would be inaccessible more often than with *Alternative 1*. Loss of fishing opportunities would also be significant due to loss of boating access and impacts on fish species. The drawdown of Kachess and Keechelus reservoirs would significantly impact usability and quality of recreation during drought years and as the reservoir refills because of the extent and slope of the exposed reservoir bed. Recreational use would be restored following construction of the BTE actions, but the character of recreation at these sites would change.	Same as *Alternative 2A*.	Construction: Construction could disrupt quality of recreation, but the impact would not be significant. Operation: There would be no significant impact. Recreational use would be restored following construction of the BTE, but the character of recreation at these sites would change.	Same as *Alternative 3A*.	Same as *Alternative 2A* and *3A*.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Land and Shoreline Use					
Current trends would continue and there would be an increased potential for the prorationing of irrigation water due to climate change. Long-term negative changes in land use could potentially result from these indirect impacts on water reliability.	Construction: There would be temporary disruption of land use. Operation: Some property easements or acquisitions would be necessary for the pumping plant site and possibly for the transmission line, and the BTE. Improved reliability of proratable water supply would be provided.	Construction: Same as *Alternative 2A*. Operation: Some property easements or acquisitions may be necessary for the transmission line and the BTE. There would be improved reliability of proratable water supply.	Construction: Same as *Alternative 2A*. Operation: Some property easements or acquisitions may be required for KKC facilities and the BTE.	Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.
Utilities					
There would be no impacts to utilities.	Construction: Interruption of services is not anticipated. Operation: There would be no impacts to electricity, wastewater, or telecommunications.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*.
Transportation					
Similar to existing conditions, except construction traffic on I-90 and there would be long-term beneficial effects resulting from the I-90 Phase 2A project.	Construction: Construction would result in a more-than-moderate increase in vehicle traffic time and is considered significant. The increase would not affect the ability of emergency personnel to respond to an incident or interrupt school bus routes, because the delays would be intermittent and of short-term duration. No road closures are planned. No changes are anticipated to existing access for pedestrians, snowmobiles, or bicycles along local roadways. There is no anticipated impact to existing parking areas. Safety risks and deterioration of roads are not considered significant. Operation: Impacts would not be significant because there would be minimal increases in traffic delays; no interruption to other means of transportation; no interruption to emergency vehicle response time; no parking impacts; and no deterioration of roads.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Cultural Resources					
Similar to existing conditions.	<u>Construction</u>: Construction at Kachess Reservoir could damage or alter the identified NRHP-eligible site and potential additional sites that have not yet been identified. The Cold Creek passage improvements would permanently change the John Wayne Pioneer Trail, but trail use would continue. <u>Operation</u>: The additional 80-foot drawdown of Kachess Reservoir would expose large portions of shoreline, potentially exposing cultural resources to degradation, looting, or vandalism.	Same as *Alternative 2A*.	<u>Construction</u>: Construction at Keechelus Reservoir could damage or alter the identified NRHP-eligible site and potential additional sites that have not yet been identified. The Cold Creek improvements would change the John Wayne Pioneer Trail, but trail use would continue. <u>Operation</u>: The additional 15-foot drawdown of Keechelus Reservoir would expose large portions of shoreline, potentially exposing cultural resources to degradation, looting, or vandalism.	Same as *Alternative 3A*.	Same as *Alternative 2A* and *3A*.
Indian Sacred Sites					
There would be no impacts.	To date, Reclamation has identified no Indian sacred sites in the study area. No impacts are anticipated.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*.
Indian Trust Assets					
There would be no impacts.	To date, Reclamation has identified no Indian trust assets in the study area. No impacts are anticipated.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*
Socioeconomics					
No impacts are anticipated and existing trends would continue.	<u>Construction</u>: Direct impacts on income and employment would be generally positive, but not significant. Workers may displace customary recreational visitors during summer, but would offset lost recreation related business. <u>Operation</u>: As a result of improved water supply, agricultural output during drought years would be significantly higher.	Same as *Alternative 2A*.	<u>Construction</u>: Impacts would be the same as *Alternative 2A*, but to a lesser degree. <u>Operation</u>: Direct impacts on income, employment, lodging, would be generally positive, but not significant. There would be no impact on agricultural output.	Same as *Alternative 3A*.	<u>Construction</u>: Impacts would be the same as *Alternative 2A*, but to a greater degree. <u>Operation</u>: Direct impacts on income, employment, lodging, would be generally positive, but not significant. As a result of improved water supply, agricultural output during drought years would be significantly higher relative to *Alternative 1* and more than KDRPP alone.
Environmental Justice					
No impacts are anticipated.	<u>Construction</u>: No significant impacts. <u>Operation</u>: No disproportionate impacts to minority or low-income populations. Impacts to fish species in Kachess Reservoir could cause a significant impact to subsistence living.	Same as *Alternative 2A*.	<u>Construction</u>: No significant impacts. <u>Operation</u>: No disproportionate impacts to minority or low-income populations.	Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Environmental Health and Safety					
There would be no increase in environmental health and safety risks over existing conditions.	Construction: There would be no impacts from hazardous sites or construction traffic. Operation: Full drawdown would expose areas with steep slopes around Kachess Reservoir which would increase the risk from falling.	Same as *Alternative 2A*.	Construction: There would be no impacts from hazardous sites or construction traffic. Operation: No impacts are anticipated.	Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.

Cumulative Impacts

Cumulative impacts are the effects that may result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7). "Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). Section 4.25 of this DEIS evaluates cumulative impacts. The various environmental element sections in Chapters 3 and 4 of the DEIS also examine many of the cumulative impacts. Those analyses discuss the effects of past processes and trends that have cumulatively influenced or led to the resource conditions that exist today.

In addition, Reclamation considers two projects to be a reasonably foreseeable future projects—the Cle Elum Pool Raise Project and ongoing construction on Interstate-90 (I-90). The Cle Elum Pool Raise Project would provide benefits to fish and streamflow conditions that would be beneficial at a basin-wide level when implemented with other proposed projects. The Cle Elum Pool Raise Project could also cumulatively contribute to regional trends toward reduced habitat, impacts to historic and cultural resources, and construction impacts in the region. Construction traffic for all projects would travel on I-90. Dust, noise, and overall traffic would be additive, although these impacts would be limited to the period of construction. While the impacts on traffic of the individual projects would not be significant, the impacts, combined with the ongoing construction on the I-90 Snoqualmie Pass East Project, would cause additive impacts. These cumulative impacts would create a nuisance for people traveling on I-90 as well as residents and recreationists in the Proposed Action areas and on the I-90 corridor.

Environmental Commitments

Environmental commitments are measures or practices adopted by a project proponent to reduce or avoid adverse effects that could result from project operations. Chapter 4 describes specific mitigation measures for project impacts on each resource. The following list summarizes major environmental commitments for the KDRPP and KKC proposals. Reclamation and Ecology share the responsibility to ensure obligations to protect natural resources are fulfilled.

- Obtain all applicable Federal, State and local permits.
- Prior to construction, conduct site-specific geotechnical studies to identify subsurface issues, unstable slopes, and other local factors that could contribute to slope instability and increase erosion potential.
- Conduct continued monitoring of site conditions and erosion potential.

- Develop a surface water quality monitoring program in cooperation with Ecology to monitor changes in water quality associated with the project.
- Monitor wells near Kachess Reservoir to determine if the additional reservoir drawdown lowers groundwater levels. Develop appropriate mitigation strategies if water levels are impacted.
- Enter into a Memorandum of Understanding (MOU) (Appendix A) with Ecology, the Yakama Nation, Service, and WDFW. The MOU provides a framework in which to coordinate and facilitate cooperation among the parties to develop and implement improvements to bull trout habitat within the Yakima River basin as described in the Bull Trout Enhancement Report in Appendix C and consistent with environmental commitments in this section.
- Support a study to examine reservoir productivity and food web impacts from future use of Kachess Reservoir inactive storage.
- Provide bull trout passage between Box Canyon Creek and Kachess Reservoir and between the Little Kachess and Kachess basins to offset impacts of additional draw down at Kachess Reservoir. Conduct general passage improvement activities within Kachess and Keechelus reservoirs.
- Prior to construction, conduct wetland surveys using current wetland delineation methodology. Design projects to avoid wetland impacts. If wetland impacts occur, comply with mitigation measures established in permit conditions to ensure no net loss.
- Prior to construction, coordinate with USFS to determine the presence of any Sensitive or Survey and Manage species and take steps to minimize impacts to those species.
- Monitor for infestations of invasive plant species associated with project ground disturbances and periods of prolonged drawdown of the reservoirs and implement suppression strategies to control invasive plant populations.
- If feasible, extend boat ramps at Kachess Reservoir when the reservoir is drawn down during drought years.
- Implement a public communication strategy to prepare recreation users for the significant impacts on recreation at Kachess Reservoir.
- Implement a construction traffic management plan with specific traffic management measures and procedures for construction contractors.
- Prior to construction, conduct cultural resource studies of all areas that would be disturbed by construction.
- In consultation with DAHP and affected Indian Tribes, develop a treatment plan for all cultural resources directly impacted by the project.

- Develop a Cultural Resource Management Plan to address ongoing and future operational and land management implications of the proposed project.
- Prior to construction, survey utilities in construction areas and take appropriate measures to minimize conflicts with any identified utilities.
- Install signage and post notices to ensure that the general public understands potential safety issues associated with steep slopes along the reservoir.

Reclamation would implement current BMPs when appropriate, to enhance resource protection and avoid additional potential affects to surface and groundwater quality, earth resources, fish, wildlife, and their habitats.

- Haul oils or chemicals to an approved site for disposal and use vegetable-based lubricants in machinery when working in or near water to prevent petroleum products from entering surface or groundwater.
- Develop and implement a Stormwater Pollution Prevention Plan (SWPPP) per Ecology's rules and regulations. The plan would include erosion control methods, stockpiling, site containment, shoreline protection methods, equipment storage, fueling, maintenance, washing, and methods to secure a construction site under circumstances of an unexpected high water or rain event.
- Equip all construction equipment with environmental spill kits to contain petroleum products in the event of a leak.
- Require all contractors to have a Spill Prevention Plan and a Toxics Containment and Storage Plan.
- Develop and implement a spill plan to implement containment of construction materials such as treated woods, contaminated soils, concrete, concrete leachate, grout, and other substances that may be deleterious or toxic to fish and other aquatic organisms.
- Develop a plan for safe handling and storage of potentially toxic construction materials, fuels, and solvents for staging sites in close proximity to receiving waters and riparian areas.
- Place stockpiles of earthen materials to minimize runoff into nearby receiving waters.
- Require all contractors to inventory noxious weed populations by marking with temporary fencing to avoid spreading weeds to other areas in accordance with Federal, State and local weed control requirements.
- Continue with ongoing weed control efforts on disturbed lands following construction and revegetation in accordance with Federal, State and local requirements.

Public Involvement

Reclamation and Ecology initiated the public scoping process for this DEIS in October 2013. Reclamation and Ecology held two public scoping meetings in Yakima, Washington on November 20, 2013 and two scoping meetings in Cle Elum, Washington on November 21, 2013. At the meetings, Reclamation described the Proposed Action and gave attendees the opportunity to comment on the project, the scope of the EIS, the EIS process, and resources evaluated in the EIS.

The scoping period began October 30, 2013, and concluded December 16, 2013. During this period 39 comment documents and telephone calls were received. The comments covered a wide range of environmental effects. One of the major concerns was the effect of the additional drawdown of Kachess Reservoir and its ability to refill following the drawdown. Comments expressed concerns about the effects of the drawdown on fish, recreation access, groundwater wells, aesthetics, and property values. Concerns about the KKC proposal related to whether the project could benefit flows and fish in the upper Yakima River and the impacts on aquatic species from the transfer of water from one reservoir to another. Other concerns included impacts of a tunnel on groundwater flow and transportation corridors, coordination of the project with other projects in the area such as the I-90 Snoqualmie East Project, and construction impacts.

Reclamation and Ecology prepared a Scoping Summary Report that summarizes the comments received (Reclamation and Ecology, 2014i). Reclamation will provide the report to readers upon request, or a reader can access the report from the Yakima River Basin Water Enhancement Project (YRBWEP) 2011 Integrated Plan website: http://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html.

Consultation and Coordination

Reclamation will consult with the U.S. Fish and Wildlife Service (Service) and NMFS under the Endangered Species Act (ESA) and has begun initial conversations about the consultation. Reclamation has completed consultation with the Service under the Fish and Wildlife Coordination Act. Reclamation has initiated consultation with the Washington Department of Archaeology and Historic Preservation under Section 106 of the National Historic Preservation Act. Government-to-Government consultation with the Confederated Tribes of the Yakama Nation, the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Confederated Tribes of the Colville Reservation is ongoing. Reclamation has contacted the Bureau of Indian Affairs (BIA) Yakima Office and the BIA Colville Tribes Office regarding Indian Trust Assets or trust lands in the project area.

Reclamation and Ecology are committed to ongoing coordination with the Tribes and resource agencies. Reclamation will complete ESA coordination with the Service and NMFS. Reclamation will complete cultural resource surveys and will continue coordination with the DAHP on impacts to cultural resources. Reclamation and Ecology will continue to consult with the Yakama Nation, CTUIR, and Colville Confederated Tribes.

What Comes Next?

Public Review of the DEIS

Reclamation and Ecology announced the release of this DEIS on their websites and in local and regional newspapers. These announcements included the timeframe for public review and dates, times, and locations of public meetings. The public will have 60 days to review and provide comments on the DEIS.

Two public hearings will be held during the public review period, as described on the Fact Sheet. Participants will be encouraged to provide comments through several mechanisms, including written comment cards, letters, e-mails, and oral comments at the meeting.

Reclamation and Ecology will give equal consideration to all comments received on the DEIS, regardless of how submitted, and will post the comments on the KDRPP and KKC websites at: http://www.usbr.gov/pn/programs/eis/kdrpp/index.html and http://www.usbr.gov/pn/programs/eis/kkc/index.html.

Preparation of the Final EIS

Reclamation and Ecology will carefully consider all comments received on the DEIS and will consider adjusting alternatives, supplementing or improving the analysis, or making factual corrections in response to substantive comments. Reclamation and Ecology will begin preparing the Final EIS in spring 2015.

Record of Decision

Reclamation will conclude the NEPA process by issuing a Record of Decision no sooner than 30 days after the FEIS is completed. The Record of Decision will identify Reclamation's decision on the Proposed Action, and will describe the basis for that decision.

CHAPTER 1 - INTRODUCTION AND BACKGROUND

Chapter 1 Introduction and Background

1.1 Introduction

The U.S. Department of the Interior Bureau of Reclamation and the Washington State Department of Ecology have prepared this Draft Environmental Impact Statement (DEIS) to evaluate the potential environmental effects of implementing two similar and closely related projects in the Yakima River basin in central Washington State:

- Kachess Drought Relief Pumping Plant (KDRPP)
- Keechelus Reservoir-to-Kachess Reservoir Conveyance (KKC)

Reclamation and Ecology are proposing these two projects as well as enhancements to improve the abundance and resiliency of bull trout populations in the basin as part of implementation of the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan) (Reclamation and Ecology, 2011h). The Integrated Plan is a comprehensive program of solutions developed to restore ecological functions in the Yakima River system and to provide more reliable and sustainable water resources for the health of the riverine environment and for agricultural, municipal, and domestic needs.

As joint lead agencies, Reclamation and Ecology have prepared this DEIS to meet requirements of both the National Environmental Policy Act (NEPA) and State Environmental Policy Act (SEPA). The Yakama Nation, U.S. Fish and Wildlife Service (Service), U.S. Forest Service (USFS), and Bonneville Power Administrative (BPA) are cooperating agencies in preparation of the DEIS in accordance with 40 CFR Section 1508.5. Under NEPA, a cooperating agency is any Federal agency, other than the lead agency, that has jurisdiction by law or special expertise with respect to any environmental impact involved in an action requiring an environmental impact statement. In addition, a State or local agency of similar qualifications or an Indian Tribe may by agreement with the lead agency become a cooperating agency.

1.2 Background

Reclamation's mission is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Ecology's mission is to protect, preserve and enhance the State of Washington's environment for current and future generations. Consistent with its mission, Ecology has been directed by the State legislature to implement actions that provide concurrent benefits for instream and out-of stream uses for the Yakima River basin.

In June 2009, Ecology and Reclamation brought representatives from the Yakama Nation, irrigation districts, environmental organizations, and Federal, State, county, and city governments together to form the Yakima River Basin Water Enhancement Project (YRBWEP) Workgroup to help develop a solution to the basin's water problems. Over the next 18 months, the group developed the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan) (Reclamation and Ecology, 2011h)[1]. The Plan includes the following seven elements:

- Reservoir Fish Passage
- Structural and Operational Changes
- Surface Water Storage
- Groundwater Storage
- Habitat/Watershed Protection and Enhancement
- Enhanced Water Conservation
- Market Reallocation

Reclamation and Ecology prepared the program-level *Yakima River Basin Integrated Water Resource Management Plan Programmatic EIS* (Integrated Plan PEIS) to determine the effects of implementing the Integrated Plan (Reclamation and Ecology, 2012)[2]. The Integrated Plan PEIS supports the conclusion that the current water resources infrastructure, programs, and policies in the Yakima River basin are not capable of consistently meeting the demands for fish and wildlife, irrigation, and municipal water supply (Reclamation and Ecology, 2012).

The Selected Alternative identified in Reclamation's Integrated Plan PEIS Record of Decision (Integrated Plan ROD) includes seven elements, each containing distinct actions,

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[1] The following websites contain information about implementation of the Integrated Plan:

- http://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html
- http://www.ecy.wa.gov/programs/wr/cwp/YBIP.html.

[2] Available online at http://www.usbr.gov/pn/programs/yrbwep/reports/FPEIS/fpeis.pdf

that collectively provide a comprehensive approach to water management in the Yakima River basin and meet the need to restore ecological functions and provide more reliable and sustainable water resources for the health of the riverine environment and for agricultural, municipal, and domestic needs (Reclamation, 2013). The KDRPP and KKC, along with enhancements for bull trout populations in the basin, are identified in the Integrated Plan ROD as necessary components of the Integrated Plan that contribute to achieving the Plan's overall goals.

1.3 Proposed Action

Reclamation's Proposed Action is to construct, operate, and maintain one or both of two closely related water resource projects in the upper Yakima River basin pending congressional authorization. Reclamation and Ecology are considering how these two parts of the Proposed Action, alone or in combination, contribute to restoring ecological functions and providing more reliable and sustainable water resources for the health of the riverine environment and for agricultural, municipal, and domestic needs. The two projects are so closely related in overlapping geography, concurrent timing, interrelated operations, cumulative impacts, and interdependence through the Integrated Plan ROD to be considered interconnected parts of a single course of action that should be evaluated in a single EIS (40 CFR 1502.4 and 40 CFR 1508.25). These relationships are detailed in Section 1.5 and Chapter 2 of this DEIS. The two projects being considered under the Proposed Action are described briefly below as:

- Kachess Reservoir Drought Relief Pumping Plant (KDRPP). Deliver up to an additional 200,000 acre-feet of water from Kachess Reservoir during drought years by installing a new deeper outlet works and pumping system to access existing stored water that cannot currently be accessed. Implement an integrated package of aquatic habitat enhancements and assessments focused on improving the abundance and resiliency of bull trout populations in the Yakima River basin.
- Keechelus Reservoir-to-Kachess Reservoir Conveyance (KKC). Augment flows into Kachess Reservoir and reduce flows in the Yakima River downstream from Keechelus Reservoir to Lake Easton[3] by transferring water from Keechelus Reservoir to Kachess Reservoir via a new tunnel. Implement an integrated package of aquatic habitat enhancements and assessments focused on improving the abundance and resiliency of bull trout populations in the Yakima River basin.

[3] Lake Easton is a reservoir on the Yakima River created by the Easton Diversion Dam, which supplies the Kittitas Reclamation District. The Yakima River flows into Lake Easton from the southwest and the Kachess River from the northwest.

1.4 Purpose and Needs for the Proposed Action

The purpose of the Proposed Action is to fulfill elements of the Integrated Plan ROD signed by Reclamation on July 9, 2013 to help restore ecological functions and provide more reliable and sustainable water resources for the health of the riverine environment and for agricultural, municipal, and domestic needs. The two projects being considered under the Proposed Action respond to specific conditions in the Yakima River basin that adversely affect and are affected by Reclamation's facilities and operations. Those conditions are identified here as the need associated with each of the two projects.

Needs related to KDRPP:

- Demand for irrigation water by existing users in the Yakima River basin exceeds supply in drought years, which can lead to substantial prorationing of water deliveries and economic losses to farmers[4].
- The productivity and function of aquatic habitat conditions for bull trout in tributaries above Keechelus and Kachess reservoirs, as well as throughout the Yakima River basin, is not of consistent quality, and in areas is substantially degraded. In addition, passage within these tributaries is in some cases impaired or blocked.

Needs related to KKC:

- Runoff from the Keechelus watershed in a typical year is greater than can be contained in the reservoir for release when most needed for instream, agricultural, municipal, and domestic uses.
- Current operations at Keechelus Dam result in high flows in the upper Yakima River during the irrigation season that impair rearing habitat for steelhead and spring Chinook upstream of Lake Easton.
- The productivity and function of aquatic habitat conditions for bull trout in tributaries above Keechelus and Kachess reservoirs, as well as throughout the Yakima River basin, is not of consistent quality, and in areas is substantially degraded. In addition, passage within these tributaries is in some cases impaired or blocked.

The objectives of each of the two projects are identified below followed by a discussion of the conditions that give rise to the identified needs and objectives.

[4] Concerns regarding economic loss are discussed in the Integrated Plan FEIS in Section 1.3, Purpose and Need for the Action, on pages 1-5 and 1-6.

The objectives of KDRPP are to:

- Access stored water in Kachess Reservoir that is currently unavailable in order to improve water supply during periods of drought, with a goal of approaching not less than 70 percent of proratable water rights whenever feasible[5].
- Implement the Bull Trout Enhancement (BTE) package of aquatic habitat enhancements, and accomplish assessments of current conditions and limiting factors for bull trout populations in the Yakima River basin to improve the effectiveness of future enhancement actions.

A substantial portion of the water stored in Kachess Reservoir is below the existing reservoir outlet. Thus, this stored water is not accessible under existing conditions due to the physical configuration of the dam. If made accessible, this water could be utilized to increase water supply during periods of drought and provide greater flexibility to deliver water to meet Reclamation's contractual obligations.

Regarding bull trout, the Service listed the Columbia River Basin Distinct Population Segment (DPS) of bull trout as threatened under the Endangered Species Act (ESA) in June 1998. The Service identified 12 subpopulations of bull trout in the Yakima River basin and designated critical habitat in a number of reaches of the Yakima River and tributaries (Reclamation and Ecology, 2014b). As an outcome of the Integrated Plan, consensus has emerged among the Yakama Nation and resource agencies with jurisdictions around an integrated package of aquatic habitat enhancements and assessments focused on improving the abundance and resiliency of bull trout populations in the Yakima River basin. The package of enhancements and assessments is referred to as Bull Trout Enhancement (BTE). The existing conditions in the basin that contributed to the listing of bull trout and the uncertainties of climate change have created an imperative for implementing affirmative steps as identified in the BTE. These conditions related to bull trout and the BTE are the same for KDRPP and KKC.

The objectives of KKC are to:

- Capture excess runoff from the Keechelus watershed
- Improve capabilities for refilling Kachess Reservoir during and following dry and drought years
- Reduce high flows from Keechelus Dam in the upper Yakima River during irrigation season to improve rearing habitat for steelhead and spring Chinook upstream of Lake Easton

[5] The basis for this threshold for prorationing is discussed in the Integrated Plan FEIS in Section 1.3, Purpose and Need for the Action, on pages 1-5 and 1-6.

- Implement the BTE package of aquatic habitat enhancements, and accomplish assessments of current conditions and limiting factors for bull trout populations in the Yakima River basin to improve the effectiveness of future enhancement actions.

The storage capacity of Kachess Reservoir is greater than the runoff in the Kachess watershed. Because of this, Kachess Reservoir does not refill in some years, especially after droughts, creating a need for additional inflow to the reservoir. On the other hand, total available runoff in the Keechelus watershed is greater than the storage capacity of Keechelus Reservoir. Consequently, this water is released down-river during the spring runoff period and is not utilized for total water supply available (TWSA) or targeted for fish benefits.

TWSA is defined as:

> *That amount of water available in any year from natural flow of the Yakima River, and its tributaries, from storage in the various Government reservoirs on the Yakima River watershed and from other sources, to supply the contract obligations of the United States to the Yakima River and its tributaries* (Civil Action No. 21 (1945 Consent Decree) Article 4, 1st Para.).

During the irrigation season, releases of stored water from Keechelus Reservoir create undesirably high flows in the Keechelus reach of the Yakima River that affect rearing habitat for steelhead and spring Chinook. As part of Reclamation's operation of the Yakima Project, these releases are necessary to meet contractual obligations to various water users. An alternative means to convey water stored in Keechelus Reservoir to points of diversion farther down the system would enable Reclamation to reduce high flows in the Yakima River and improve fish habitat while meeting contractual obligations.

Reclamation's Federal actions would be to construct, operate, and maintain one of the alternatives evaluated in this EIS. These Federal actions that require review under NEPA, and are the focus of this EIS. Reclamation's decisions that will rely upon the analysis presented in this EIS and supporting documents are:

- Determination that the feasibility of alternatives to provide additional water for irrigation needs and improve habitat below Keechelus Dam and evaluation of those alternatives under NEPA is complete.
- Determination that Reclamation will or will not pursue a recommendation for congressional action to authorize or fund the implementation of an alternative or combination of alternatives.
- If Reclamation decides to pursue a recommendation for congressional action for authorization or funding, which alternative or combination of alternatives will be recommended.

Ecology's State actions will be to participate financially, issue permits as required, and issue water rights as necessary for one of the alternatives evaluated in this EIS. These State actions require review under SEPA in this EIS.

1.5 Kachess and Keechelus Reservoirs Setting and History

1.5.1 Location and Setting

Keechelus and Kachess Reservoirs are located in the upper Yakima River basin (Figure 1-1). Keechelus Reservoir is located 10 miles northwest of the town of Easton, Washington. At river mile (RM) 214.5, it is farther upstream than any other reservoir in the Yakima River system. Keechelus Reservoir was constructed over a natural lake and is impounded by Keechelus Dam, which was completed in 1917. Keechelus Dam is an earthfill structure, 128 feet high, and 6,650 feet wide at the crest. Keechelus Reservoir drains an area of 54.3 square miles and has an active capacity (accessible storage) of 157,800 acre-feet (Reclamation, 2002). The Yakima River flows out of the outlet works of the dam.

Kachess Reservoir is located about 2 miles northwest of the town of Easton. It releases water into the Kachess River, which flows into the Easton Reservoir. Like Keechelus Reservoir, Kachess Reservoir was constructed over a natural lake. Its historical glacial lake was separated into two basins—the upper Little Kachess Lake and the lower Big Kachess Lake. Kachess Reservoir's earthfill dam, completed in 1912, is 115 feet high and 1,400 feet wide at the crest. Kachess Reservoir drains an area of 63 square miles and has an active storage capacity of 239,000 acre-feet (Reclamation, 2002).

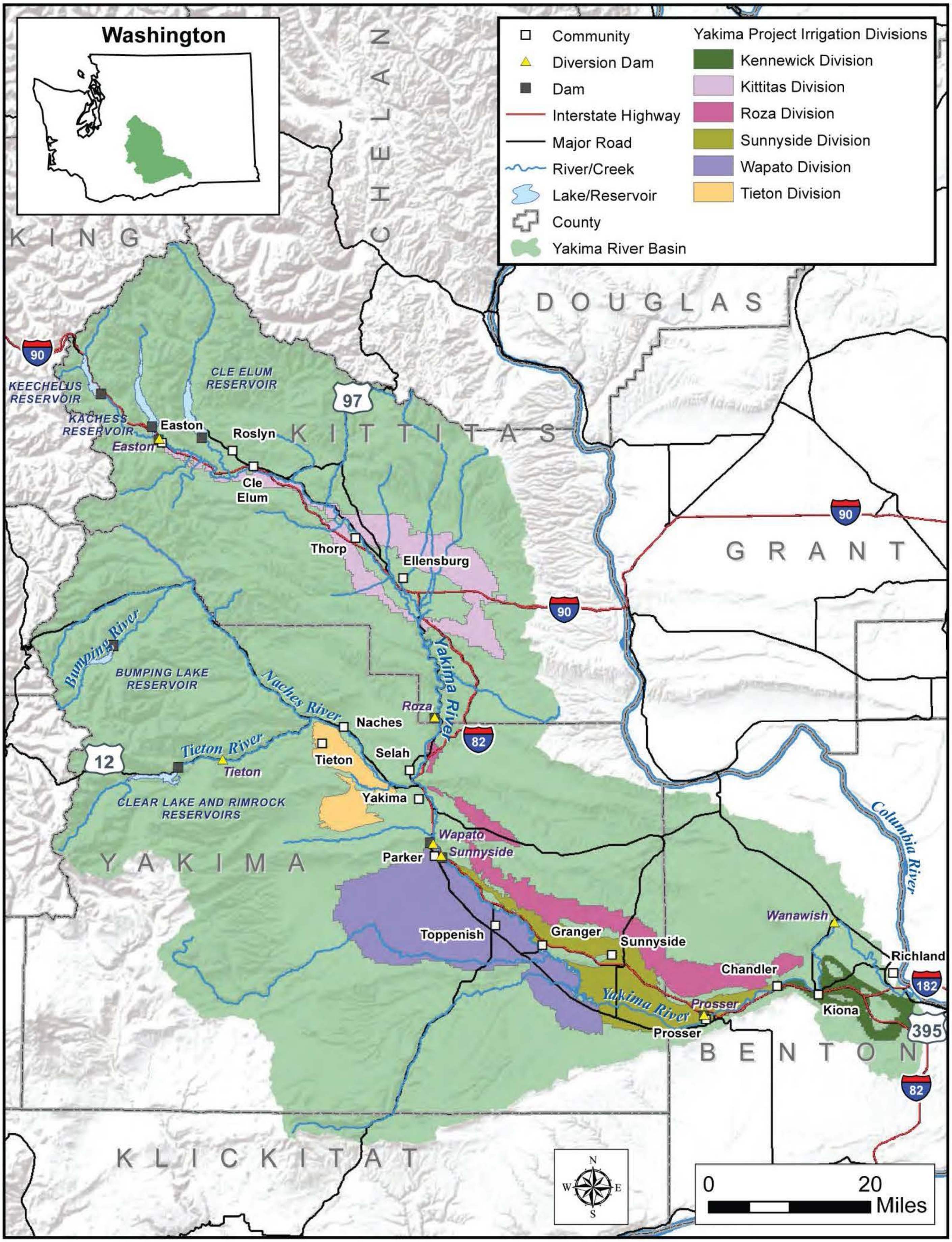

Figure 1-1. Yakima River Basin

1.5.2 Yakima Project

Reclamation operates the Kachess and Keechelus reservoirs as part of the Yakima Project. Congress authorized the Yakima Project under the Reclamation Act of June 17, 1902 directing Reclamation to develop irrigation facilities in the Yakima River basin. The Yakima Project includes five major storage reservoirs—Keechelus, Kachess, Cle Elum, Bumping Lake, and Rimrock (Figure 1-1). These reservoirs store and release water to meet irrigation demands, flood control needs, and instream flow requirements. Reclamation operates the reservoirs as a pooled system with no reservoir or storage space designated for a specific irrigation district.

A complex group of Federal and State statutes and regulations, as well as court decisions and orders, regulate water management in the Yakima River basin. Additionally, Reclamation operates the Yakima Project according to the United States' Yakama Treaty obligations, delivering the Yakama Nation's trust "time immemorial" water right according to court orders. Sections 1.6.3 and 1.6.4 of the Integrated Plan PEIS (Reclamation and Ecology, 2012) describe regulations and legal decisions related to water management in the basin.

Water entitlements[6] in the Yakima River basin, including irrigation and municipal entitlements, are based on two classes of water rights—nonproratable and proratable. Nonproratable entities are considered "senior" and generally hold rights for water users who were irrigating prior to authorization of the Yakima Project reservoirs. Water users with nonproratable water rights are served first. Proratable entitlements share equal priority.

Prorationing refers to the process of equally reducing the amount of water delivered to proratable water right users in deficit years based on the court doctrine of TWSA. TWSA is estimated annually based on forecasted runoff, forecasted return flows, and storage contents.

In 1981, the Reclamation Yakima Field Office Manager established the System Operations Advisory Group (SOAC) to advise the Yakima Project Field Manager regarding flow-related impacts on fish. SOAC is an advisory board to Reclamation, consisting of fishery biologists representing the Yakama Nation, the Service, Washington Department of Fish and Wildlife (WDFW), and irrigation entities represented by the Yakima Basin Joint Board. The SOAC provides information, advice, and assistance to Reclamation on fish-related issues associated with the operations of the Yakima Project.

1.5.3 History of KDRPP, KKC and BTE

The KDRPP was proposed as the Kachess Reservoir Inactive Storage Project in the Integrated Plan. "Inactive" storage is water in the reservoir that is inaccessible because it is below the elevation of the outlet works. The Integrated Plan proposal included conceptual

[6] Water entitlements in the Yakima River basin are derived from water rights, but are not the same as water rights.

design of two options: a gravity tunnel and a pump station (Reclamation and Ecology, 2012). A 2013 technical memorandum compared the two options to determine if both should be advanced for further design and analysis (Reclamation and Ecology, 2013b). Based on results of that analysis, Reclamation and Ecology determined that the gravity tunnel option was not feasible due to high cost and difficulty in engineering and not reasonable because it could not adequately serve the proratable irrigation districts because its outlet on the Yakima River was downstream from Kittitas Reclamation District’s (KRD) diversion; only the pump station option should be carried forward for more detailed study. The project was then renamed the Kachess Drought Relief Pumping Plant (KDRPP) to better reflect its purpose, i.e., the pumping plant would be built specifically to reduce prorationing during drought years. Section 2.10 provides additional information on reasons for eliminating the gravity tunnel option from further consideration.

As described in Section 2.4.4.3 of the Integrated Plan PEIS, the KKC project was refined and included as a component of the Integrated Plan because it would reduce flows in the upper Yakima River, improving fish habitat conditions (Reclamation and Ecology, 2012). The ability to move water from Keechelus Reservoir to Kachess Reservoir and augment refill of Kachess Reservoir would also improve Reclamation’s flexibility to provide water for both irrigation and fish needs. The concept for transferring water from Keechelus Reservoir to Kachess Reservoir that Reclamation and Ecology evaluated in the Integrated Plan was a 5-mile-long, above-ground pipeline from Keechelus Dam to an outlet on the west shore of Kachess Reservoir.

The Integrated Plan PEIS identified substantial impacts associated with the KKC pipeline, including the permanent removal of 40 to 50 acres of vegetation in the pipeline corridor and permanent removal of sensitive wildlife habitat (Reclamation and Ecology, 2012). USFS staff expressed concerns about these impacts as well as impacts on recreation access and cultural resources.

In response to these concerns, Reclamation and Ecology evaluated alternative conveyance routes that would result in fewer adverse resource impacts. A technical memorandum evaluated three pipeline and three tunnel options (Reclamation and Ecology, 2013c). Based on this analysis, Reclamation and Ecology decided to eliminate the pipeline options and carry forward the tunnel conveyance alternatives proposed in this DEIS. Section 2.10 provides additional information on reasons for eliminating the other conveyance options from further consideration in this EIS. The tunnel concepts were further refined in a value planning study (Reclamation and Ecology, 2014k).

The Service, WDFW, National Marine Fisheries Service (NMFS), USFS, Yakama Nation, Reclamation, and Ecology developed the BTE to enhance resiliency of bull trout populations in the Yakima River basin. Bull trout are currently listed as “threatened” under the ESA. Reclamation and Ecology are also developing a Memorandum of Understanding (MOU) with these agencies to commit to continued cooperation. Future implementation of the BTE is contingent on the decisions of Reclamation and Ecology following completion of the Final EIS (FEIS).

1.6 Intended Use of this Environmental Impact Statement

The purpose of this EIS is to inform the public and decisionmakers of the Proposed Action, reasonable alternatives, and their environmental impacts. This EIS identifies and evaluates alternatives that meet the purpose and needs for the Proposed Action. It also evaluates the effectiveness of the alternatives in achieving the identified project objectives, analyzes the potential direct and indirect environmental effects, and identifies measures to reduce or avoid potential effects of the action alternatives on the human environment. This EIS discloses unavoidable, adverse environmental impacts; cumulative impacts; the relationship between local short-term uses of the human environment and the maintenance and enhancement of long-term productivity; and irreversible and irretrievable commitments of resources.

This DEIS is being circulated for review and comment to engage interested members of the public, agencies, stakeholders, and Tribes. Reclamation and Ecology will consider comments received during the public review period, and responses to comments will be included in the FEIS. The agencies will conduct continued public outreach before completion of the FEIS.

Reclamation will use the FEIS, in conjunction with other relevant material, when considering alternatives to accomplish the Proposed Action. Reclamation will publish the FEIS and document its decision in Reclamation's Record of Decision. All cooperating agencies and other Federal, State, and local agencies with authority over any aspect of the Proposed Action are expected to use the information contained in the FEIS to meet some, if not all, of their information needs, to make decisions, and to issue permits with respect to the Proposed Action consistent with their authority. Some of the specific proposals identified within the BTE may require additional project-level NEPA and SEPA evaluation prior to construction and operation. Additional project-level evaluation may also be required as part of acquisition of Federal and State aquatic and resource permits and approvals. Table 1-1 presents the roles and responsibilities of Federal agencies that may use the FEIS to support their decision making.

Table 1-1. Federal Agency Roles and Responsibilities

Federal Agency	Role and Responsibility
Reclamation	• NEPA lead agency • Prepare EIS and Reclamation's Record of Decision
USFS (cooperating agency)	• Regulate occupancy and use of National Forest lands under the National Forest Management Act and Northwest Forest Plan
NMFS	• Complete Federal Endangered Species Act Biological Opinion • Verify compliance with the Magnuson-Stevens Act
Service	• Complete Federal Endangered Species Act consultation • Monitor compliance with the Fish and Wildlife Coordination Act
U.S. Army Corps of Engineers	• Permit project under Section 404 of the Clean Water Act
U.S. Environmental Protection Agency	• Review EIS

1.7 Next Steps in Implementation

Additional congressional authorization and funding in addition to environmental permitting are required before Reclamation and Ecology can implement the Proposed Action. Reclamation is conducting feasibility studies for both KDRPP and KKC. Pending an affirmative finding of feasibility by the Department of the Interior, both feasibility studies and the FEIS may be advanced to the Office of Management and Budget for consideration.

Other steps required for implementation include:

- Reclamation's Planning Report feasibility analysis, including benefit-cost analysis and other environmental analyses
- Cultural resource surveys and other cultural and Tribal consultations
- Endangered Species Act compliance
- Federal and State consultation and permitting.

Reclamation and Ecology are currently seeking concurrence on an MOU with the Yakama Nation, Service, NMFS, USFS, and WDFW guiding continued cooperation and proposed implementation of the BTE. The Draft MOU is included in this EIS as Appendix A.

1.8 National and State Environmental Policy Acts

1.8.1 NEPA and SEPA Requirements

The National Environmental Policy Act of 1969 (40 USC Section 4321 et seq.) requires that a Federal agency analyze the impacts on the human environment associated with its proposed Federal action. This DEIS discloses this analysis and resulting conclusions. The State Environmental Policy Action (Chapter 43.21C Revised Code of Washington [RCW]) requires an EIS for all major actions taken by a State agency having a probable significant adverse environmental impact.

Reclamation published a Notice of Intent to prepare an EIS in the Federal Register on October 30, 2013, informing the public of the proposed environmental analysis and identifying opportunities for involvement during EIS preparation. On November 4, 2013, Ecology issued a SEPA Determination of Significance. The Notice of Intent and Determination of Significance initiated the scoping process. The scoping process for the DEIS provided an opportunity for the public, governmental agencies, and Tribes to identify their concerns, potential impacts, relevant effects of past actions, and possible alternative actions.

This DEIS presents Reclamation's and Ecology's analysis and disclosure of the potential effects of the Proposed Action along with accompanying reasonable alternatives and mitigation. Reclamation will publish a Notice of Availability in the Federal Register announcing the availability of this DEIS for review and comment by the public, as well as Tribes, other Federal and State agencies, decisionmakers, and local jurisdictions having interest in the Proposed Action. The comment period for this DEIS is 60 days.

After the DEIS public comment period is completed, Reclamation and Ecology will consider all comments, conduct further analysis if necessary, and prepare an FEIS that includes modifications made in response to comments on the draft or as a result of additional evaluation. Reclamation will publish a Notice of Availability in the Federal Register for the FEIS. The NEPA process concludes when Reclamation completes a Record of Decision by Reclamation. The Record of Decision explains the agency's decision, describes the alternatives considered (including the environmentally preferred alternative), and discusses any commitments for mitigating potential environmental effects and monitoring those commitments. Reclamation would not complete the Record of Decision sooner than 30 days after the Environmental Protection Agency (EPA) Notice of Availability for receipt of the FEIS is published in the Federal Register.

SEPA does not require preparation of a decision document, but does require that the lead agency defer action on a project for 7 days after issuance of the FEIS.

1.8.2 Tiering to the Integrated Plan PEIS

This DEIS is tiered to the Integrated Plan PEIS (Reclamation and Ecology, 2012). According to NEPA, tiering of environmental analysis

> *…refers to the coverage of general matters in broader environmental impact statements … with subsequent narrow statements or environmental analyses …, incorporating by reference the general discussions and concentrating solely on the issues specific to the statement subsequently prepared* (40 CFR 1508.28)

SEPA regulations are similar, stating that agencies may conduct a "phased review" so that the environmental analysis "focuses on issues that are ready for decision and exclude from consideration issues already decided or not yet ready" (Washington Administrative Code [WAC] 197-11-060).

Reclamation and Ecology originally evaluated KDRPP and KKC at a program-level in the Integrated Plan PEIS (Reclamation and Ecology, 2012). KDRPP was evaluated as a project action under the Surface Water Storage Element of the Integrated Plan, and KKC was evaluated as a project action under the Structural and Operational Changes Element of the Integrated Plan. The Integrated Plan PEIS evaluated the benefits of improving bull trout habitat in the Yakima River basin under the Habitat/Watershed Protection and Enhancement Element. The findings of the Integrated Plan PEIS regarding the conditions and environmental effects of KDRPP, KKC and bull trout are still valid. The more site-specific analysis in this DEIS is based on additional technical and environmental studies and project design undertaken since issuance of the Integrated Plan ROD. The Integrated Plan PEIS is available at: http://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html.

1.8.3 Incorporation by Reference

This DEIS incorporates by reference portions of the Integrated Plan PEIS relevant to the KDRPP and KKC under the provisions of 40 CFR 1502.21 and 43 CFR 46.135. The Integrated Plan PEIS evaluated the impacts of implementing the Integrated Plan, a comprehensive approach to water resources and ecosystem restoration in the Yakima River basin.

Chapter 1 of the Integrated Plan PEIS includes background information on the Integrated Plan which provides additional information to support the information presented for KDRPP and KKC in this DEIS. The specific sections described below from the Integrated Plan PEIS are incorporated by reference.

- Section 1.1 describes how Reclamation and Ecology developed the Integrated Plan and specific goals of the Integrated Plan to restore ecological functions in the Yakima River system and to provide more reliable and sustainable water resources.

- Section 1.3 presents the Purpose and Need for the Integrated Plan. The section describes specific problems in the Yakima River basin that the Integrated Plan is intended to address, including depletion of anadromous and resident fish, the demand for irrigation water exceeds supply in dry years, the need for a water supply of 70 percent of proratable water rights during a drought year to avoid economic loss, and the potential impacts of climate change on water supply and fisheries health. The section also describes the specific needs for water in the Yakima River basin.
- Section 1.5 provides background information about the need to develop an integrated approach to addressing water resource issues in the basin. The section provides additional information about the fisheries and water supply problems in the basin as well as information on the potential impacts of climate change that will affect both fisheries and water supply.
- Section 1.6 describes the location and setting of the Yakima River basin and the history of the Yakima Project.
  - Subsection 1.6.4 includes a summary of the legal decisions that affect how water is allocated in the Yakima basin. This information provides additional information to support the descriptions in Sections 1.5 and 1.10 of this DEIS.
- Section 1.7 summarizes the major studies Reclamation, Ecology, and other entities have undertaken to evaluate water problems in the Yakima River basin and to propose potential solutions to those problems.
  - Subsection 1.7.2 describes the YRBWEP legislation and projects.
- Section 1.9 provides more detailed information on the actions that led to development of the Integrated Plan.
  - Subsections 1.9.2 and 1.9.3 describe how Reclamation and Ecology worked together to establish the YRBWEP Workgroup and developed the Integrated Plan.

Chapter 2 of the Integrated Plan PEIS presents the alternatives that were evaluated, the process used to develop the alternatives and the alternatives that were eliminated from detailed study. The specific sections described below are incorporated by reference.

- Section 2.2 summarizes how the Integrated Plan was developed, including the development of the seven elements of the Integrated Plan.
- Section 2.3, No Action Alternative, describes the ongoing projects and programs to improve water resources and fisheries in the Yakima River basin. The section also describes the criteria that define the projects included in the No Action Alternative (p. 2-7). Those criteria are used to define the No Action Alternative project in this DEIS (Section 2.3).

- Section 2.4 provides details on the Integrated Plan including its seven elements and projects proposed under those elements.
  - Subsection 2.4.4.3 describes the Keechelus-to-Kachess Pipeline as a project under the structural and operational changes element. This DEIS updates the impact analysis based on current tunnel designs and more detailed feasibility evaluations.
  - Subsection 2.4.5.2 describes the Kachess Reservoir Inactive Storage project that has been developed into KDRPP which is evaluated in this DEIS.

1.8.4 SEPA Adoption of the Integrated Plan PEIS

Pursuant to provisions of the SEPA rules (WAC 197-11-630), Ecology has adopted the Integrated Plan PEIS to meet a portion of its responsibilities under SEPA (see Notice of Adoption in Appendix B).

1.9 Authorization

1.9.1 Federal Authorization

Under the Reclamation Act of June 17, 1902, the Secretary of the Interior authorized the Tieton and Sunnyside Divisions of the Yakima Project on December 12, 1905, for the purposes of storage, diversion, development of waters, and the construction of irrigation works for the reclamation of arid lands. Reclamation constructed Kachess and Keechelus reservoirs under this authority.

The Yakima River Basin Water Enhancement Project (YRBWEP) was authorized on December 28, 1979 (93 Stat. 1241, Public Law 96-162, Feasibility Study—Yakima River Basin Water Enhancement Project [YRBWEP]). This provides the authority for the on-going feasibility studies in relation to this EIS. Section 1205 of the YRBWEP Act of 1994 (108 Stat. 4526 Public Law 103-434) authorized fish, wildlife, and recreation as additional purposes of the Yakima Project. Section 1207 of the YRBWEP Act of 1994 provides authority for enhancement programs in other Yakima River basin tributaries that would include those proposed for habitat restoration and enhancement as part of the action alternatives being considered in this EIS.

Additional congressional authorization and funding in addition to environmental permitting are required before Reclamation and Ecology can implement the Proposed Action. Reclamation is conducting feasibility studies for both KDRPP and KKC. Pending an affirmative finding of feasibility by the Department of the Interior, both feasibility studies and the FEIS may be advanced to the Office of Management and Budget for consideration.

1.9.2 Washington State Authorization

The Washington State Legislature authorized implementation of the Integrated Plan, including the KDRPP and KKC projects in the 2013 Yakima Policy Bill (2SSB 5367). The bill establishes mechanisms for implementing work on the Integrated Plan. It authorizes Ecology to implement the Integrated Plan and to develop solutions that provide concurrent benefits for instream and out-of stream uses. The goals of this effort are to protect and enhance fish and wildlife resources, improve water availability and reliability, establish more efficient water markets, manage the variability of water supplies, and prepare for the uncertainties of climate change through operational and structural changes. The bill includes authorization for the Washington State Department of Natural Resources (DNR) to purchase private land in the Teanaway River basin to establish the Teanaway Community Forest (TCF) and instructions that DNR, in collaboration with WDFW, manage it for the following purposes consistent with the Integrated Plan:

- Protect and enhance the water supply and protect the watershed
- Maintain working lands for forestry and grazing while protecting key watershed functions and aquatic habitat
- Maintain and, where possible, expand recreational opportunities consistent with watershed protection
- Conserve and restore vital habitat for fish

The DNR completed purchase of the property in October 2013. DNR and WDFW are working with an Advisory Committee to develop a management plan for the TCF.

The TCF would benefit from implementing KDRPP. A specific provision of the bill related to KDRPP and KKC projects is establishment of a "Water Supply Facility Permit and Funding Milestone" (Milestone). To achieve the Milestone, permitting and funding are to be completed by 2021 for one or more water supply facilities designed to provide at least 214,000 acre-feet of additional water supply. If the Milestone is not met, the bill authorizes the Board of Natural Resources to transfer the TCF land to the common school trust and to manage the land for the beneficiaries of the trust. The intent of the KDRPP proposal is to provide 200,000 acre-feet toward the 214,000 acre-foot Milestone.

Additional authorization for the State of Washington to implement the Integrated Plan is contained in the 2013 to 2015 Capital Budget (ESSB 5035, Section 3077). This section of the Capital Budget appropriated $32 million in capital funds to move several Integrated Plan projects and activities forward and approximately $99 million for the purchase of the TCF land.

1.10 Water Rights and Contracts

1.10.1 Water Rights

Reclamation operates the Yakima Project according to Federal and State law, and court orders and decisions as described in Section 1.5.2 of this DEIS and in Sections 1.6.3 and

1.6.4 of the Integrated Plan PEIS. Reclamation will comply with State storage permitting requirements regarding this Proposed Action. Additionally, existing water rights may need to proceed through a State administrative process to change elements of the water right, such as place of use or purpose of use, if necessary.

1.10.2 Water Contracts

Reclamation is conducting feasibility studies for KKC and KDRPP that include economic and financial feasibility considerations pursuant to the Reclamation Project Act of 1939, subsection 9(a). Information on feasibility studies will be provided in Feasibility Planning Reports.

To protect the interests of the United States, general Reclamation law requires contracts for the delivery and storage of project and nonproject water, for the use of Federal facilities, and for the recovery of reimbursable project costs. Contracts are always required, unless a superseding Federal authority dictates otherwise, and must be executed pursuant to appropriate authority, whether found in general Reclamation law, project-specific legislation, or other congressional authorization. This is true whether the water is to be delivered for consumptive or nonconsumptive use.

Under all action alternatives, contract(s) will be required for the repayment of reimbursable project costs based on the irrigator’s ability to pay. Contractors’ obligations to repay capital project costs under contracts made pursuant to subsection 9(d) of the Reclamation Project Act are generally based on their ability to pay.

Reclamation’s water-related contracts must protect the Federal investment and ensure that repayment of the reimbursable capital cost is made in accordance with Reclamation law. Subsections 9(c), (d), and (e) of the Reclamation Project Act of 1939 require repayment of all reimbursable costs (Public Law 76-260; 43 U.S.C. § 485h[c], [d], and [e]). Subsection 9(f) covers public participation requirements for contracting. The methods used in recovering these costs vary.

1.11 Regulatory Compliance and Directions to Agencies

This section describes Federal laws, Secretarial orders, and Executive Orders (EOs) that may apply to the Proposed Action. This listing is not an exhaustive list of potential all laws and orders. Section 1.8 describes the NEPA process. Chapter 5 describes the status of consultation and compliance with the regulations. The following list may not be comprehensive. Additional regulations are included in applicable resource sections in Chapter 3.

1.11.1 Endangered Species Act

The Endangered Species Act (ESA) (Public Law 93-205, dated December 28, 1973) requires all Federal agencies to ensure that their actions do not jeopardize the continued existence of ESA-listed species, or destroy or adversely modify their critical habitat. As part of the ESA Section 7 consultation process, an agency must request a list of species from the Service and NMFS that identifies threatened and endangered species within or near the Federal action area. The agency then must evaluate impacts on those species and designated critical habitat through preparation of a Biological Assessment. If the action may impact any ESA-listed species or designated critical habitat, the agency must consult with the Service or NMFS, or both. Section 4.9 describes potential impacts on ESA-listed species.

1.11.2 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA) (Public Law 96-366, dated September 29, 1980) provides for equal consideration of wildlife conservation in coordination with other features of water resource development programs. The FWCA requires that any plans to impound, divert, control, or modify any stream or other body of water must be coordinated with the Service and State wildlife agency (WDFW) through consultation directed toward prevention of fish and wildlife losses and development or enhancement of these resources. The Coordination Act Report (CAR) documents the results of the consultation. Section(s) 4.6, 4.8, and 4.9 describe how the Proposed Action and alternatives might affect resources addressed through FWCA. Section 5.5.2 describes Reclamation's FWCA consultation process.

1.11.3 National Historic Preservation Act

The National Historic Preservation Act (NHPA) (Public Law 89-665, dated October 15, 1966), as amended, requires that Federal agencies consider the effects of their projects on properties eligible for or listed on the National Register of Historic Places (NRHP). Regulations in 36 CFR 800 describe the procedures that Federal agencies must follow to comply with the NHPA. For any undertaking, Federal agencies must determine if there are properties of NRHP quality in the project area, the effects of the project on those properties, and the appropriate mitigation for adverse effects. In making these determinations, Federal agencies are required to consult with the State Historic Preservation Officer (SHPO), Native American Tribes with a traditional or culturally significant religious interest in the study area, the interested public, and, in certain cases, the Advisory Council on Historic Preservation. Section 4.18 describes potential impacts on listed and eligible resources.

1.11.4 Native American Graves Protection and Repatriation Act

Native American Graves Protection and Repatriation Act (NAGPRA) (Public Law 101-601, dated October 16, 1990) regulates Tribal consultation procedures in the event of discoveries of Native American graves and other NAGPRA "cultural items." Under the Act, discovery of graves or other NAGPRA cultural items requires the Federal agency to consult with Tribes during project planning. NAGPRA details the procedures required for repatriation of human skeletal remains and other cultural items with the Tribes. Section 5.4 describes Reclamation's consultation process with Tribal representatives.

1.11.5 Clean Water Act

The Clean Water Act (Public Law 92-500, dated October 18, 1972) regulates discharges of pollutants into the water of the U.S. and establishes surface water quality standards. The U.S. Army Corps of Engineers (Corps) regulates the discharge of dredge and fill material into the waters of the United States, including wetlands, under Section 404 of the Act. Permit review and issuance follows a process that encourages, in sequence, avoiding impacts, minimizing impacts, and requiring mitigation for unavoidable impacts to the aquatic environment. Issuance of a Section 404 authorization by the Corps triggers the need to comply with the provisions of Section 401 of the act, which requires water quality certification. Section 401 authorization is issued by the State. Sections 4.4 and 4.7 of this DEIS describe the potential impacts to water quality and wetlands, respectively.

1.11.6 Executive Order 11990: Wetlands

Executive Order 11990, dated May 24, 1977, directs Federal agencies to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial value of wetlands in carrying out programs affecting land use. Wetlands provide great natural productivity, hydrological utility, environmental diversity, natural flood control, improved water quality, recharge of aquifers, flow stabilization of streams and rivers, and habitat for fish and wildlife resources. Section 4.7 of this DEIS describes potential impacts to wetlands.

1.11.7 Executive Order 13007: Indian Sacred Sites

Executive Order 13007, dated May 24, 1996, instructs Federal agencies to promote accommodation of access to, and to protect the physical integrity of, American Indian sacred sites. A "sacred site" is a specific, discrete, and narrowly delineated location on Federal land. An Indian Tribe or an Indian individual determined to be an appropriately authoritative representative of an Indian religion must identify a site as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion. The Tribe or authoritative representative must inform the agency of the existence of such a site. Section 4.19 of this DEIS describes potential impacts to Indian sacred sites.

1.11.8 Executive Order 12898: Environmental Justice

Executive Order 12898, dated February 11, 1994, instructs Federal agencies to make achieving environmental justice part of its mission to the extent practicable and permitted by law. Agencies are to achieve this element of their missions by addressing, as appropriate, disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. Environmental justice means the fair treatment of people of all races, income, and cultures with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no person or group of people shoulders a disproportionate share of negative environmental impacts resulting from the execution of environmental programs. Section 4.22 of this DEIS describes the potential environmental justice impacts associated with the proposed projects.

1.11.9 Executive Order 13175: Consultation and Coordination with Tribal Governments

Executive Order 13175, dated November15, 2000, instructs Federal agencies to consult, to the greatest extent practicable and to the extent permitted by law, with Tribal Governments prior to taking actions that affect federally recognized Tribes. Each agency shall assess the impact of Federal Government plans, projects, programs, and activities on Tribal trust resources and assure consideration of Tribal rights and concerns during the development of such plans, projects, programs, and activities. Section 5.4 of this DEIS documents Reclamations' Tribal consultation and coordination process for this project.

1.11.10 Secretarial Order 3175: Department Responsibilities for Indian Trust Assets

Indian Trust Assets (ITAs) are legal interests in property held in trust by the United States (with the Secretary of the Interior acting as trustee) for Indian Tribes or Indian individuals. Examples of ITAs are lands, minerals, hunting and fishing rights, and water rights.

The United States has an Indian trust responsibility to protect and maintain rights reserved by or granted to Indian Tribes or Indian individuals by treaties, statutes, and EOs. These rights are sometimes further interpreted through court decisions and regulations. This trust responsibility requires that officials from Federal agencies, including Reclamation, take all actions reasonably necessary to protect ITAs. Section 4.20 of this DEIS describes potential ITAs in the area of the proposed projects.

1.11.11 Executive Order 11988: Floodplain Management

Executive Order 11988, dated May 24, 1977, instructs Federal agencies to determine prior to taking an action whether the Proposed Action will occur in a floodplain. If the action does occur in a floodplain, the agency must consider alternatives to avoid adverse effects to the greatest extent practicable. If the only feasible alternatives are located within a floodplain, the agency shall take action to design or modify its action to minimize potential harm to or within the floodplain consistent with regulations accompanying EO 11988. Section 5.5.7 describes the potential project effects to floodplains.

1.11.12 Executive Order 13112: Invasive Species

Executive Order 11312, dated February 3, 1999, directs all Federal agencies to prevent and control introductions of invasive nonnative species in a cost-effective and environmentally sound manner to minimize their economic, ecological, and human health impacts. Executive Order 11312 established the national Invasive Species Council, made up of Federal agencies and departments, and the supporting Invasive Species Advisory Committee, composed of State, local, and private entities. The Invasive Species Council and Advisory Committee oversee and facilitate implementation of the executive order, including preparation of a national invasive-species management plan. Section 4.7 of this DEIS describes Reclamation's process for addressing invasive species.

1.12 Permits, Consultations, and Approvals

Prior to constructing and implementing the Proposed Action, Reclamation and Ecology will obtain required Federal, State, and local permits, as appropriate, and meet other requirements set forth by law, regulation, ordinance, and policy. Table 1-2 summarizes the potential permit and other requirements that have been identified to date. The applicable resource sections in Chapters 3 and 4 of this DEIS discuss other laws. Chapter 5 describes Reclamation and Ecology's public involvement and agency consultations and coordination.

Table 1-2. Summary of Potential Permit Requirements, Consultations, and Required Approvals

Agency	Permits and Other Requirements	Jurisdiction or Purpose
Federal Agencies		
Service and NMFS	Endangered Species Act (16 USC § 1531)	Consultation to determine effects on threatened and endangered species.
NMFS	Magnuson-Stevens Fishery Conservation and Management Act (16 USC §§ 1801-1802)	Consultation with NMFS on activities that may adversely affect essential fish habitat to determine whether the Proposed Action “may adversely affect” designated essential fish habitat for relevant commercially, federally managed fisheries species within the area of the Proposed Action.
Service	Fish and Wildlife Coordination Act (16 USC 661066c)	Coordination with the Service on the effects of the proposed project on fish and wildlife.
Corps	Clean Water Act Section 404 (§ 404, 33 USC §1251 et seq.)	Permitting and minimization of impacts associated with the discharge of dredged or fill material into waters of the United States, including wetlands.
State Agencies		
Ecology	Clean Water Act Section 401 (33 USC § 1251 et seq.)	Issuance of a Section 401 Water Quality Certification to indicate reasonable assurance that a project will comply with Federal and State water quality standards and other aquatic resources protection requirements under Ecology’s authority. Federal regulation delegated to the State. Triggered as part of CWA Section 404 authorization.
Ecology	Construction National Pollutant Discharge Elimination System (NPDES) (90.48 RCW); Clean Water Act Section 402 (§ 402, 33 USC § 1251 et seq.)	Issuance of a permit for construction projects engaged in clearing, grading, and excavating activities that disturb an area of at least 1 acre. Federal regulation delegated to the State.
Ecology	Chapter 90.03 RCW	Issue water rights, as necessary.
WDFW	Hydraulic Project Approval (77.55 RCW)	Granting of approval for construction projects that use, divert, obstruct, or change the natural bed or flow of State waters.
WDFW	Fish and Wildlife Coordination Act (16 USC 661066c)	Coordination with WDFW on effects of the project on fish and wildlife species.
Washington Department of Archaeology and Historic Preservation (DAHP)	National Historic Preservation Act (NHPA) (16 USC § 470 et seq.)	Section 106 Consultation to determine whether the project would impact historic or cultural resources; to be completed by Reclamation and Ecology. DAHP advises and assists Federal agencies in carrying out their Section 106 responsibilities.
Local Agencies		
Kittitas and Yakima Counties	Critical Areas Ordinance, Shoreline Master Program	Granting of approval for actions on private land within the Counties shoreline jurisdiction.

1.13 Public Involvement

Reclamation and Ecology collaborated with several agencies, entities, and organizations to develop the Integrated Plan and the KDRPP, KKC, and BTE proposals. Chapter 6 of the Integrated Plan PEIS (Reclamation and Ecology, 2012) describes the public process for developing the Integrated Plan.

The scoping process for this DEIS officially began on October 30, 2013, with the publication of a Notice of Intent to prepare an EIS in the Federal Register. Reclamation and Ecology held public scoping meetings on November 20, 2013, in Yakima and November 21, 2013, in Cle Elum, Washington. Major issues raised about the KDRPP included operations, reservoir levels and refill, spoils disposal, traffic, hydrologic connectivity between surface and groundwater, surface water quality, slope stability and erosion, noise during construction and operation, socioeconomics and impacts on fish, recreation, groundwater wells, aesthetics, and property values. Concerns expressed about the KKC proposal included whether the project would benefit flows and fish in the upper Yakima River and impacts on aquatic species from the transfer of water between reservoirs. Other concerns included operations, wetlands, spoils disposal, traffic, year-round recreation and access, wildlife and migration, impacts of a tunnel on groundwater flow and transportation corridors, and coordination of the project with other activity in the area such as the Interstate-90 (I-90) Snoqualmie East Project, and construction impacts.

Chapter 5 of this DEIS provides a brief summary of the scoping comments. The scoping report is available at http://www.usbr.gov/pn/programs/eis/kdrpp/index.html. Chapter 5 also describes additional public outreach efforts undertaken and public input received by Reclamation and Ecology.

1.14 Document Organization

This DEIS includes the following chapters:

- **Chapter 1** provides background information on the KDRPP, KKC, and BTE proposals and the Integrated Plan, the purpose and need for the action, legal authorities for the projects, permits and approvals, and a brief description of public involvement. Chapter 1 also includes information on Reclamation's incorporation by reference of the Integrated Plan PEIS and Ecology's adoption of the Integrated Plan PEIS.
- **Chapter 2** describes the Proposed Action, reasonable alternatives to the Proposed Action, and the No Action Alternative. The chapter describes the alternatives development process and alternatives eliminated from detailed evaluation.
- **Chapter 3** describes the affected environment and existing conditions for the environmental resources that could be affected by the Proposed Action and alternatives.
- **Chapter 4** evaluates the potential environmental consequences (direct and indirect) of the Proposed Action and alternatives, and identifies mitigation measures that would avoid or reduce the effects of the Proposed Action and alternatives. For the purpose of this document, cumulative impacts are presented in a section at the end of the chapter and a section is included to describe how the Proposed Action meets the goals of the Integrated Plan. The chapter also includes sections that describe other aspects of Reclamation's compliance with NEPA procedures, including a description of unavoidable adverse impacts, the commitment of resources, relationship between short-term and long-term productivity, and Reclamation's environmental commitments for the Proposed Action.
- **Chapter 5** describes the public involvement, consultation and coordination, and compliance undertaken in the preparation of this DEIS.

Ancillary materials follow Chapter 5 and include a list of EIS preparers, the distribution list, references, and a glossary of project-specific terms. Appendices are attached at the end of the document.

CHAPTER 2 - PROPOSED ACTION AND ALTERNATIVES

Chapter 2 Proposed Action and Alternatives

2.1 Introduction

This DEIS evaluates the potential environmental impacts associated with the Proposed Action. As described in Section 1.3, Reclamation proposes to construct, operate and maintain one or both of two related water resource projects in the upper Yakima River basin to further water supply and habitat restoration. These projects are the Kachess Reservoir Drought Relief Pumping Plan (KDRPP) and Keechelus Reservoir-to-Kachess Reservoir Conveyance (KKC). The Proposed Action also includes an integrated package of aquatic habitat enhancements and assessments focused on improving the abundance and resiliency of bull trout populations in the Yakima River basin. These enhancements are included as part of both the KDRPP and KKC projects.

KKC and KDRPP could potentially be constructed, operated and maintained as stand-alone projects. However, they are evaluated in a single EIS because they could affect and be affected by each other. Reclamation and Ecology are considering how these two parts of the Proposed Action, alone or in combination, contribute to restoring ecological functions and providing more reliable and sustainable water resources for the health of the riverine environment and for agricultural, municipal, and domestic needs. The action alternatives include: KDRPP alone (*Alternatives 2A* and *2B*), KKC alone (*Alternatives 3A and 3B*), and a combination of KDRPP and KCC (*Alternative 4*). Bull trout enhancement is a component of all of the action alternatives.

2.2 Alternatives Development Process

Reclamation and Ecology evaluated KDRPP and KKC conceptually at a programmatic level in the Integrated Plan PEIS (Reclamation and Ecology, 2012) and supporting technical memoranda (Reclamation and Ecology, 2011d and 2011e). Section 2.2 of the Integrated Plan PEIS provides detailed information about the original development of the proposals (Reclamation and Ecology, 2012). The Integrated Plan PEIS also included concepts to address bull trout conditions (see PEIS Sections 2.4.3 Reservoir Fish Passage and 2.4.7.2 Mainstem Floodplain and Tributary Habitat/Watershed Protection and Enhancement).

Since the Integrated Plan was developed, Reclamation and Ecology have advanced the feasibility analysis and design of KKC and KDRPP, and have developed a bull trout enhancement plan in coordination with the Yakama Nation, USFS, Service, and WDFW. Additional concepts for both KKC and KDRPP were developed during Reclamation's Value Planning process identifying new alternatives for conveying water between Keechelus and

Kachess Reservoirs as well as a new pumping plant location and design for KDRPP (Reclamation and Ecology, 2014j and 2014k).

Reclamation and Ecology are in the process of conducting feasibility studies on KKC and KDRPP. As part of the feasibility analyses**,** additional technical memoranda were prepared (Reclamation and Ecology, 2013b and 2013c) and provide refined design, cost estimates, economics and alternatives analysis. The feasibility reports will be finalized in 2015.

Reclamation and Ecology also received input from public scoping, and coordination with cooperating agencies (Chapter 5) in developing the alternatives. Section 2.9 describes other alternatives that Reclamation and Ecology considered, but eliminated from further study. The alternatives evaluated in this DEIS are:

- *Alternative 1 – No Action*
- *Alternative 2A – KDRPP East Shore Pumping Plant*
- *Alternative 2B – KDRPP South Pumping Plant*
- *Alternative 3A – KKC North Tunnel Alignment*
- *Alternative 3B – KKC South Tunnel Alignment*
- *Alternative 4 – Combined KDRPP and KKC*

2.3 Alternative 1 – No Action

The No Action Alternative represents the most likely future in the absence of implementing any of the proposals that are part of the Proposed Action. The No Action Alternative forms the baseline for comparing potential impacts of the Proposed Action and its alternatives. Under *Alternative 1 – No Action*, Reclamation would continue to manage water supply provided by Kachess and Keechelus reservoirs consistent with current operational practices and constraints.

2.3.1 Current Yakima Project Operations and Typical Annual Operations – No Action

The objectives of the current Yakima Project operation are to:

- Store as much water as possible up to the reservoir system’s full active capacity of about 1 million acre-feet from the end of the irrigation season through early spring
- Provide for target flows and diversion entitlements downstream from the dams, meeting Title XII[1] flows at Sunnyside and Prosser Diversion Dams
- Provide reservoir space for flood control operations

[1] Title XII flows were authorized under Phase II of the Yakima River Basin Water Enhancement Project. See Section 3.3.1.4 for additional information.

The irrigation season starts about April 1. During the initial part of the irrigation season, unregulated runoff from tributaries downstream from the five reservoirs, incidental releases from the reservoirs (for target flows and flood control), and irrigation return flows are generally adequate to meet irrigation diversion demands and the Title XII target instream flows at Sunnyside Diversion Dam until about June 24 (but in some years as early as April 1 and as late as August 17). Once these flows fail to meet diversion demands and Title XII instream target flows, Reclamation releases water from the reservoirs, resulting in depletions in the stored water supply. This is commonly referred to as the beginning of the storage control period.

From the beginning of the storage control period until early September, Reclamation uses releases from Cle Elum Reservoir in coordination with releases from Keechelus and Kachess reservoirs to meet mainstem Yakima River water entitlements from the Cle Elum River confluence (River Mile [RM] 179.6) to Sunnyside Diversion Dam (RM 103.8). These water entitlements amount to about 1.46 million acre-feet to supply diversions, mostly from Roza Diversion Dam downstream, including Roza Division, Wapato Irrigation Project, and Sunnyside Division. A peak of about 3,600 cubic feet per second (cfs) for irrigation is moved through this area.

Starting in late August and continuing to about September 12, Reclamation reduces Cle Elum Reservoir releases substantially from about 3,000 cfs or greater down to near 200 cfs, and substantially increases releases from Rimrock Reservoir to meet the September and October irrigation demands downstream from the confluence of the Naches and Yakima rivers. This is referred to as the “flip-flop” operation. The flip-flop operation was instituted to encourage spring Chinook salmon to spawn at a lower streamflow that requires Reclamation to release less stored water during the egg incubation period to protect spawning nests (redds). Affected spring Chinook spawning reaches include the Yakima River from Easton Dam to the city of Ellensburg and the Cle Elum River downstream from the dam.

Reclamation performs a similar operation in years of sufficient water supply, referred to as “mini flip-flop” between Keechelus and Kachess reservoirs, for similar reasons as discussed for the flip flop operation. Reclamation’s releases for irrigation supply from Keechelus Reservoir are substantially greater than from Kachess Reservoir during the June to mid-August period. Beginning in late August, Reclamation gradually switches the releases between the two reservoirs. By September and October, reservoir releases from Keechelus Reservoir are reduced to 100 cfs (or 80 cfs in dry years), and flows from Kachess Reservoir are raised to 1,000 to 1,400 cfs. However, Reclamation cannot always reduce flows to the target level from Keechelus Reservoir because it must continue to supply downstream users in this time period and at times more water is needed from Keechelus Reservoir. Under current conditions, flows more than 10 cfs above the target level occur about 15 percent of the time, and flows of 400 cfs or greater above the target level occur about 2 percent of the time.

2.3.1.1 Keechelus Reservoir

Reclamation fills the Keechelus Reservoir and tries to limit flows to the target of 80 to 100 cfs from early September typically to mid-April. Keechelus Reservoir usually continues to fill until late May or early June, but the outflows are typically higher. In mid-April when Kittitas Reclamation District (KRD) starts diverting from Lake Easton, the flow from Keechelus Reservoir increases as needed up to about 1,100 to 1,300 cfs in June and July. In August, Reclamation ramps flows down again as described above.

2.3.1.2 Kachess Reservoir

Kachess Reservoir operations are similar. Reclamation fills Kachess Reservoir from mid-October to June or July with reservoir releases typically in the 20 to 60 cfs range. This saves the water supply for flip flop operations as explained in Section 2.3.1. After storage control and into August, Reclamation would spill inflows or make releases in the 50 to 400 cfs range. During mini flip-flop, starting in late August and continuing into October releases of up to 1,000 to 1,200 cfs are made to meet demands. Diversions from the reservoir decline from end of September to mid-October, and the cycle starts over again.

2.3.2 Projects, Actions, and Policies under the No Action Alternative

For the purpose of this DEIS Reclamation and Ecology consider *Alternative 1 – No Action* to include the following:

- Planned and designed projects
- Authorized projects that have identified funding for implementation
- Projects scheduled for implementation

In addition to those projects identified in Section 2.3 of the Integrated Plan PEIS (Reclamation and Ecology, 2012), the following projects meet the criteria for No Action.

2.3.2.1 YRBWEP Phase II

The Yakima River Basin Water Enhancement Project Act of 1994, commonly referred to as YRBWEP Phase II, provides for a water conservation program with joint Federal and State funding coupled with local matches. The program provides economic incentives to implement structural and nonstructural water conservation measures. As required by YRBWEP Phase II, a Conservation Advisory Group and Reclamation completed a *Basin Conservation Plan* in 1998, and implementation of conservation measures identified in the plan is ongoing (Yakima River Basin Conservation Advisory Group, 1998). *Alternative 1 – No Action* includes those conservation measures currently being implemented. The *Basin Conservation Plan* also includes limited provisions to acquire land and water rights on a permanent and temporary basis to improve instream flows.

On-going YRBWEP Phase II projects that fit the criteria in Section 2.3.2 are:

- Roza Irrigation District Reregulation Reservoir which would conserve 8,584 acre-feet annually when construction is completed and it is operational in 2016.
- Sunnyside Division Board of Control Phase IIB Enclosed Lateral Improvement Projects which would conserve 6,461 acre-feet annually when construction is completed and it is operational in 2032.

2.3.2.2 WSDOT I-90 Snoqualmie Pass East Phase 2A

Another project that meets the no action criteria is the Washington State Department of Transportation's (WSDOT) I-90 - Snoqualmie Pass East Phase 2A - Keechelus Dam Vicinity to the Stampede Pass Interchange project. As part of this project, WSDOT and the Federal Highway Administration (FHWA) will replace a 2.1-mile section (milepost 59.9 to 62.0) of existing interstate highway with a new six-lane highway, add a new chain-up area, stabilize rock slopes, remove and reclaim the Price Noble Creek Rest Area and sno-park, and construct a wildlife over-crossing near Price Noble Creek. Construction is scheduled to begin in spring 2015 with completion planned for fall 2019. WSDOT evaluated the impacts of this project in the *I-90 - Snoqualmie Pass East Final EIS and Section 4(f) Evaluation* (WSDOT, 2008).

2.4 Alternative 2A – KDRPP East Shore Pumping Plant

KDRPP consists of a series of facilities to pump water from Kachess Reservoir and convey it to the Kachess River, which discharges to the Yakima River at Lake Easton. KDRPP would allow the reservoir to be drawn down to about elevation 2,110, approximately 80 feet lower than the current outlet and 152 feet below full pool by using a pumping plant. This would allow access to up to an additional 200,000 acre-feet of water that is currently stored in the reservoir below the elevation of the existing outlet (elevation 2,192.75).

The pumping plant would be used to deliver up to 200,000 acre-feet of water during drought years to downstream Yakima Project irrigation districts, including KRD, Roza Irrigation District (RID), and the Wapato Irrigation Project (WIP)[2]. Reclamation and Ecology define a drought year as a year when water supply falls below 70 percent of proratable water rights. KDRPP would enable delivery of enough water to contribute to increasing prorationing up to 70 percent. As described in Section 1.3 of the Integrated Plan PEIS, 70 percent would provide a water supply sufficient to prevent severe economic losses to proratable water rights users (Reclamation and Ecology, 2012).

Reclamation would use the pumping plant during drought years and could possibly use it in following years as the reservoir is refilling to a level above the

> Water year is the 12-month period from October 1 through September 30.

[2] Kennewick Irrigation District is also considering participating in the KDRPP proposal.

existing gravity outlet. This would result in the reservoir being drawn down to the gravity outlet level (elevation 2,110) by about August in drought years. KDRPP would deliver water stored in Kachess Reservoir throughout the remainder of the water year and until the reservoir refills above the gravity outlet level. At the proposed rate of 1,000 cfs, it would take about 101 days to pump the entire 200,000 acre-feet of stored water that is below the elevation of the existing outlet. Section 4.3 includes information about expected reservoir levels under operation of KDRPP.

This DEIS evaluates two alternatives for KDRPP: *Alternative 2A – KDRPP East Shore Pumping Plant*, and *Alternative 2B – KDRPP South Pumping Plant*. The alternatives primarily differ in location of the pumping plant, but also have differences in infrastructure because of pumping plant designs. Reclamation would operate KDRPP the same, regardless of the location of the facilities.

Alternative 2A – KDRPP East Shore Pumping Plant includes a mostly underground pumping plant located on the east shore of Kachess Reservoir. The pumping plant would receive water via a tunnel from an intake located on the floor of the reservoir (Figure 2-1). A pipeline located on the reservoir bed would convey water from the pumping plant to a spillway and discharge structure located just downstream from the existing Kachess Dam outlet channel, where it would be released to the Kachess River (Figure 2-2). A more technical description of the project design is included in the Draft KDRPP Construction Scheme and Schedule (Reclamation and Ecology, 2014e).

This section describes the proposed facilities and construction methods for *Alternative 2A – KDRPP East Shore Pumping Plant*. Table 2-1 lists the *Alternative 2A* facilities and the DEIS sections in which they are described. Table 2-2 lists the same for the *Alternative 2A* construction methods. Figures 2-1, 2-2, and 2-3 illustrate the facilities. The bull trout enhancements included as part of this alternative are described in Section 2.4.5.

Table 2-1. *Alternative 2A* Facilities

Facilities	EIS Section
Reservoir intake and tunnel	2.4.1.1
Pumping plant	2.4.1.2
Pipeline	2.4.1.3
Surge tank	2.4.1.4
Outlet works and discharge	2.4.1.5
Permanent access roads	2.4.1.6
Power substation and transmission line	2.4.1.7

Table 2-2. *Alternative 2A* Construction Methods

Facilities	EIS Section
Site preparation	2.4.2.1
Reservoir intake and tunnel	2.4.2.2
Pumping plant	2.4.2.3
Pipeline	2.4.2.4
Outlet works and discharge	2.4.2.5
Surge tank	2.4.2.6
Power substation and transmission line	2.4.2.7
Temporary construction facilities	2.4.2.8

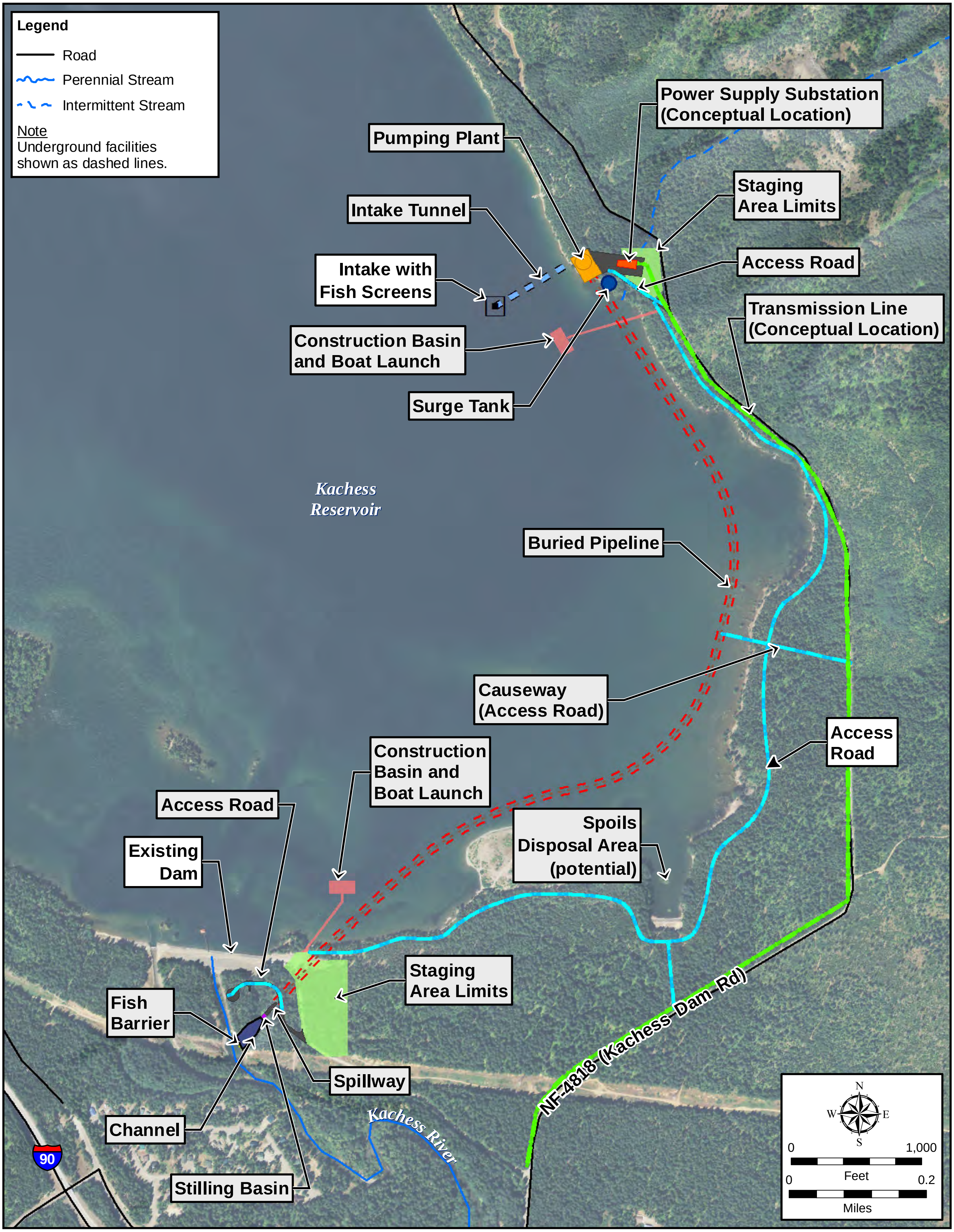

Figure 2-1. ***Alternative 2A – KDRPP East Shore Pumping Plant*** **Overview**

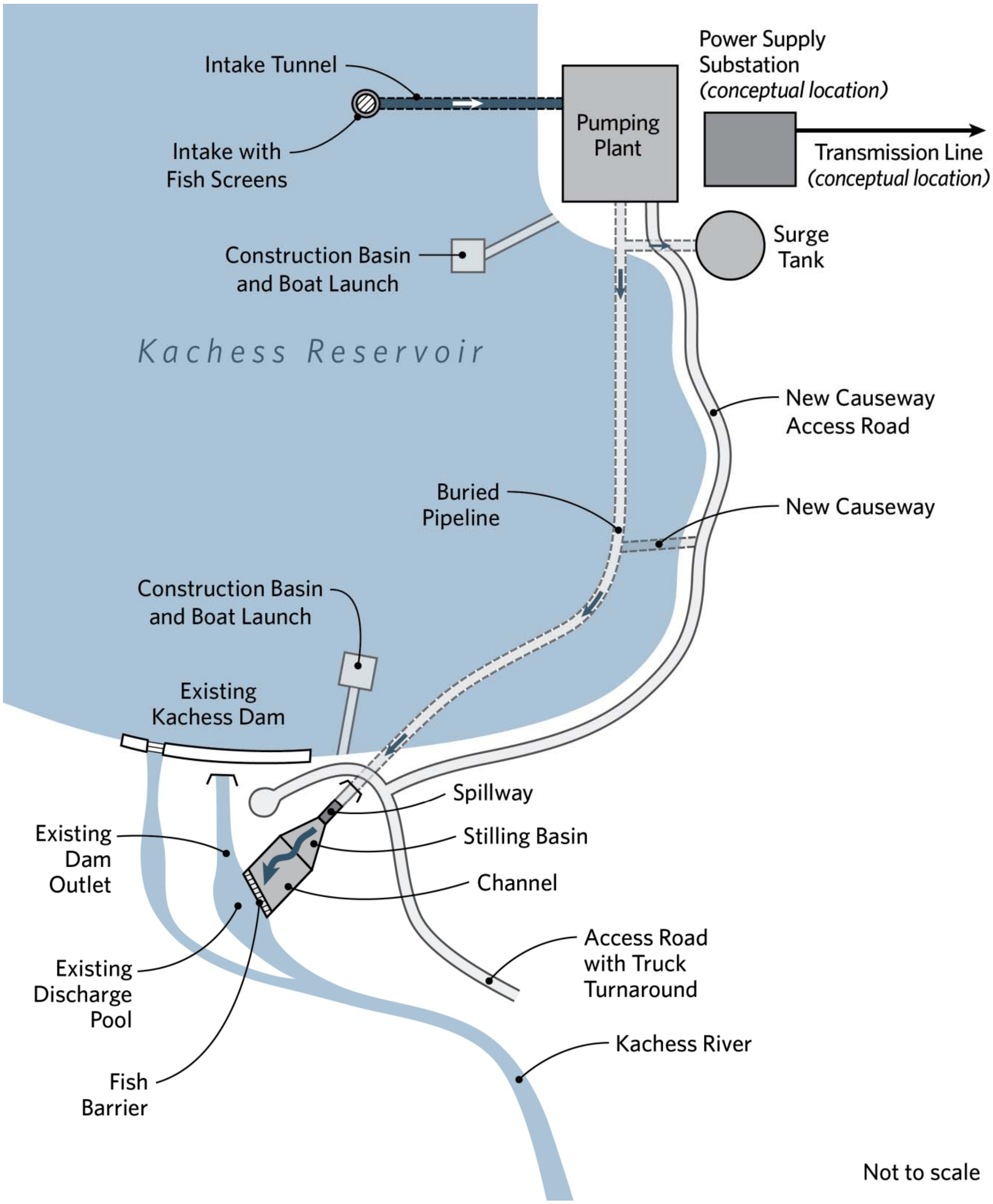

Figure 2-2. ***Alternative 2A – KDRPP East Shore Pumping Plant*** **Conceptual Site Plan**

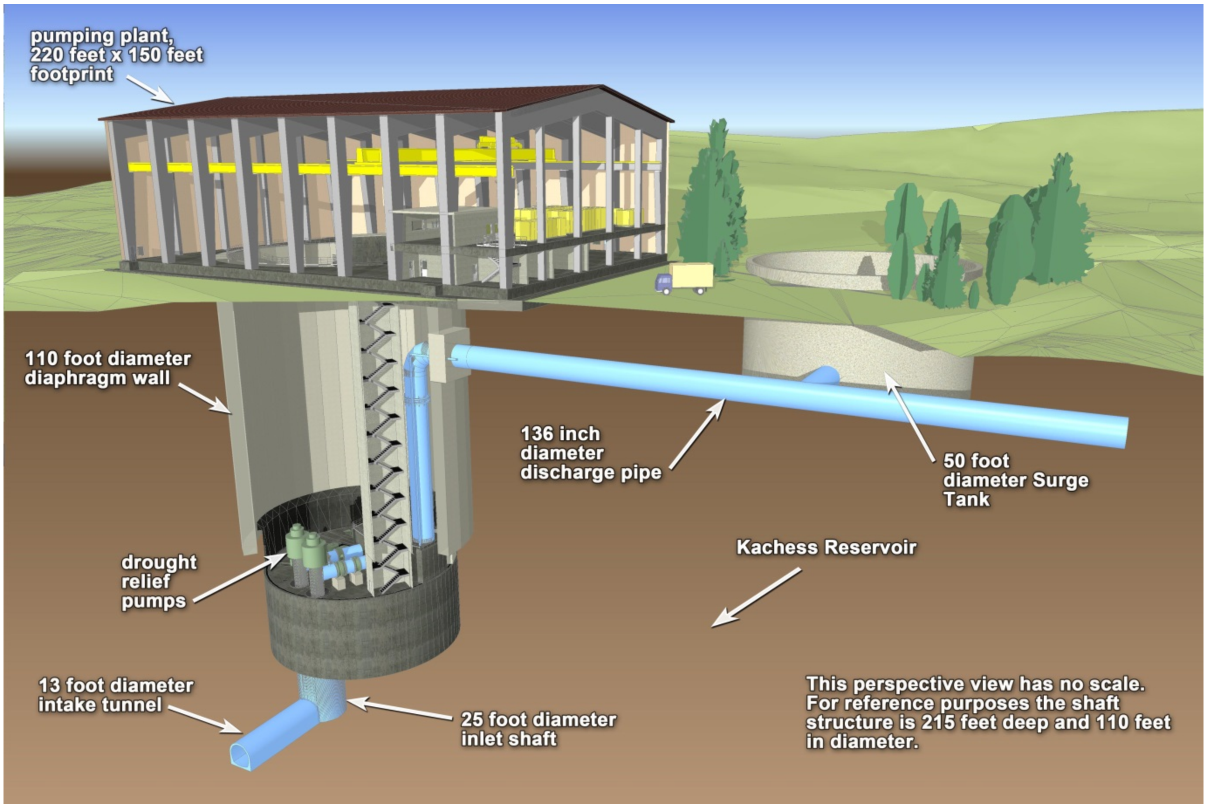

Figure 2-3. ***Alternative 2A – East Shore Pumping Plant***

2.4.1 Facilities

2.4.1.1 Reservoir Intake and Tunnel

For *Alternative 2A – KDRPP East Shore Pumping Plant*, the reservoir intake structure would include a 13-foot-diameter steel-lined intake, installed on the floor of the reservoir at elevation 1,989. The location of the intake is in the southeast corner of the reservoir, approximately 5,000 feet northeast of the existing dam (Figure 2-1). The intake would contain motorized slide gates to control the flow through the structure and include a fish screen structure, consisting of cylindrical 7-foot by 10-foot stainless steel screens. An approximately 650-foot-long, 15-foot-diameter intake tunnel would connect the intake to the pumping plant on the shore of the reservoir.

2.4.1.2 Pumping Plant

Pumping Plant Shaft. The pumping plant would be housed in a below-ground circular shaft made of reinforced concrete (approximately 170 feet deep and 110 feet in diameter) on the east shore of the reservoir. The shaft would have equipment at the bottom. Additional equipment would be housed in a building situated above the shaft at elevation 2,265. From the floor of the shaft (in the wetwell of the pumping plant), a smaller 25-foot-diameter shaft would continue down in rock to the intake tunnel.

Pumping Units. The primary drought relief pumping units to transfer water from Kachess Reservoir would be four vertical turbine pumps with pump suction inlets located at approximate elevation 2,080. Two vertical turbine pumps capable of pumping 20 cfs each would provide minimum flows in the Kachess River whenever the pool level falls below the existing outlet, but the primary drought relief pumps are not in operation. Further, two vertical turbine pumps would facilitate dewatering of the suction inlet conduit, which in turn would facilitate maintenance of the primary pumps. Two drainage sump pumps would convey clean water, processed through an oil-water separator sump, back to Kachess Reservoir.

Pumping Plant Building. An above-ground steel building (approximately 150 feet long by 220 feet wide and 65 feet high) would house the ancillary systems for the pumping plant. Systems include access and operating space; heating, ventilation, and air conditioning (HVAC) equipment; pump instrumentation and controls; flow meters and other automated controls; security features; a crane for delivering materials to below-ground floors; elevator; delivery bay; and fire suppression and stormwater systems.

2.4.1.3 Pipeline

As part of *Alternative 2A – KDRPP East Shore Pumping Plant*, a single 136-inch-diameter steel pipeline would convey water from the pumping plant approximately 7,755 feet along the reservoir bed for release to the Kachess River just downstream from the dam. The pipeline alignment would generally follow the shoreline of the reservoir, just below the reservoir high pool level at approximate elevation 2,240. The pipeline corridor would be under water when the reservoir is at full pool. Soil (approximately 7 feet deep) would cover the pipeline to maintain zero buoyancy and keep it submerged. The pipeline would exit the pumping plant shaft at invert elevation 2,212 and discharge into the dam spillway outlet works at invert elevation 2,220. The pipeline would deliver water through a discharge spillway into the Kachess River downstream from the dam.

A 25-foot-wide gravel access road alongside the entire pipeline alignment would provide permanent access to the pipeline (Figure 2-1). The pipeline would include three access points: at the pumping plant shaft, at the midway point (causeway), and at the south end of the pipeline near the discharge spillway. The access points would be located on the side of the pipe, with access provided from an adjacent 8-foot-diameter, prefabricated concrete structure. The causeway would have a finished grade above elevation 2,265, higher than the normal full pool elevation of the reservoir. The causeway would be 1,080-foot-long with a 50-foot-radius truck turn-around at the reservoir end.

2.4.1.4 Surge Tank

A 110-foot-diameter 30-foot-high surge tank, connected to the pipeline immediately downstream from the pumping plant, would provide protection against hydraulic surge. The surge tank would be fully fenced and uncovered, with approximately 3 feet extending above ground.

2.4.1.5 Outlet Works and Kachess River Discharge

The pipeline for *Alternative 2A – KDRPP East Shore Pumping Plant* would terminate at a new discharge spillway near the top of the left abutment of the dam. The existing Kachess Dam would not be modified. The new concrete spillway would include energy dissipaters to reduce the water velocity at the bottom of the spillway. The water would flow into a concrete stilling basin and then through a concrete channel into a discharge pool. The Kachess River flows out of the discharge pool towards Lake Easton Reservoir.

2.4.1.6 Permanent Access Roads

In addition to the permanent pipeline access road and causeway described in Section 2.4.1.3, new gravel access roads would be required for the pumping plant, and at the spillway and discharge structure. The pumping plant access road would be approximately 26 feet wide and 435 feet long and the spillway and discharge structure access road would be approximately 26 feet wide and 910 feet long. The total distance of new access road would be about 2,425 feet.

2.4.1.7 Power Supply Substation and Transmission Line

An interconnection to the PSE supply would be required in order to provide power for KDRPP pumps. A power supply substation, surrounded by a fence, would be constructed adjacent to the east shore pumping plant. Service load is measured in units called megavolt amperes (MVA). The pumping plant service load would be approximately 33 MVA. The substation would have two transformers with a self-cooled rating of no less than 16 MVA and a full-load rating no less than 35 MVA. Power would be supplied to the substation via a new 115 kilovolt (kV) transmission interconnection at the existing Puget Sound Energy (PSE) Easton 115 kV substation.

Approximately 5 miles of new 115 kV, single wood pole overhead transmission line would be needed to convey electric power from the Easton substation to the proposed Kachess Reservoir substation. The alignment for the proposed transmission line has not yet been finalized. Reclamation and PSE have developed a conceptual plan for the transmission line, which is evaluated at a programmatic level in this DEIS. PSE will conduct a route study and appropriate environmental review on the proposed transmission line. PSE and Reclamation propose to overbuild the existing distribution system where possible and thus locate portions of the new line in existing rights-of-way. Some of the existing poles would be replaced with taller poles and some easement modifications may be necessary. Beginning at the Easton substation, the transmission line would follow the existing transmission line on Railroad Street and Lake Easton Road and use existing crossings of the Yakima River and I-90. North of I-90, the transmission line would follow existing transmission corridors or be located along roads. At some point, the transmission line would follow Kachess Dam Road to the proposed Kachess Reservoir substation. A partial potential alignment is illustrated in Figure 2-1. The pumping plant would include a permanent diesel-powered generator to provide a backup power supply.

2.4.2 Construction

Construction of *Alternative 2A – KDRPP East Shore Pumping Plant* is expected to be completed over three construction seasons. Normal reservoir operations would continue during construction and Kachess Reservoir would not be drawn down for construction purposes below the current operations drawdown. The following general construction activities would be included.

2.4.2.1 Site Preparation

Site preparation for construction would include establishing erosion and sedimentation control measures and clearing and grubbing. Clearing and grubbing would be required for facilities, roads, temporary construction facilities, construction parking, as well as staging and material storage. A total of approximately 65 acres would be cleared for the construction of *Alternative 2A – KDRPP East Shore Pumping Plant* (not including the transmission line); of this approximately 58 acres would be restored after construction with native vegetation. Most of the clearing would be for temporary roads, construction staging, and construction parking.

2.4.2.2 Reservoir Intake and Tunnel

The intake would be installed in bedrock through a 15-foot-diameter hole drilled from a barge in approximately 140 to 210 feet of water or from a temporary offshore platform. To construct the intake, a small conical area would first be dredged. The contractor would hang a turbidity curtain from moored buoys prior to the initiation of dredging. Rock would be blasted or split and the material clam shelled out of the excavation, progressively enlarging the hole until it reached its full 15-foot-wide diameter. The contractor would float the prefabricated steel intake, lower it into place in the drilled hole, and fill the space on the outside of the shaft with concrete.

The intake would include a prefabricated fish screen, which would be manufactured off-site, and assembled on the reservoir bed when the reservoir is drawn down in late summer and fall. The fully assembled fish screen would be floated when the reservoir refills in the winter, and lowered from a barge into place above the intake as the reservoir draws down.

The intake tunnel would be mined in rock from the pumping plant shaft on shore out to the intake. The mining process includes ground excavation using the drill and blast method. Temporary rock support would be installed until the permanent walls were constructed. Interior reinforced concrete walls would then be installed.

2.4.2.3 Pumping Plant

The area of the east shore pumping plant would be excavated down to the elevation of the pumping plant shaft and a dewatering system would be installed. The shaft would be installed using confined drill-and-blast methods. Spoils would be transported from the site by truck and hauled to an approved disposal site. Following shaft excavation, construction would include two sets of tasks:

- Mine a tunnel from the pumping plant shaft out to the intake, complete construction of the pumping plant shaft, connect to the intake tunnel, and install fish screens
- Construct the building over the pumping plant shaft, install the bridge crane inside the building, and install mechanical equipment and piping and concrete works within the pumping plant shaft

2.4.2.4 Pipeline

A 300-foot-wide construction corridor along the reservoir shore would be used to facilitate pipeline installation. The pipeline corridor would be on the reservoir bed; therefore, no clearing would be required during site preparation.

2.4.2.5 Outlet Works and Kachess River Discharge

An ogee-crest spillway outlet structure to slow water in the spillway and dissipate its energy would be constructed at the outlet works. Other outlet facilities include a rectangular concrete chute and discharge channel with fish screen connected to the existing Kachess discharge pool.

2.4.2.6 Surge Tank

The surge tank would be constructed after the pipeline is completed. First, a reinforced concrete ground slab would be placed, and then reinforced concrete sidewalls would be constructed.

2.4.2.7 Power Supply Substation and Transmission Line

The power supply substation would be located adjacent to the east shore pumping plant on a flat bench. Approximately 0.6 acres would be cleared for construction of the substation. Substation components, such as transformers and switchgear would be placed on reinforced concrete foundations. For the transmission line, wooden poles would be erected in a cleared right-of-way with a minimum width of 50 feet. To the extent feasible, the existing right-of-way would be used, minimizing the need for additional clearing. Poles would be 55 to 85 feet tall. The right-of-way would be cleared and regularly maintained to prohibit vegetation that may interfere with the transmission line. Where possible, the existing distribution system would be overbuilt, although some easement modifications may be necessary. Overbuilding would involve replacing some of the existing poles with taller poles that would support another line above the existing line. The substation and transmission line would be constructed using conventional construction equipment.

2.4.2.8 Temporary Construction Facilities

The following sections describe the temporary facilities needed to facilitate construction. The specifications for these facilities would be developed in the final design phase of design, but are expected to be generally consistent with the locations identified in the DEIS.

Access Roads, Staging Areas, and Construction Parking. Primary construction access would be via local roads to and from the I-90 Sparks Road Interchange at Milepost 70. A travel route would be necessary along the southeast shore of Kachess Reservoir to facilitate construction activities, hauling of materials, and access to the construction sites. In addition to the existing access road, there would be three new access roads all of which would connect to the existing gravel Kachess Dam Road and be gravel-surfaced. The roads would provide access to the spoil disposal area, the pipeline causeway, and the pumping plant area. Approximately 0.4 miles would be cleared for construction of the access roads. The new access roads would be constructed using conventional construction equipment.

The primary construction staging for temporary storage of equipment and materials, as well as parking and administration offices would be located along the existing graveled Kachess Dam Access Road near the dam end of the road. Additional construction staging and parking would be located at the pumping plant site. Staging areas would cover about 4 acres.

The entire pumping plant construction site would be surrounded by a security fence and gates would be installed on construction access roads.

Concrete Batch Plant. A concrete batch plant is proposed to supply concrete onsite for the construction of the pumping plant shaft and outlet works facilities. The batch plant and materials stockpile area would be located along the existing Kachess Dam Access Road near the dam end of the road. The batch plant would include necessary material stockpiles and provisions for concrete production activities such as rewashing, rescreening, and winterization.

Construction Basin and Boat Launch. A temporary construction basin and boat launch is proposed on either the south or east shore of Kachess Reservoir to facilitate construction of the intake tunnel, intake, and fish screens (see Section 2.4.2.2). The south shore facility would be shallow and most easily accessible. It could be used most of the year, but would be inaccessible when the reservoir is drawn down. If a year-round boat launch is needed, it would be a deep-water facility located near the east shore pumping plant site. It would be usable year-round, including when the reservoir is drawn down. Short temporary access roads would be necessary for both construction basin and boat launch areas. Portions of the road may be located on the reservoir bed.

Spoils Disposal Area. Construction of the facilities would require excavation and stockpiling of approximately 117,000 cubic yards (cy) of soil and rock material. Spoils would be disposed of in the abandoned historical spillway channel located at the southeast corner of Kachess Reservoir. The spoils disposal area would be approximately 148,000 square feet and could accommodate the full volume of excavated spoils. If the spillway channel cannot be used for spoils disposal, Reclamation would transport and dispose of the materials off-site. For this DEIS analysis, Reclamation assumed the offsite location would be within 12 miles of the reservoir, although no specific site has been identified. Reclamation is consulting with WSDOT to determine if construction spoils could be used by WSDOT as part of the ongoing I-90 improvements located approximately 1 mile from the site. Underwater dredge spoils and pipeline excavation spoils would be returned to the reservoir floor.

Temporary Power Supply. The local power grid or onsite generators would supply temporary power for construction. PSE currently supplies power to the south end of Kachess Reservoir. Otherwise, generators would supply temporary construction power.

2.4.2.9 Construction Scheduling and Sequencing

Construction of all the facilities associated with *Alternative 2A – KDRPP East Shore Pumping Plant* is expected to last 3 years, (Table 2-3). The start date for construction is contingent upon the proposals receiving congressional authorization and funding, and completion of all permitting and consultation requirements[3].

The estimated duration for the different construction phases is as follows:

- Mobilization, clearing, grading, establish construction facilities (7 months)
- Intake and fish screens (8 months)
- Intake tunnel (6 months)
- Surge tank (6 months)
- Pumping plant (12 months)
- Pumping plant building and equipment (6 months)
- Pipeline (10 months)
- Outlet works and discharge structure (6 months)
- Power supply substation and transmission line (12 months)
- Restoration (3 months)

[3] For the purposes of economic and cost estimates prepared for feasibility study and socioeconomic analysis prepared for this DEIS, 2016 was assumed to be the start of construction; however, this is speculative due to the fact that authorization and funding are needed to proceed with construction.

Table 2-3. *Alternative 2A – KDRPP East Shore Pumping Plant* Approximate Construction Schedule

Year 1	
	Clear and grade pumping plant and outlet works sites
	Construct construction access roads
	Establish administration offices, parking, and staging areas
	Construct construction basin and boat launch area
	Establish concrete batch plant, stockpile areas, and spoils disposal areas
	Set up temporary power supply and generator
	Begin pipeline construction
	Begin pumping plant shaft construction
Year 2	
	Dredge for intake and construct intake
	Add fish screens
	Continue pipeline construction
	Construct surge tank and concrete outlet works structures
	Complete pumping plant shaft construction
	Construct tunnel access shaft and begin constructing of the intake tunnel
	Construct transmission line and substation
Year 3	
	Complete pipeline construction
	Complete intake tunnel
	Assemble prefabricated building for the pumping plant
	Install ancillary equipment in the pumping plant building (electrical, HVAC)
	Install pumps and other equipment
	Complete site cleanup and restoration

2.4.3 Typical Annual Operations

Alternative 2A – KDRPP East Shore Pumping Plant would be operated remotely from Reclamation's Yakima Operations Center, but local operational capabilities would be available. Reclamation would use *Alternative 2A – KDRPP East Shore Pumping Plant* to supply water to proratable water users such KRD, RID, and WIP. *Alternative 2A* would be used in a drought year, typically during the period that begins on about July 1 and ends about 10 to 12 weeks later. Depending on the duration and severity of the drought, it would be operated for that 10- to 12-week period for a single year or multiple consecutive years. Reclamation may also operate KDRPP in years after a drought when the reservoir is refilling. Reclamation would operate KDRPP when water supply falls below 70 percent of proratable water rights. As described in Section 1.3 of the Integrated Plan PEIS, 70 percent would provide a water supply sufficient to prevent severe economic losses to proratable water rights users (Reclamation and Ecology, 2012).

Reclamation would operate the *Alternative 2A – KDRPP East Shore Pumping Plant* by pumping water out of Kachess Reservoir that is below the existing gravity outlet located at elevation 2,192. It would allow pumping of 200,000 acre-feet, lowering the reservoir by as much as 80 feet. The pumping plant would pump up to 1,000 cfs during drought years and in following years when needed to meet water supply requirements while the reservoir is refilling to a level above the gravity outlet. In years when Reclamation uses KDRPP, Kachess Reservoir water levels would be lowered starting early in the irrigation season (generally April to October). This would result in the reservoir being drawn down to the gravity outlet level by about August. *Alternative 2A – KDRPP East Shore Pumping Plant*, would deliver Kachess stored water throughout the remainder of the water year and in subsequent years until the reservoir refills above the gravity outlet level. Section 4.3 includes information about expected reservoir levels under operation.

2.4.4 Maintenance Activities

For *Alternative 2A – KDRPP East Shore Pumping Plant*, Reclamation would perform ongoing maintenance activities associated with the pumping equipment and operable mechanical equipment to ensure that the equipment is fully operational when needed. Reclamation would conduct periodic inspection and testing of all civil, mechanical, and electrical features in accordance with its existing standards and directives. Reclamation would develop additional maintenance practices during the final design phase.

Typical maintenance would include annual facility reviews, and daily cleaning of debris off the trashrack and fish screens. At the pumping plant, minor painting, facility cleaning, and lubrication would be required on a monthly and annual basis depending on when it is operated. Major maintenance and disassembly of pumps would take place on a 5-year cycle. Replacement of pumps and associated equipment would be on a 20-year cycle.

2.4.5 Bull Trout Enhancement

As discussed in Section 1.5, Reclamation and Ecology are developing an MOU with the Service, NMFS, USFS, WDFW, and the Yakama Nation to implement bull trout enhancement to enhance the resiliency of bull trout populations in the Yakima River basin. The BTE is included as a component of all the action alternatives evaluated in this DEIS. The BTE is included in Appendix C of this DEIS. The BTE includes projects to enhance bull trout habitat as well as assessments of future efforts to enhance bull trout populations. This DEIS evaluates proposed stream channel and floodplain restoration at Gold Creek and stream passage improvement at Cold Creek. Both creeks are tributaries of Keechelus Reservoir (Figure 2-4).

Historically, bull trout populations in the Yakima River basin interacted with one another and contributed to the overall resiliency of the species. Passage barriers, including reservoir dams, have reduced movement of fish, limiting the potential for genetic exchange between populations. Currently eight of the 12 populations of bull trout in the Yakima River basin are isolated from one another, including those in Kachess and Keechelus reservoirs.

Three bull trout populations of adfluvial fish (fish that live in reservoirs and migrate to rivers or streams) inhabit Kachess and Keechelus reservoirs: Box Canyon Creek and Kachess River populations in Kachess Reservoir, and the Gold Creek population in Keechelus Reservoir. Each population has chronically low abundance. The primary threats to bull trout include low abundance, passage barriers caused by storage dams and reservoir drawdowns, and dewatering in tributary streams where bull trout spawn and rear (Reiss et al., 2012).

The South Fork Tieton River, with an average of 187 redds counted annually, is considered the strongest population in the Yakima River basin (Reiss et al., 2012). However, this population is threatened by Tieton Dam (at Rimrock Reservoir) (Figure 1-1), which creates a passage barrier, entrains fish, and contributes to a reduced prey base. The South Fork Tieton population is further threatened by habitat-limiting channel modifications in the river.

The BTE includes habitat restoration and enhancements for two tributaries of Keechelus Reservoir (Gold Creek and Cold Creek), studies of improved bull trout passage for Kachess Reservoir tributaries (Kachess River and Box Canyon Creek), studies of fish passage improvements on the South Fork Tieton River, and assessments of bull trout population enhancements and nutrient enhancement in Kachess and Keechelus reservoirs (see Appendix C for a description of the studies and assessments). This DEIS evaluates the impacts of the enhancements proposed at Gold and Cold creeks, which are described in this section. If the studies and assessments included in the BTE recommend implementation of specific projects, Reclamation and Ecology would undertake additional NEPA and SEPA analysis and obtain regulatory approvals, including ESA consultation.

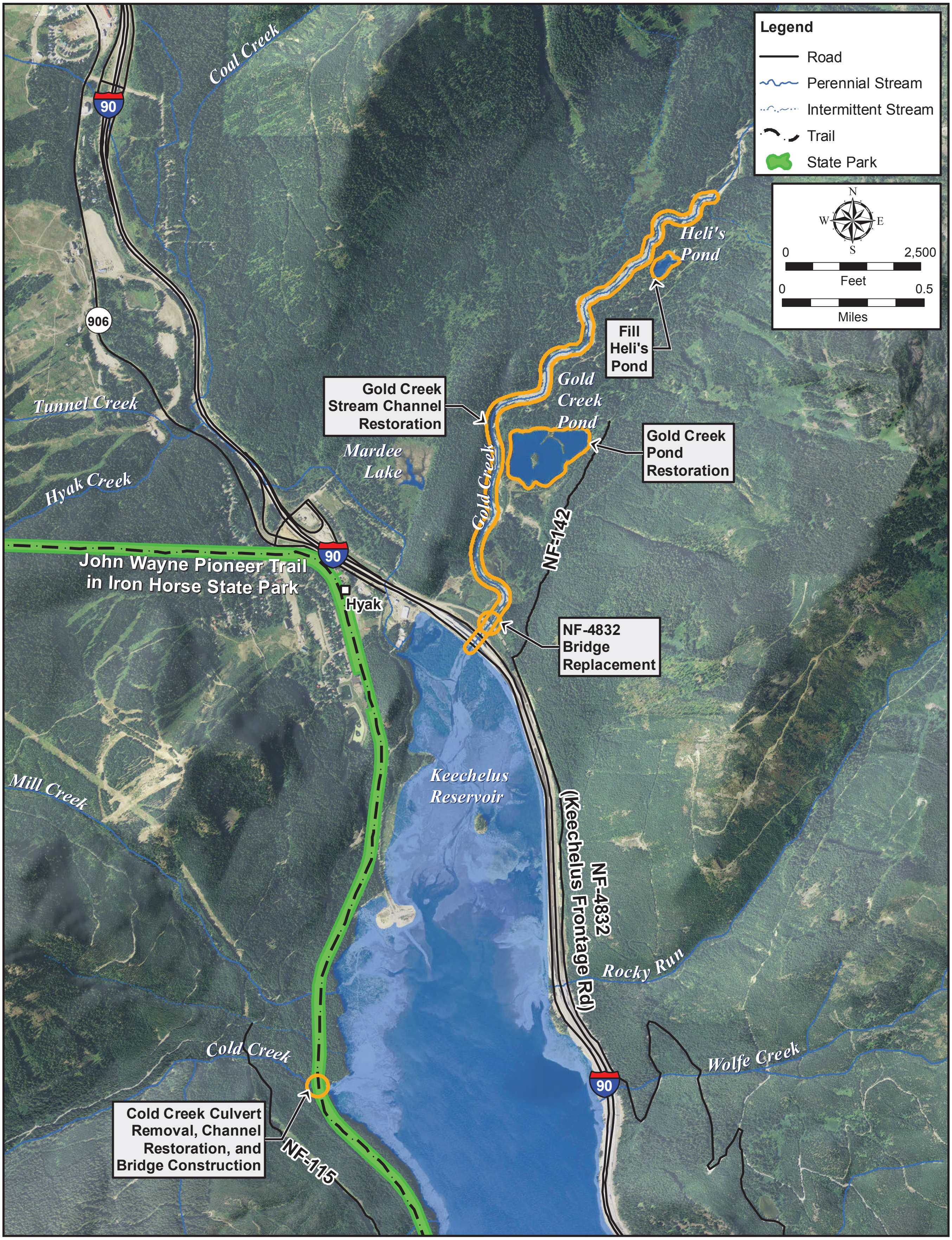

Figure 2-4. Bull Trout Enhancement Area at Gold Creek and Cold Creek

2.4.5.1 Gold Creek Passage and Habitat Improvements

Gold Creek is the only tributary of Keechelus Reservoir that supports bull trout spawning. The goal of BTE projects at Gold Creek is to restore and enhance channel hydraulic connectivity to provide better bull trout passage to spawning grounds, improve rearing habitat, and reduce stranding of fish. Reclamation and Ecology would undertake several specific projects to address Gold Creek dewatering:

- Narrow the channel width along 1.0 to 2.3 miles of Gold Creek
- Narrow the channel down from 100 to 200 feet wide to 50 to 125 feet wide
- Restore a hardened channel utilizing wood and rock to aid in perennial flow and adding habitat along 1.0 to 2.3 miles of Gold Creek

The Kittitas Conservation Trust (KCT) is assessing the effect of two artificial ponds, Gold Creek and Heli's ponds, on dewatering Gold Creek. Based on the results of this assessment, Reclamation and Ecology would implement projects to reduce dewatering by:

- Reconfiguring the Gold Creek Pond size and shape and pond outlet. This may involve partial filling of the pond or raising the pond surface elevation.
- Regrading of berms surrounding Gold Creek Pond (approximately 13 to 16 acres)
- Filling Heli's Pond and outlet channel (approximately 2 acres)

Some of the property included in the proposed restoration at Gold Creek and at Heli's Pond is located on private land so real property or easement acquisitions may be required. Acquisitions would be from willing sellers.

Channel restoration would require inwater work and possibly short-term diversion of flows. Construction would require temporary access roads and the operation of heavy equipment in riparian areas. Erosion and sediment control measures would be implemented during construction. Immediately after construction, disturbed areas would be restored by regrading the surface and planting native species. All inwater work would be subject to work windows that minimize disturbance to bull trout and other aquatic species.

2.4.5.2 Gold Creek USFS Bridge Replacement

Reclamation and Ecology would partner with USFS to replace the bridge on USFS Road NF-4832 to restore the Gold Creek floodplain, a project for which the USFS has already prepared a NEPA Environmental Assessment (EA) and Finding of No Significant Impact (USFS, 2011a and 2011d). The new Gold Creek USFS Bridge would span the floodplain of Gold Creek (approximately 725 feet wide) and would provide the following benefits: improved hydrologic connectivity, lower stream velocities, improved channel migration, floodplain restoration, restored capacity for sediment transport, reduced sediment and temperature, and improved groundwater flow. Bridge replacement would require the following construction activities:

- Placement of shafts or pilings to provide a foundation for the bridge structure. Installing pilings would require an impact hammer and shafts would require drilling machines
- Installation of the bridge superstructure using cranes and other heavy equipment
- Installation of a detour around the construction area
- Construction of temporary roads and staging areas
- Clearing and grubbing
- Removal of the existing bridge and approach roadway fills (approximately 50,000 cubic yards of material)
- Construction of a new embankment (approximately 6,000 cubic yards of material).

Bridge and foundation installation would require inwater work and flows may need to be partially or completely diverted from the existing channel. The timing of all inwater work would be subject to work windows that minimize the disturbance to bull trout and other aquatic species. Erosion and sediment control plans would be implemented and disturbed areas would be regraded and revegetated with appropriate native plant species.

2.4.5.3 Cold Creek Passage Improvement

Currently, a perched culvert and a dewatered stream channel during low pool elevations prevents bull trout access to Cold Creek from Keechelus Reservoir. Cold Creek may provide significant tributary habitat for Keechelus Reservoir bull trout if access is provided. The existing culvert crosses Cold Creek at Washington State Park’s John Wayne Pioneer Trail. Reclamation and Ecology would remove the passage barrier at the mouth of the creek and replace it with a bridge.

The specific method of providing passage into Cold Creek has not been determined, but a concept-level plan exists which includes the following elements (Tappel, 2012):

- Excavate the existing John Wayne Pioneer Trail (historical railroad grade) to an elevation approximately 55 feet below existing trail elevation, including removal of the existing concrete culvert
- Build a new stream channel with 50-foot-wide bottom under the trail crossing, with cross-section dimensions to connect to the undisturbed creek sections upstream. Use the existing creek's downstream control (plunge pool below culvert) for channel vertical control
- Install a 120-foot-long by 14-foot-wide steel beam or prestressed concrete girder bridge for a new trail over Cold Creek, about 35 feet lower than the existing trail

crossing. Place the bridge superstructure on precast concrete footings protected by large armor rock (buried in streambanks)

- Gradually slope the trail at 6 percent grade on both sides of the new bridge, to intersect the existing trail about 600 feet from the creek
- Roughly excavate a 50-foot-wide channel at about 8 percent slope to 200 feet upstream of the new bridge. This channel would be excavated through existing streambed deposits (natural alluvial materials). High flows in Cold Creek would be expected to develop (headcut) an armored channel at about 5 percent slope to taper into existing creek channel reaches upstream
- Excavated materials from the trail embankment excavation and from channel excavation would be used onsite to construct more natural bank extensions for Cold Creek downstream from the trail
- Replace the galvanized steel cable braces and anchors at the existing powerline and reset them for a lower trail grade
- Reconstruct more natural topography and ground contours downstream (south) of the trail and revegetate the area with native shrubs and trees to improve upland resources within the project vicinity

To preserve recreation access, the new bridge could be installed prior to excavation of the trail. Channel excavation and culvert removal would require inwater work and diversion of flow from the existing channel. Construction would require temporary access roads and the operation of heavy equipment in the riparian area. During construction, and sediment control measures would be implemented. Immediately after construction, disturbed areas would be restored by regrading the surface and planting native species. All inwater work would be subject to work windows that minimize disturbance to bull trout and other aquatic species in the project area.

2.4.6 Mitigation

Reclamation and Ecology would provide mitigation for impacts associated with *Alternative 2A – KDRPP East Shore Pumping Plant.* Specific mitigation measures are described in Chapter 4 at the end of each resource section. Reclamation and Ecology would also comply with the environmental commitments for the Proposed Action as described in Section 4.30.

2.5 Alternative 2B – KDRPP South Pumping Plant

Alternative 2B – KDRPP South Pumping Plant Alternative is similar to *Alternative 2A* except that the intake and pumping plant would be located at the south end of the reservoir downstream from Kachess Dam and adjacent to the Kachess River (Figure 2-5). The proposed south pumping plant would be adjacent to the existing outlet works discharge pool, just downstream from the existing Kachess Dam outlet channel, where the water would be released to the Kachess River. Thus, a pipeline between the pumping plant and outlet works would not be needed. Figure 2-6 shows the major facilities associated with *Alternative 2B – KDRPP South Pumping Plant.*

This section describes the proposed facilities and construction methods for *Alternative 2B – KDRPP South Pumping Plant*. Table 2-4 lists the *Alternative 2B* facilities and the DEIS sections in which they are listed. Table 2-5 does the same for the *Alternative 2B* construction methods. Figures 2-5, 2-6, and 2-7 illustrate the facilities. The BTE is described in Section 2.5.5.

Table 2-4. *Alternative 2B* Facilities

Facilities	EIS Section
Reservoir intake and tunnel	2.5.1.1
Pumping plant	2.5.1.2
Surge tank	2.5.1.3
Outlet works and discharge	2.5.1.4
Permanent access roads	2.5.1.5
Power substation and transmission line	2.5.1.6

Table 2-5. *Alternative 2B* Construction Methods

Facilities	EIS Section
Site preparation	2.5.2.1
Reservoir intake and tunnel	2.5.2.2
Pumping plant	2.5.2.3
Surge tank	2.5.2.4
Outlet works and discharge	2.5.2.5
Power substation and transmission line	2.5.2.6
Temporary construction facilities	2.5.2.7

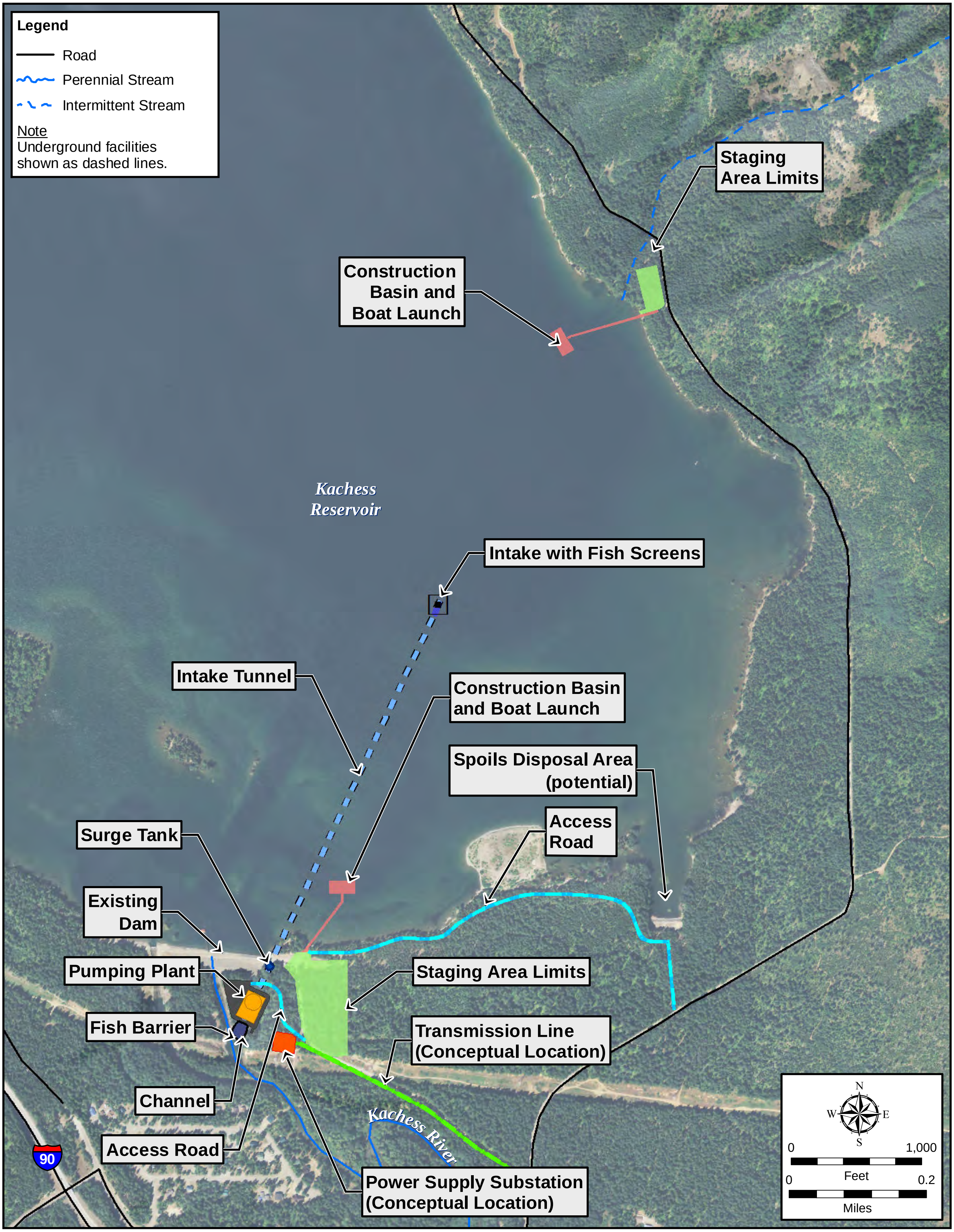

Figure 2-5. ***Alternative 2B – KDRPP South Pumping Plant*** **Overview**

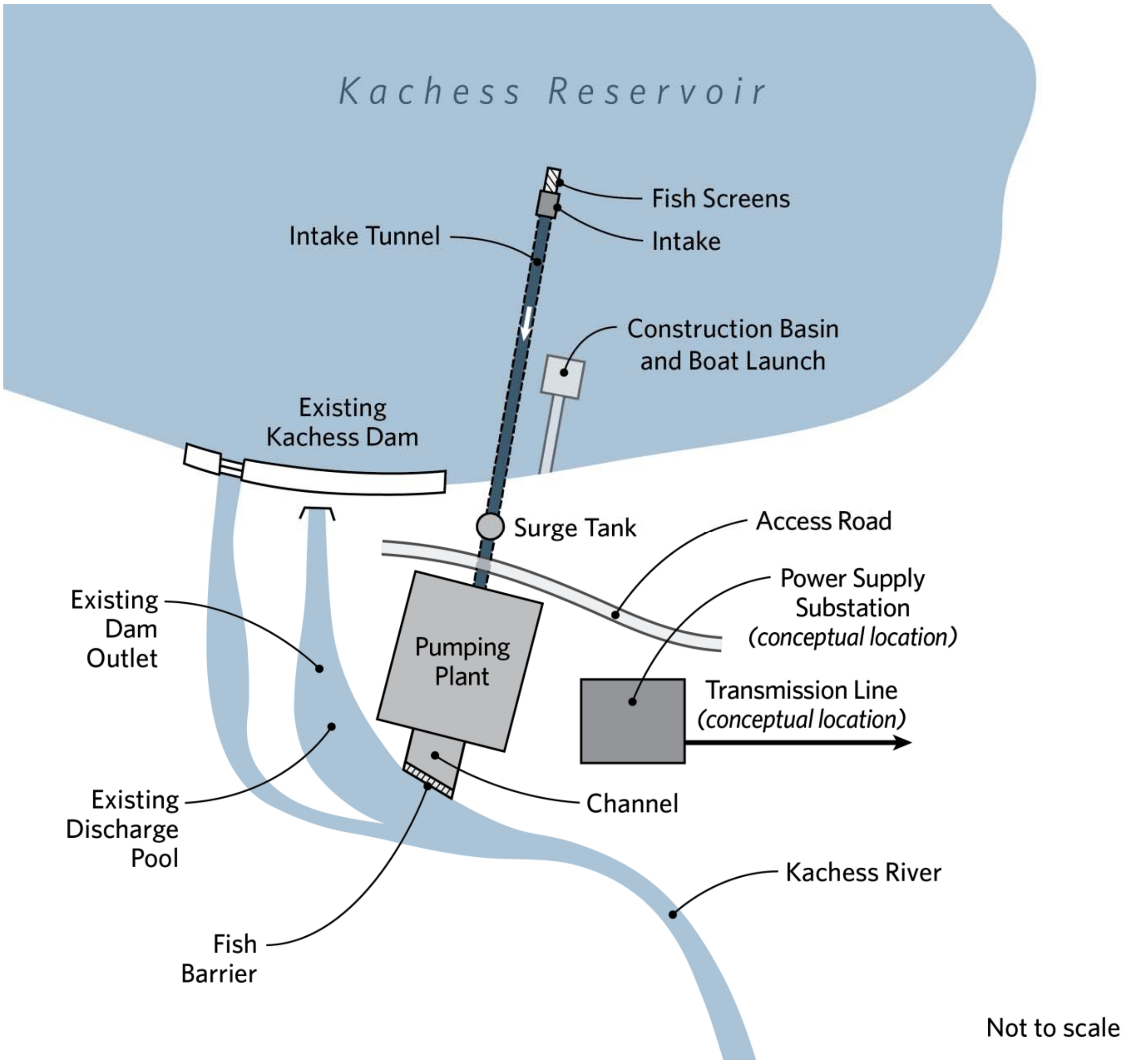

Figure 2-6. ***Alternative 2B – KDRPP South Pumping Plant*** **Conceptual Site Plan**

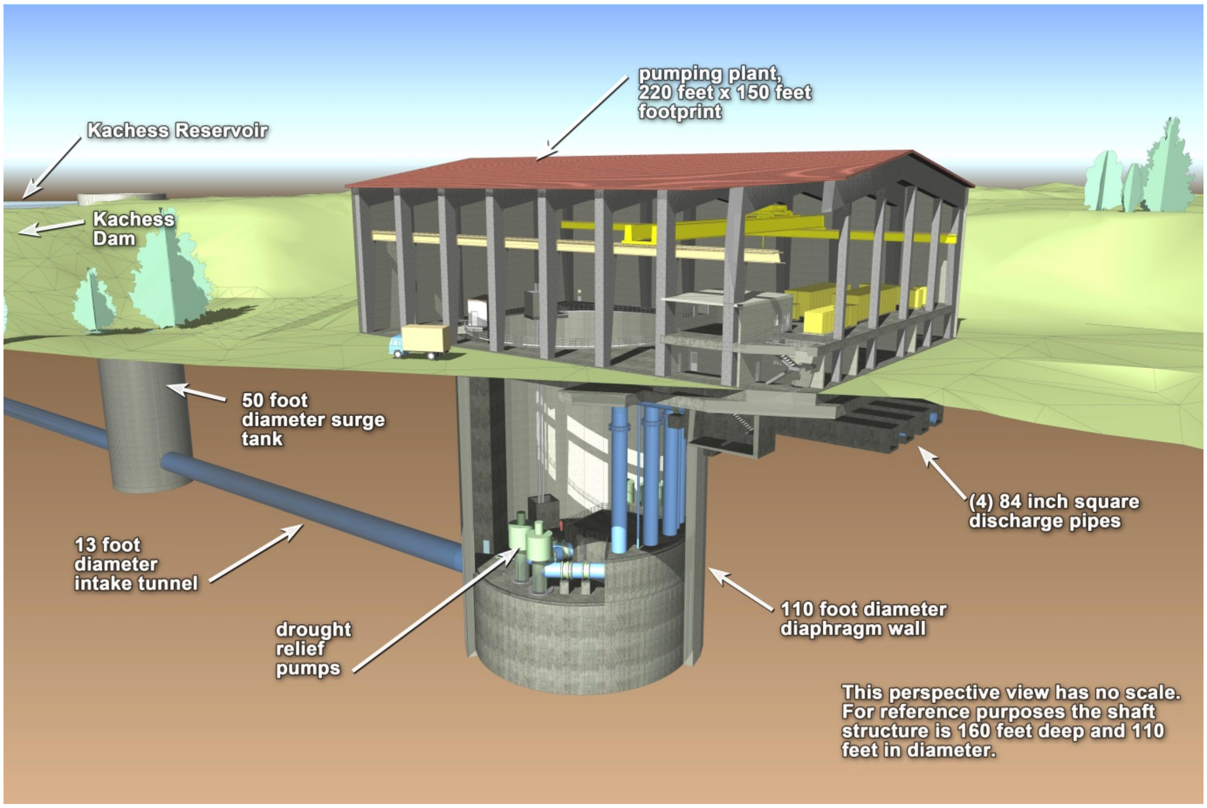

Figure 2-7. ***Alternative 2B – KDRPP South Pumping Plant***

2.5.1 Facilities

2.5.1.1 Reservoir Intake and Tunnel

For *Alternative 2B – KDRPP South Pumping Plant Alternative*, a new intake would be installed on the floor of the reservoir at approximately elevation 2,110. The intake would be located near the south end of the reservoir approximately 3,200 feet from the existing dam. With exception of location, the intake and fish screens would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 2.4.1.1). For *Alternative 2B – KDRPP South Pumping Plant Alternative*, the intake and tunnel would be sited in soft surface soils on the reservoir bottom. Construction would be accomplished with a tunnel boring machine (TBM) as described below, rather than the rock mining techniques used for *Alternative 2A – KDRPP East Shore Pumping Plant*. The intake tunnel, which would convey water from the intake to the pumping plant, would be approximately 3,350 feet long and 15 feet in diameter.

2.5.1.2 Pumping Plant

The south pumping plant would be located on a bench immediately downstream of the existing Kachess Dam. The pumping plant shaft and ancillary systems would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* except the shaft would be only 115 feet deep. Because the pumping plant would be in a different location for

Alternative 2B – KDRPP South Pumping Plant, the pumping unit configurations, and the pumping lift, locations, and discharges inside the pumping plant would differ.

Alternative 2B – KDRPP South Pumping Plant Alternative would include pumps similar to those in *Alternative 2A – KDRPP East Shore Pumping Plant*. The four vertical turbine pumps with suction inlets would be located at approximate elevation 2,115. As described in *Alternative 2A – KDRPP East Shore Pumping Plant*, several other pumping units with different functions would also be used (two vertical turbine pumps to dewater the suction inlet conduit, two drainage sump pumps to convey clean water back to Kachess Reservoir, and two vertical turbine pumps to provide Kachess River minimum flows when the primary drought relief pumps are not operating).

2.5.1.3 Surge Tank

A 50-foot-diameter surge tank buried 200 feet deep would be located just upstream of the pumping plant. *Alternative 2B* would require a tall narrow surge tank because the distance from the surface to the pipeline below would be deep. It would connect to the 13-foot-diameter tunnel with a short 10-foot-diameter pipe. The surge tank would be fully fenced and uncovered, with approximately 3 feet extending above ground.

2.5.1.4 Outlet Works and Kachess River Discharge

Water would be conveyed from the pumping plant to a discharge structure that would flow directly into the existing gravity outlet works discharge pool on the Kachess River.

2.5.1.5 Permanent Access Roads

A new gravel access road, approximately 26 feet wide and 690 feet long, would be located on the east side of the pumping plant and would connect to NF-4818.

2.5.1.6 Power Supply Substation and Transmission Line

Alternative 2B – KDRPP South Pumping Plant would require a new interconnection to the PSE supply. A power supply substation would be constructed adjacent to the south pumping plant and surrounded by a fence. The service load for the pumping plant is estimated at approximately 19 MVA. The substation would have two transformers with a self-cooled rating of no less than 10 MVA and a full-load rating no less than 20 MVA. PSE would supply power via a new 115 kV transmission interconnection at the existing PSE Easton 115 kV substation as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 2.4.1.7). A portion of the proposed alignment is identified in Figure 2-5. From the Easton substation to Kachess Dam Road, the transmission line route would be the same as proposed for *Alternative 2A*. However, it would veer off the dam access road to the proposed power supply substation at the south pumping plant.

2.5.2 Construction

Construction of *Alternative 2B – KDRPP South Pumping Plant* is expected to be completed over three construction seasons. For most facilities, construction would be similar to the description for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 2.4.2). Differing construction methods are described below.

2.5.2.1 Site Preparation

Site preparation activity would be similar to that described for *Alternative 2A – KDRPP East Shore Pumping Plant. Alternative 2B – KDRPP South Pumping Plant* would involve clearing and grading approximately 42 acres for pumping plant construction (including the access road but not the transmission line), 36 acres of which would be restored after construction is completed. Most of the clearing would be for temporary roads, construction staging, and parking.

2.5.2.2 Reservoir Intake and Tunnel

The reservoir intake and tunnel would be constructed using a TBM, which is similar to a large-diameter drill that excavates a circular tunnel and avoids surface disturbance and blasting. A TBM consists of a shield with a rotating cutter head at the leading face and trailing support mechanisms. Excavated soil is collected in a chamber behind the cutting wheel and is removed from the tunnel launch shaft (in this case, the pumping plant shaft). The interior lining of the tunnel is installed concurrently with TBM advancement.

The TBM would start from the pumping plant shaft and advance to the intake location in the reservoir. The outside diameter of the TBM would be approximately 15 feet. The tunnel would include seepage controls to prevent the inadvertent flow of water along the outside of the tunnel. To provide for gravity flow of drainage entering the tunnel during construction, the tunnel would be driven with a gentle uphill slope from the pumping plant shaft to the intake in the reservoir.

Construction would include the following general steps:

- Prepare the intake location by removing the soft soils with a barge-mounted dredge to expose harder soils. Install a steel-reinforced mat in the dredged area and fill with concrete to create a foundation pad
- Install jet grouting at the tunnel location
- Dredge a channel (approximately 50-feet wide by 145-feet long by 3-feet deep) extending from the jet grouting further into the reservoir to invert elevation 2,085
- Fill the dredge area with concrete
- Install docking sleeve and fish screens
- Launch TBM from tunnel shaft; TBM excavates to docking sleeve
- Remove TBM

2.5.2.3 Pumping Plant

For *Alternative 2B – KDRPP South Pumping Plant*, the pumping plant circular shaft would house the pumping plant and provide access to serve as the portal for the intake tunnel construction. The pumping plant shaft walls would be constructed using a hydro mill and the slurry wall construction technique. The pumping shaft would be 160 feet deep and 110 feet in diameter and lined with reinforced concrete to provide a permanent structure for the pumping plant. Construction would include the following activities:

- Excavate and construct the pumping plant shaft
- Connect the shaft to the intake tunnel
- Construct the building over the pumping plant shaft
- Install pumps and other equipment

2.5.2.4 Surge Tank

The surge tank shaft would be constructed using a hydro mill and the slurry wall construction technique. Once the diaphragm wall is complete the shaft interior would be excavated from the top down. Seepage water would be collected in internal sumps pumped to the surface, treated, and released back to the reservoir. Seepage through the 5-foot-thick concrete walls would be controlled either by hand packing or by the use of grout injection to provide a relatively water tight permanent structure.

2.5.2.5 Outlet Works and Kachess River Discharge

The area would be excavated, then the concrete outlet structure constructed in the area of excavation using conventional construction equipment. The structure would have a reinforced concrete ground slab with reinforced concrete sidewalls.

2.5.2.6 Power Supply Substation and Transmission Line

Construction of the power supply substation and transmission line would be similar to *Alternative 2A – East Shore Pumping Plant* (Section 2.4.2.7). However, there is a steep slope between the proposed substation and the South Pumping Plant, thus a directional drill may be used to install casing to carry transmission and communication wires.

2.5.2.7 Temporary Construction Facilities

The temporary construction facilities would be constructed using the same methods described for *Alternative 2A – East Shore Pumping Plant* (Section 2.4.2.8), but in different locations.

Access Roads, Staging Areas, and Construction Parking. Primary construction access would be via local roads to and from the I-90 Sparks Road Interchange at Milepost 70. In addition to the existing dam access road, there would be two new construction access roads, both connecting to the existing Kachess Dam Road. They would provide access to the spoil disposal area, construction basin, and the deep-water boat launch. The approximately 0.2 miles of new roads would be gravel-surfaced and constructed using conventional construction equipment.

An approximately 2 acre area would be established along the existing Kachess Dam Access Road near the dam end of the road. This area would be used for staging, stockpiling, administrative offices, and construction parking.

Concrete Batch Plant. A concrete batch plant as described for *Alternative 2A – KDRPP East Shore Pumping Plant* would be used to supply concrete onsite for construction of the pumping plant shaft and outlet works facilities. The batch plant would be located along Kachess Dam Road in the same area described above (Section 2.4.2.8).

Construction Basin and Boat Launch. The shallow and deep water construction basins and boat launches described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 2.4.2.8) are also being considered for *Alternative 2B* (Figure 2-5).

Spoils Disposal Area. Similar to *Alternative 2A – KDRPP East Shore Pumping Plant*, Reclamation is considering two options for disposal of spoils from construction (Section 2.4.2.8).

Temporary Power Supply. The local power grid or onsite generators would supply temporary power for construction of *Alternative 2B – KDRPP South Pumping Plant*. An existing PSE power source is available near the south end of Kachess Reservoir. Otherwise, generators would supply temporary construction power.

2.5.2.8 Construction Scheduling and Sequencing

Construction of *Alternative 2B – KDRPP South Pumping Plant* is expected to last 3 years (Table 2-6). The start date for construction is contingent upon the proposals receiving congressional authorization and funding, and completion of all permitting and consultation requirements[4].

The estimated duration for the different construction phases is as follows:

- Mobilization, clearing, grading, establish construction facilities (7 months)
- Intake and fish screens (8 months)
- Intake tunnel (12 months)
- Surge tank (8 months)
- Pumping plant (12 months)

[4] For the purposes of economic and cost estimates prepared for feasibility study and socioeconomic analysis prepared for this DEIS, 2016 was assumed to be the start of construction; however, this is speculative due to the fact that authorization and funding are needed to proceed with construction.

- Pumping plant building and equipment (9 months)
- Outlet works and discharge structure (6 months)
- Power supply substation and transmission line (15 months)

Table 2-6. *Alternative 2B – KDRPP South Pumping Plant* Approximate Construction Schedule

Year 1
Clear and grade pumping plant and outlet works sites
Construct construction access roads
Establish administration offices, parking, and staging areas
Construct construction basin and boat launch area
Establish concrete batch plant, stockpile areas, and spoils disposal areas
Set up temporary power supply and generator
Begin dredge for intake construction
Begin surge tank construction
Year 2
Finish intake construction
Add fish screens
Complete surge tank
Construction tunnel to intake
Construct pumping plant
Construct tunnel access shaft and begin constructing of the intake tunnel
Begin construction of the transmission line and substation
Year 3
Complete construction of the transmission line and substation
Assemble prefabricated building for the pumping plant
Install ancillary equipment in the pumping plant building (electrical, HVAC)
Install pumps and other equipment
Construct outlet works and discharge
Complete site cleanup and restoration

2.5.3 Typical Annual Operations

Operations would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 2.4.3).

2.5.4 Maintenance Activities

Maintenance would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 2.4.4).

2.5.5 Bull Trout Enhancement

Alternative 2B includes the BTE projects identified in *Alternative 2A*, Section 2.4.5. The construction and operation of the BTE would be the same as described in *Alternative 2A*.

2.5.6 Mitigation

Reclamation and Ecology would provide mitigation for impacts associated with *Alternative 2B – KDRPP South Pumping Plant.* Specific mitigation measures are described in Chapter 4 at the end of each resource section. Reclamation and Ecology would also comply with the environmental commitments for the Proposed Action as described in Section 4.30.

2.6 Alternative 3A – KKC North Tunnel Alignment

KKC consists of an underground tunnel to convey water from Keechelus Reservoir to Kachess Reservoir. This would allow Reclamation to reduce flows in the upper Yakima River, thereby improving rearing habitat for steelhead and spring Chinook, and improving the ability to refill Kachess Reservoir following drought years. The proposed conveyance extends east from the Keechelus Dam outlet and discharges on the west shore of Kachess Reservoir.

Reclamation would operate KKC by diverting water by gravity flow from the Yakima River downstream of Keechelus Reservoir to the Kachess Reservoir. Reclamation would transfer flows in all years when Keechelus Reservoir is above its target pool elevation and Kachess Reservoir is below target pool elevation.

Under existing conditions, flows released from Keechelus Reservoir are too high in summer months to provide habitat for anadromous fish. This proposal would reduce flows in July and August and provide a more gradual reduction in flows until September when flows are reduced to 80-100 cfs as part of “mini flip-flop” operations (see Section 3.3).

This DEIS evaluates two alternatives for KKC: *Alternative 3A – KKC North Tunnel Alignment* and *Alternative 3B – KKC South Tunnel Alignment*. The alternatives primarily differ in how the tunnel and portals are configured. Reclamation would operate KKC the same, regardless of the location of the facilities.

The *Alternative 3A – KKC North Tunnel Alignment* extends east from the Keechelus Dam area to an outlet on the west shore of Kachess Reservoir (Figure 2-8). The tunnel is a single segment tunnel that would be excavated upgradient from a portal at Kachess Reservoir. The tunnel design evaluated in this DEIS curves slightly to the south to avoid a rock formation that would require deep excavation to install the tunnel. Additional geotechnical information (expected spring 2015) would be considered in selecting the tunnel route. This DEIS assumes the curved tunnel alignment because it represents a worst-case scenario for environmental analysis. All of the facilities would be same regardless of whether the curved or straight tunnel alignment is selected.

A more technical description of the design is presented in the Draft KKC Feasibility Design Report (Reclamation and Ecology, 2014g). Figure 2-9 shows the major facilities associated with *Alternative 3A – KKC North Tunnel Alignment.*

Tables 2-7 and 2-8 list the proposed facilities and construction methods, respectively, and indicate the DEIS section in which they are described. Figures 2-8 and 2-9 illustrate the facilities. Section 2.6.5 describes the BTE.

Table 2-7. *Alternative 3A* Facilities

Facilities	EIS Section
Yakima River diversion and intake	2.6.1.1
Mechanical building	2.6.1.2
Conveyance from Yakima River to Keechelus portal	2.6.1.3
Keechelus portal	2.6.1.4
Tunnel from Keechelus Portal to Kachess Lake Road Portal	2.6.1.5
Kachess Lake Road portal and discharge structure	2.6.1.6

Table 2-8. *Alternative 3A* Construction Methods

Facilities	EIS Section
Site preparation	2.6.2.1
Yakima River diversion and intake	2.6.2.2
Mechanical building	2.6.2.3
Conveyance from Yakima River to Keechelus portal	2.6.2.4
Keechelus portal	2.6.2.5
Tunnel from Keechelus Portal to Kachess Lake Road Portal	2.6.2.6
Kachess Lake Road portal	2.6.2.7
Kachess Lake Road discharge structure	2.6.2.8
Temporary construction facilities	2.6.2.9

2.6.1 Facilities

2.6.1.1 Yakima River Diversion and Intake

A new diversion and intake would be constructed in and next to the north (left) bank of the Yakima River at the end of the existing rock-lined channel about 500 feet downstream from the end of the existing concrete outlet from Keechelus Dam. The Yakima River diversion dam would be a 7-foot-high adjustable crest dam. The crest dam could be raised or lowered depending upon flow from the Keechelus Dam outlet and the desired flow to Kachess Reservoir and desired flow in this reach (Figure 2-9). The diversion dam would include a velocity barrier to prevent fish from moving upstream when water is being diverted to the Kachess Reservoir. The intake would be protected by a 125-foot-long structure containing fish screens along the north bank of the channel. The fish screens were designed to meet NMFS fish screening criteria[5]. The intake structure would also contain eight motorized slide gates to control the flow through the intake structure. To accommodate any potential future fish passage facilities, the Yakima River diversion dam, fish screens, and intake would be designed so that potential future fish passage facilities could be added.

2.6.1.2 Mechanical Building

An approximately 18-foot-by-30-foot building would house the electrical and mechanical control systems and flow measurement instrumentation. The new building would have concrete walls and a metal roof and be located adjacent to the intake and diversion dam. The existing transmission line would be extended to provide power to the mechanical building and the motorized gates in the intake. The Yakima River gaging station would be relocated to a new location downstream from the new diversion.

2.6.1.3 Conveyance from Yakima River to Keechelus Portal

A pipeline would convey water from the Yakima River intake to the Keechelus portal. This pipeline would be constructed and aligned via one of two options (Figure 2-8): boring a 1,200-foot-long tunnel (Option B) or, if tunneling proves to be infeasible, constructing an approximately 1,450-foot-long conventional open-cut-and-cover pipeline (Option A). Additional geotechnical testing would be conducted prior to final design to determine the feasibility of the tunneling option. The pipeline would have an inside diameter of 8 feet and be steel for Option B, but could be either steel or concrete if Option A is chosen. Either pipeline option would be approximately 30 to 50 feet below ground surface (bgs) at approximate elevation 2,415.

[5] Fish screen criteria come from NMFS Northwest Region report, "Anadromous Salmonid Passage and Facility Design" (NMFS, 2011).

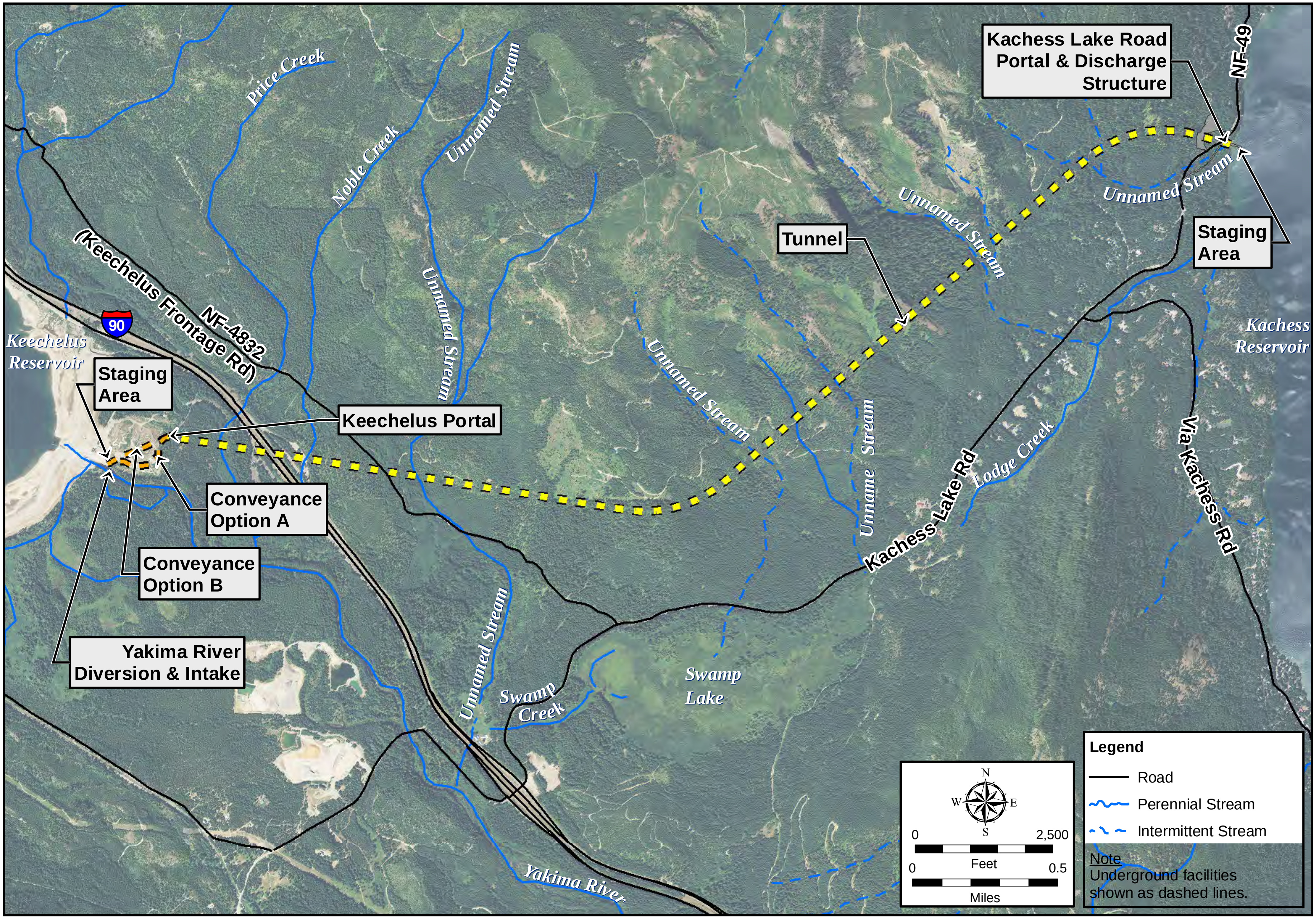

Figure 2-8. ***Alternative 3A – KKC North Tunnel Alignment*** **Overview**

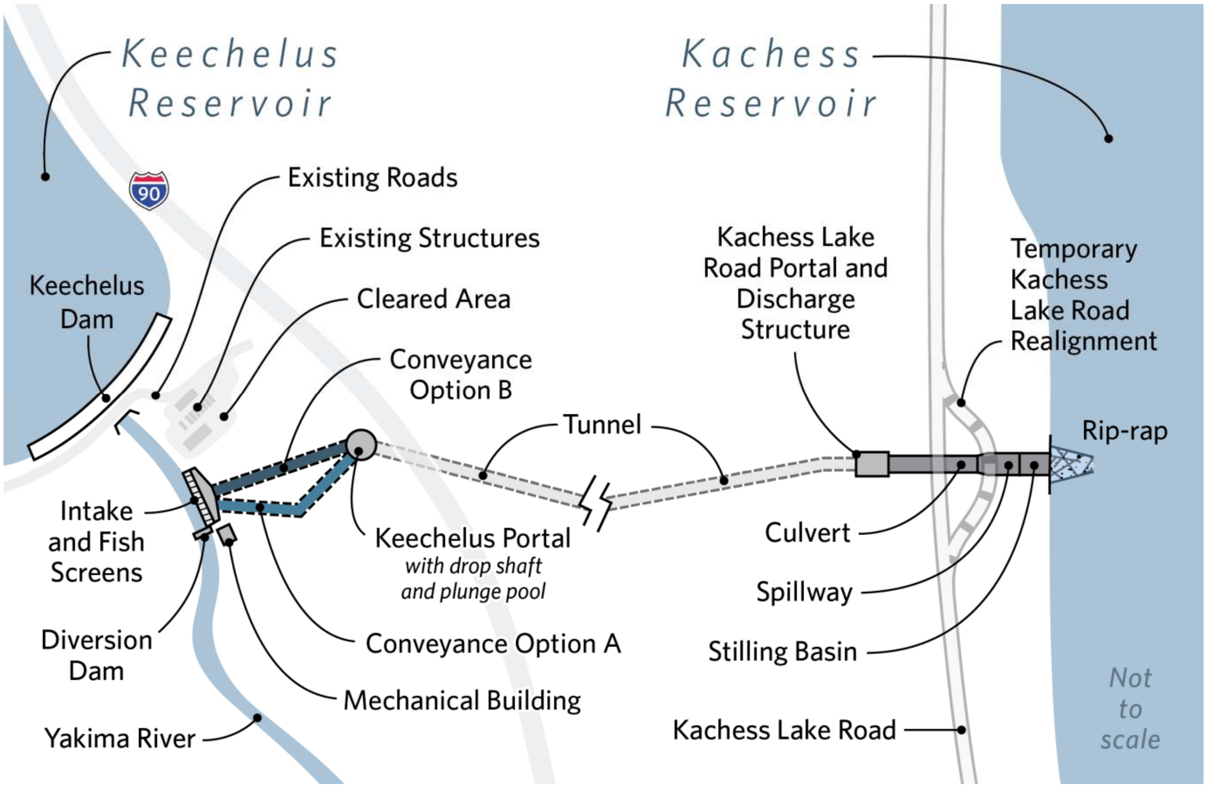

Figure 2-9. ***Alternative 3A – KKC North Tunnel Alignment*** **Conceptual Site Plan**

2.6.1.4 Keechelus Portal

The Keechelus portal would connect the conveyance pipeline to the western terminus of the tunnel (Figure 2-8). The portal would include a vertical drop shaft with a plunge pool and de-aeration chamber. The concrete-lined drop shaft would be approximately 130 feet deep and 25 feet in diameter with Option A. For Option B, it would be elliptically shaped, 25 feet wide and 40 feet long to accommodate pipe jacking equipment and 30-foot pipe sections during construction. Water from the conveyance pipeline would enter from side about one third of the way down the shaft, then free fall to the bottom of the plunge pool. Flow energy caused by the elevation difference between Keechelus Reservoir and Kachess Reservoir would be dissipated through the drop shaft and plunge pool. The tunnel to Kachess Reservoir would exit the drop shaft approximately 120 feet bgs (elevation 2,330), at the top of the plunge pool.

> Pipe jacking uses hydraulic jacks to push specially designed pipes through the ground behind the excavation.

2.6.1.5 Tunnel from Keechelus Portal to Kachess Lake Road Portal

The tunnel for *Alternative 3A – KKC North Tunnel Alignment* would be approximately 21,400 feet (4 miles) long and 12 feet in diameter. It would be a round, concrete lined, free flow tunnel, designed to convey 400 cfs during flow transfer operation. If geological conditions warrant, the tunnel may be a flat-bottom horseshoe shape. The tunnel would extend from the Keechelus portal to the Kachess portal (Figure 2-8). The tunnel would have a slight downward slope to facilitate drainage.

2.6.1.6 Kachess Lake Road Portal and Discharge Structure

The east terminus of the tunnel - the Kachess Lake Road portal - would be located on the west shore of Kachess Reservoir near Kachess Lake Road (Figure 2-8 and Figure 2-9). The Kachess portal would be excavated into the hillside to the northwest of Kachess Lake Road allowing at-grade access to the partially buried structure. The wall of the portal, concrete deck panels and vent stacks would be visible above ground. Reclamation would screen the site from Kachess Lake Road using a berm and trees. Standard medium voltage power would be connected from Kachess Lake Road at the site to supply power for security lighting and a water level and velocity flow meter.

The tunnel would enter the portal at elevation 2,300; water would then flow into an approximately 10-foot deep, 20-foot wide by 40-foot long discharge drop structure. Water would be conveyed from the discharge structure under Kachess Lake Road through a 400-foot long double box culvert, 6 feet wide by 6 feet high. From there, the water would be routed through an energy dissipation spillway channel (90 feet long and 20 feet wide), into a 60-foot long, 20-foot wide stilling basin located approximately 10 feet below the full pool elevation of the Kachess Reservoir. Water would then flow over a riprap pad (200 feet long by 30 feet wide) directly into the Kachess Reservoir (Figure 2-9). The final size, shape, and extent of riprap would be determined based on bed materials, slope, and erosion potential. The site would be fenced for security purposes.

2.6.2 Construction

Construction of *Alternative 3A – KKC North Tunnel Alignment* is expected to be completed over three construction seasons. The following general construction activities would be included.

2.6.2.1 Site Preparation

Site preparation for construction would include establishing erosion and sedimentation control measures and clearing and grubbing. A total of approximately 12.5 acres would be cleared for the construction of *Alternative 3A – KKC North Tunnel Alignment* with Option A and approximately 8.5 acres with Option B. After construction, approximately 8.5 and 4.5 acres with Option A and Option B respectively, would be restored with native vegetation.

At the Yakima River diversion dam and intake, construction would require that approximately 2 acres be cleared of trees and vegetation. No additional surface disturbance would be necessary for the Option B tunnel. For the Option A open-cut-and-cover pipeline; however, an additional 4 acres would need to be cleared, including a construction pathway approximately 200 feet wide along the open-cut-and-cover pipeline alignment. Of this, approximately 0.5 acre would remain permanently cleared. Approximately 5 acres would be cleared for the Kachess Lake Road portal and temporary road relocation.

2.6.2.2 Yakima River Diversion Fish Screens and Intake

The Yakima River diversion, fish screens, and intake would be constructed in an open cut excavation. Cofferdams would be installed across the Yakima River, both above and below the construction area. River flow would be conveyed between the cofferdams through a steel pipe or pipes. The bypass system would be sized to accommodate Yakima River flow needed for irrigation. A shoring system would also be installed. Dewatering would be required to maintain a dry site behind the cofferdam until the foundation slabs and walls of the diversion and intake structure are constructed. Wells adjacent to the excavation and inside the cofferdam system would be used to dewater the area to a depth roughly 2 to 4 feet below the bottom of the excavation during construction.

2.6.2.3 Mechanical Building

Reclamation would construct the 18-foot-by-30-foot mechanical building with concrete walls and a standing seam metal roof using conventional construction techniques. Reclamation would also remove its existing gaging station and install a new one downstream.

2.6.2.4 Conveyance from Yakima River to Keechelus Portal

For Option B, an 8-foot-diameter pipeline would be tunneled from approximately 40 feet below ground in the Keechelus portal drop shaft to the excavation for the intake structure next to the Yakima River. Reclamation would install the tunnel using an open face TBM that would be advanced by jacking steel pipe sections behind the TBM. Dewatering would occur in advance of the tunneling operation allowing personnel to access the tunneling face to break up and clear obstructions such as boulders. The pipeline would be grouted in place. The TBM would begin in the Keechelus Portal and be removed from the Yakima River intake structure when tunneling is complete.

If future geotechnical investigations deem tunneling (Option B) to be infeasible, an open-cut-and-cover method (Option A) would be used to install the 96-inch-diameter pipeline. The Option A pipeline would skirt the wetland area below the dam and follow the lowest ground elevations to reduce the depth of excavation required. To reduce riparian impact, a trenchless method, such as pipe ramming, would be used to construct 250 feet of pipeline under a berm adjacent to the river. This section would be grouted in place and connected to the open trenched pipeline. Depending upon the final depth of the pipeline, the open-cut-and-cover pipeline would require a cleared area of up to 200 feet wide along the pipeline alignment. Both options would require installation of dewatering wells to keep the work area relatively dry during construction. The dewatering water would be piped to a settling basin and infiltration basins. The groundwater is expected to be relatively free of turbidity; therefore, further treatment would not be required.

2.6.2.5 Keechelus Portal

Construction of the drop shaft at the Keechelus portal may require shoring by sheet piling or secant pile construction down to bedrock to allow for excavation without dewatering. Some dewatering may be required to allow construction of the drop shaft in the dry. The drop shaft would be advanced into the underlying bedrock using confined drill-and-blast methods to the required depth.

For Option A, the portal would be 25 feet in diameter. For Option B, the upper part of the portal shaft would also serve as a jack-and-bore launching shaft, thus it would be elliptical, 25 feet wide and 40 feet long to accommodate the pipe jacking equipment and 30-foot pipe sections. With both options, tunnel-boring equipment would be retrieved from the Keechelus Portal.

2.6.2.6 Tunnel from the Keechelus Portal to the Kachess Lake Road Portal

Construction access and material hauling to and from the tunnel would be through the Kachess Lake Road portal. To provide for gravity flow of drainage from the tunnel during construction, the TBM would be launched from the Kachess Lake Road portal and the tunnel would be mined by proceeding upslope to the Keechelus portal. The Keechelus portal would serve as the retrieval portal for the tunneling equipment.

The tunnel most likely would be a circular tunnel constructed using a TBM assembled for the specific rock materials through which the tunnel would be advanced. Alternatively, the tunnel could have a flat-bottom horseshoe shape that would be excavated using drill-and-blast methods, road header methods, or both. Tunnel construction would occur throughout the year. Power would be supplied by hookup to the local power grid or by onsite generators. The tunnel would be vented with electrical blowers and temporary air supply ducts during construction. It may be necessary to sink a 36- to 48-inch-diameter shaft approximately half way along the alignment for ventilation. If this ventilation shaft is necessary, it would be drilled from the surface and sited near the existing USFS road. Another option would be to enlarge the tunnel diameter to allow for the installation of larger ventilation ducting and intermediate air blower stations to convey fresh air to the TBM end of the tunnel.

2.6.2.7 Kachess Lake Road Portal

On the northwest side of Kachess Lake Road, the rock face of the adjacent hillside would be excavated so that there would be approximately 20 to 30 feet of rock over the portal. The rock face would be laid back at a steep angle. This excavation would also provide approximately 4 acres of level area at road grade adjacent to Kachess Lake Road for siting the tunnel power, ventilation support systems, as well as for receiving, storing, and loading of tunnel muck onto trucks.

Approximately 1,200 feet of Kachess Lake Road would be temporarily realigned around the Kachess Lake Road portal area in order to maintain traffic access around the site during construction (Figure 2-9). The portal would be constructed using drill-and-blast methods and supported using rock bolts and shotcrete.

Shotcrete is a construction method in which concrete is projected at high velocity onto a surface using a hose.

Once the work area is constructed and the road relocated, a 50-foot-long starter tunnel would be constructed using drill and blast methods and supported using rock bolts and shotcrete. The TBM and trailing gear would then be launched to bore the tunnel.

2.6.2.8 Kachess Lake Road Discharge Structure

The discharge structure into Kachess Reservoir would be constructed while Kachess Lake Road is temporarily realigned. Once the tunneling is finished and the portal discharge structure, road crossing, and upper half of the energy dissipation spillway channel are constructed, the permanent road would be restored and reopened. The lower half of the spillway and stilling basin would be constructed after the road is reopened.

The energy dissipation spillway and stilling basin would likely be constructed when the reservoir is drawn down in the fall to permit construction of the outlet in either dry or shallow-water conditions. A sheet pile cofferdam and localized dewatering would likely be required to install the outlet structure. Depending upon the geology of the slope below the stilling basin, riprap may also need to be installed on the slope below the stilling basin. This riprap could be placed when the reservoir is drawn down.

2.6.2.9 Temporary Construction Facilities

Access Roads, Staging Areas, and Construction Parking. No new roads would be needed for construction in the Keechelus Dam area. However, clearing and improvement of about 400 feet of road below Keechelus Dam would be required to access the Keechelus portal area. An approximately 2 acre area within the open area adjacent to the existing Reclamation buildings and parking slabs would be used for staging, stockpiling, construction parking, truck turn around, and construction offices.

An area of approximately 600 feet by 250 feet along Kachess Lake Road would be used to support tunneling operations from the Kachess Lake Road portal. This area would house tunnel construction offices, be used to stage tunnel mining equipment, and provide space to load excavated material into trucks for removal. This construction staging area near Kachess Lake Road Portal would be restored following construction.

Approximately 1,200 feet of Kachess Lake Road would be temporarily realigned around the Kachess Lake Road portal area in order to maintain traffic access around the site during construction. The rock slope adjacent to the northwest side of the road would be cut back and some of the excavated material would be used as grading material to relocate Kachess Lake Road. Road would be realigned 3 to 6 months.

Concrete Batch Plant. A concrete batch plant may be used during construction. The batch plant would be located at a staging area.

Spoils Disposal. Approximately 90,000 cy of material would be excavated from the tunnel and hauled from the Kachess Lake Road portal. The Keechelus portal drop shaft and other tunnel pipeline excavations and discharge structure excavations would add about 25,000 cy, for a total of approximately 115,000 cy of excavated material. This material would be disposed at an approved off-site location. Additional Kachess Lake Road portal cut-and-fill operations would be required for leveling the site, tunneling, and temporary relocation of Kachess Lake Road.

Disposal areas have yet to be identified; however, there is an existing quarry near Keechelus Dam that may be available for disposing of the crushed material excavated from the tunnel. Depending upon construction timing, WSDOT could potentially use the material as fill for the I-90 improvement project. This DEIS assumes that a disposal area would be identified within approximately 10 miles of the Proposed Action.

2.6.2.10 Construction Scheduling and Sequencing

The sequence of construction activity would depend upon construction start dates, reservoir water surface elevations, contractor resources, weather, and construction activities associated with the proposed I-90 Phase 2A project. Table 2-9 presents one of the possible construction sequencing scenarios, more details are available in the KKC Draft Feasibility Design Report (Reclamation and Ecology, 2014g). The total construction period is expected to last approximately 3 years. The start date for construction is contingent upon the proposals receiving congressional authorization and funding, and completion of all permitting and consultation requirements.

Table 2-9. *Alternative 3A - KKC North Tunnel Alignment* Approximate Construction Schedule

Year 1
Clear sites for the Kachess Lake Road and Keechelus portal
Extend and realign Kachess Lake Road
Prepare for portals, including dewatering as needed; excavate for river diversion, intake portal, fish screens
Mobilize and install tunneling machine, begin construction of river diversion and fish screens
Begin TBM and shallow tunnel mining operations
Year 2
Continue TBM mining of tunnel
Continue river diversion and fish screen construction
Complete construction of the Keechelus portal drop shaft depth, and complete the diversion, fish screen, and intake structures
Begin construction of the de-aeration chamber and tunnel receiving section
Year 3
Complete TBM mining of tunnel and remove TBM
Begin construction of remaining tunnel portal structure, Kachess Lake Road portal discharge structure, conveyance, and spillway
Complete construction of Keechelus portal drop shaft, and install remaining mechanical, electrical, and control systems at the portal and Yakima River intake
Complete site cleanup and restoration
Reopen Kachess Lake Road
Put tunnel into operation

2.6.3 Typical Annual Operations

Reclamation would operate *Alternative 3A – KKC North Tunnel Alignment* by releasing water from Keechelus Reservoir and diverting it from the Yakima River just downstream from the reservoir (Keechelus Reach). Water would be transferred from Keechelus Reservoir to Kachess Reservoir to help balance storage between the two reservoirs and to improve instream flow conditions for specific aquatic species in the Keechelus Reach. Water would be transferred up to a rate of 400 cfs depending upon water availability. Flows could be transferred throughout the year but the hydrologic modeling conducted for KKC assumed the transfers would occur when Keechelus Reservoir storage is greater than 80,000 acre-feet.

Transfers of water throughout the year would reduce the volume of water that would need to be released from Keechelus Reservoir to meet water supply needs during the midi-to late irrigation season. This would enable Reclamation to maintain lower flows in the Keechelus Reach while still allowing Keechelus stored water to provide for downstream demands. These flows would be held to a 500 cfs level in July and then ramped down gradually from 500 cfs on August 1 to 120 cfs by September 1. After September 1, Reclamation would maintain flows between 100 and 200 cfs for spawning during the winter months, except during dry years when the minimum flow would be 80 cfs and when high runoff would require more water to be spilled from the reservoir in early September.

Reclamation would operate KKC in all years when there is adequate water in Keechelus Reservoir (i.e., it is above its target pool elevation) and when there is adequate space in Kachess Reservoir (i.e., it is below its target pool elevation). The surface water elevation in Keechelus Reservoir would remain within the historical range between low and high pool levels with operation of KKC.

2.6.4 Maintenance Activities

The existing maintenance, inspection, monitoring, and debris removal activities at Keechelus Dam would continue. New maintenance work would include daily removal of debris from the fish screens; care of the flow control gates and controls; inspection and care of the new Kachess Lake Road discharge structure and spillway; and inspection and repairs of the conveyance, pipeline, and portals. Ice management would be needed to prevent ice from plugging or damaging the fish screen. Reclamation would use a low-pressure air bubbler to release a small constant air flow across the intake to reduce anchor ice and assist in keeping floating debris moving across the screens.

For flow control Reclamation would use a programmable logic control (PLC), set to the desired diversion flow, the Keechelus Dam release rate, and the Yakima River instream flow requirement. The PLC would use these parameters, and real-time water surface elevation and discharge pipeline flow meter data, to automatically adjust the flow diversion dam height and the motorized flow control gate settings.

Typical maintenance would also include annual facility reviews. Major maintenance would take place on a 5-year cycle. Replacement of equipment would be on a 20-year cycle.

2.6.5 Bull Trout Enhancement

Alternative 3A includes the BTE identified in *Alternative 2A*, Section 2.4.5. Construction and operation would be the same as described in *Alternative 2A*.

2.6.6 Mitigation

Reclamation and Ecology would provide mitigation for impacts associated with *Alternative 3A – KKC North Tunnel Alignment.* Specific mitigation measures are described in Chapter 4 at the end of each resource section. Reclamation and Ecology would also comply with the environmental commitments for the Proposed Action as described in Section 4.30.

2.7 Alternative 3B – KKC South Tunnel Alignment

Alternative 3B – KKC South Tunnel Alignment is similar to *Alternative 3A – KKC North Tunnel Alignment*. All of the facilities located in the Keechelus Dam area would be the same as proposed for *Alternative 3A – KKC North Tunnel Alignment* (Sections 2.6.1.1 through 2.6.1.4). The tunnel would start at the Keechelus Reservoir portal, but would be located further south than for *Alternative 3A*, discharging into Kachess Reservoir at the Kachess Reservoir portal just to the south of the portal proposed for *Alternative 3A* (Figure 2-10 and Figure 2-11). In order to reduce truck traffic on Kachess Lake Road and eliminate the need to relocate that road, the access portal for construction would be located near the I-90 Exit 62 Stampede Pass interchange. Construction from this portal would be done in two segments, one extending northwest to the Keechelus portal and one extending northeast to the Kachess Reservoir outlet.

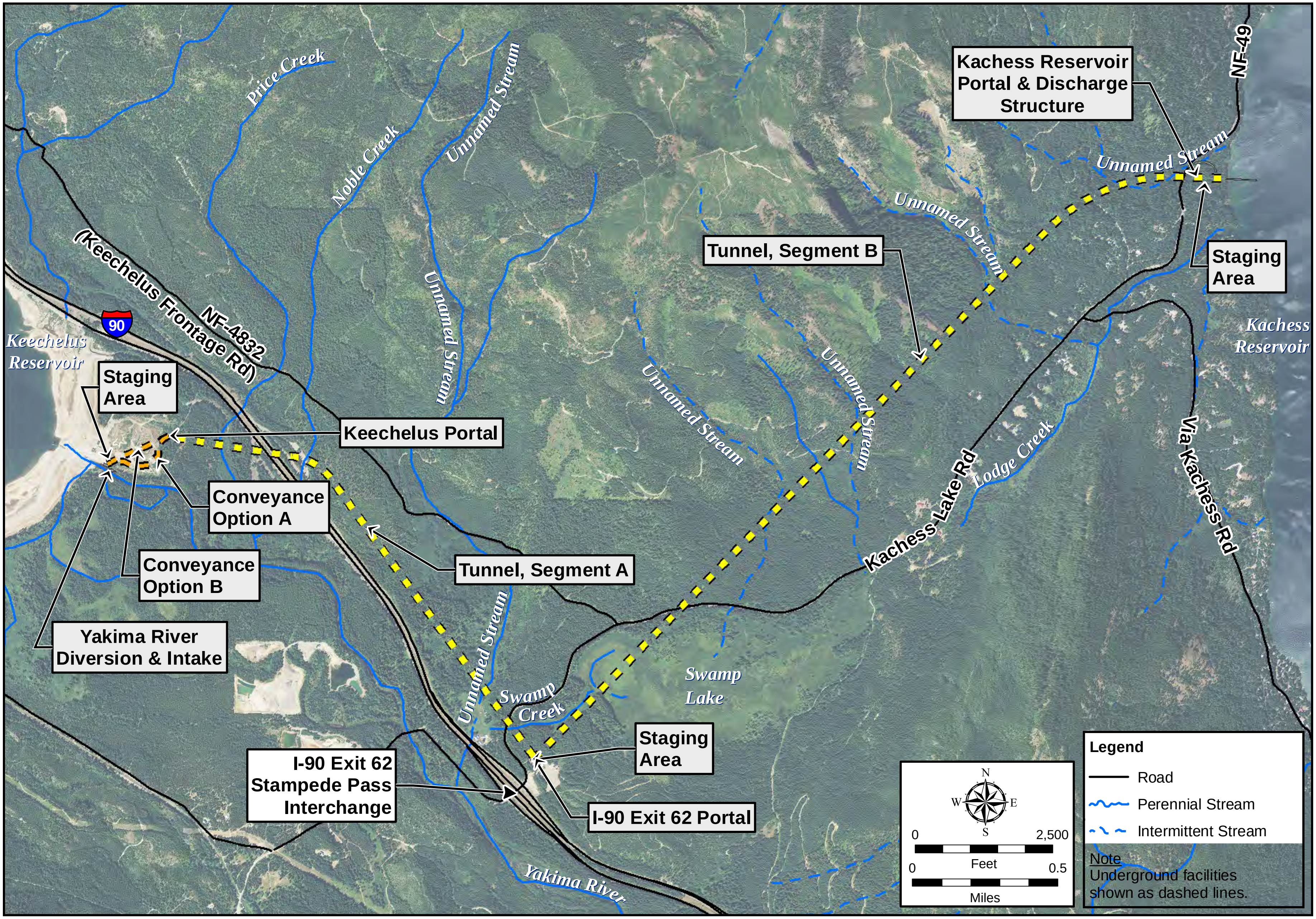

Figure 2-10. ***Alternative 3B – KKC South Tunnel Alignment*** **Overview**

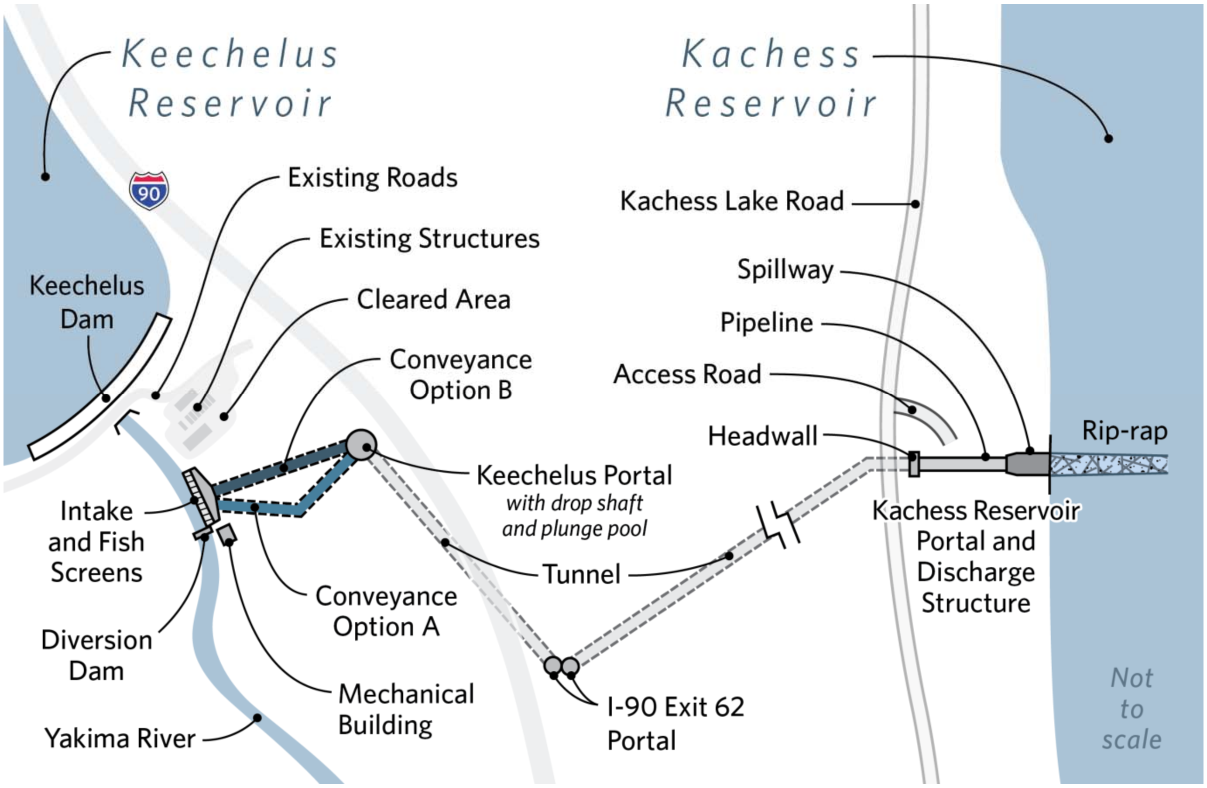

Figure 2-11. ***Alternative 3B – KKC South Tunnel Alignment*** **Conceptual Site Plan**

Tables 2-10 and 2-11 list the proposed facilities and construction methods, respectively, that are different than in *Alternative 3A – KKC North Tunnel Alignment*, and indicate the DEIS section in which they are described. Figures 2-10 and 2-11 illustrate the facilities. The BTE is described in Section 2.7.5.

Table 2-10. *Alternative 3B* Facilities

Facilities	EIS Section
I-90 Exit 62 portal	2.7.1.1
Tunnel from I-90 Exit 62 Portal to Keechelus and Kachess Reservoir portals	2.7.1.2
Kachess Reservoir portal and discharge structure	2.7.1.3

Table 2-11. *Alternative 3B* Construction Methods

Facilities	EIS Section
Site preparation	2.7.2.1
I-90 Exit 62 portal	2.7.2.2
Tunnel from I-90 Exit 62 Portal to Keechelus and Kachess Reservoir portals	2.7.2.3
Kachess Reservoir portal and discharge structure	2.7.2.4
Temporary construction facilities	2.7.2.5

2.7.1 Facilities

2.7.1.1 I-90 Exit 62 Portal

The I-90 Exit 62 portal would be located in WSDOT's existing I-90 construction staging area just northeast of I-90 at Exit 62 Stampede Pass interchange. The portal would include two 25-foot-diameter lined shafts, one approximately 160 feet deep and an adjoining shaft approximately 93 feet deep. A hydraulic transition structure would be included at the bottom of the portal to connect both tunnel segments and to efficiently manage and guide the flow of water and air as the flow changes direction at the portal.

2.7.1.2 Tunnel from I-90 Exit 62 Portal to Keechelus and Kachess Reservoir Portals

The tunnel for *Alternative 3B – KKC South Tunnel Alignment* would be approximately 4.9 miles long, divided into two segments. Segment A starts at the Keechelus portal and extends southeast to the Exit 62 portal. Segment B would start at the I-90 Exit 62 portal, but would angle to the northeast and discharge to Kachess Reservoir. Segment A from Keechelus portal to the I-90 Exit 62 portal would be approximately 1.8 miles long and be at elevation 2,330 to 2,320. Segment B from the I-90 Exit 62 portal to Kachess Reservoir would be approximately 3.2 miles long be at elevation 2,260 to 2,360. The tunnel has been designed to convey 400 cfs during flow transfer operation.

As for *Alternative 3A – KKC North Tunnel Alignment*, the tunnel would be 12 feet in diameter and most likely circular; but a flat-bottom horseshoe shape is also an option.

2.7.1.3 Kachess Reservoir Portal and Discharge Structure

The Kachess Reservoir portal and discharge structure would be located at the Kachess Reservoir west shoreline on a parcel managed by the USFS south of a residential development (Figure 2-10). A permanent access road from Kachess Lake Road, 25 feet wide and 500-feet long would be constructed just north of the portal. The portal would consist of a TBM removal portal headwall. The discharge structure would be a buried 10-foot-diameter pipeline or concrete box structure, 300 feet long. The pipeline would be connected to a 20-foot-wide, 50-foot-long spillway by a 30-foot-long transition structure. The entire structure would be made of concrete. It then would exit into the Kachess Reservoir over a concrete or riprap lined channel. Permanent electrical service would be provided for lighting and flow monitoring systems.

2.7.2 Construction

Construction of *Alternative 3B – KKC South Tunnel Alignment* is expected to be completed over three construction seasons, beginning in 2016. The following general construction activities would be included.

2.7.2.1 Site Preparation

Site preparation for construction would include establishing erosion and sedimentation control measures and clearing and grubbing. A total of approximately 13 acres would be cleared for the construction of *Alternative 3B – KKC South Tunnel Alignment* with Option A and 9 acres with Option B. After construction approximately 11.5 and 7.5 acres with Options A and B respectively, would be restored with native vegetation.

Clearing for the Yakima River diversion and intake would be the same as described for *Alternative 3A – KKC North Tunnel Alignment* in Section 2.6.2.1. At the I-90 Exit 62 Portal approximately 4 acres would be cleared and at the Kachess Reservoir portal and discharge structure approximately 2 acres would be cleared.

2.7.2.2 I-90 Exit 62 Portal

The I-90 Exit 62 portal would consist of two portal shafts for access by equipment (including the TBM) and personnel, removal of excavated material, and management of power and air. The portal would be constructed using open-cut drill-and-blast methods. A 50-foot-long starter tunnel would be built for each tunnel heading using drill-and-blast methods to facilitate installation of the TBM and trailing gear. The starter tunnels would eventually serve as parts of the portal's hydraulic transition structure. Concrete would be poured to complete the hydraulic transition structure, and permanent access facilities would be installed after completion of the tunnel mining and lining activities. The 160-foot deep portal shaft would serve as TBM launch location for tunnel Segment A, and the approximately 93-foot-deep shaft would launch the TBM for tunnel Segment B.

2.7.2.3 Tunnel from I-90 Exit 62 Portal to Keechelus and Kachess Reservoir Portals

The tunnel for *Alternative 3B – KKC South Tunnel Alignment* would be constructed in two segments from the I-90 Exit 62 portal. Both segments would likely be circular tunnels constructed using one or two TBMs. Alternatively, one or both could be a flat-bottom horseshoe-shaped tunnel excavated using drill-and-blast methods, road header methods, or both.

If only one TBM were used, the segments would be constructed one after the other. If two TBMs were used, the segments would be constructed concurrently. This decision to use one or two TBMs would depend upon factors such as scheduling constraints, construction access requirements, and equipment availability. If two TBMs were used, one would have to be installed and launched before the other. As for *Alternative 3A – KKC North Tunnel Alignment*, the TBM would be powered by a hookup to the local power grid or by onsite generators.

To provide for gravity flow of drainage from the tunnel during construction, tunnel Segment A would be mined upgradient northwest toward the Keechelus portal drop shaft. Tunnel

Segment B would be mined northeast to the Kachess Reservoir discharge structure. Tunnel drainage collecting at the Exit 62 portal would be pumped and treated prior to discharge. Tunnel construction would occur throughout the year.

2.7.2.4 Kachess Reservoir Portal and Discharge Structure

A 500-foot long access road from Kachess Lake Road would be constructed to access the site from the north. An approximately 2-acre area between Kachess Lake Road and Kachess Reservoir would be cleared, and part of it would be excavated. Depending upon the final method of construction and depth of water in the reservoir, a sheet pile cofferdam may be required for construction of the portal and discharge structure. If required, the cofferdam would be constructed first to keep the site dry. A headwall, base slab, and side walls would be constructed to receive the TBM from the I-90 Exit 62 portal. Once the TBM is dismantled and removed, the remaining walls of the discharge structure would be constructed and the cofferdam removed.

Depending upon the geology of the slope below the discharge structure, riprap may also need to be installed on the slope below the stilling basin. The riprap would be placed in the dry when the reservoir is drawn down.

2.7.2.5 Temporary Construction Facilities

Access Roads, Staging Areas, and Construction Parking. In the Keechelus Dam area access roads, staging, and parking would be the same as for *Alternative 3A – KKC North Tunnel Alignment* (Section 2.6.2.9). Construction staging would also be established at the I-90 Exit 62 portal. Tunnel staging at the I-90 Exit 62 portal would require approximately 3.5 acres. At present, WSDOT uses the portal area as a construction staging area; therefore, little additional clearing would be required. The existing disturbed area is approximately 4.5 acres.

Concrete Batch Plant. A concrete batch plant may be used during construction. If used it would be located at a staging area.

Spoils Disposal. The volume of material to be excavated and hauled from the I-90 portal is approximately 110,000 cy. Together, the Keechelus portal shaft, I-90 Exit 62 portal shaft, other tunnel excavations, and discharge structure excavations would add about 20,000 cy, for a total of approximately 130,000 cy of excavated material.

Disposal areas have yet to be identified; however, there is an existing quarry near Keechelus Dam that may be available for disposing of the crushed material excavated from the tunnel. Depending upon construction timing, WSDOT could potentially use the material as fill for the I-90 improvement project. This DEIS analysis assumes that a disposal area would be identified within 10 miles of the Proposed Action.

2.7.2.6 Construction Scheduling and Sequencing

Construction of *Alternative 3B – KKC South Tunnel Alignment* is expected to last 3 years, assuming year-round activity. The inreservoir work would be scheduled for fall when the reservoir is drawn down. The start date for construction is contingent upon the proposals receiving congressional authorization and funding, and completion of all permitting and consultation requirements.

The sequence of construction activity would depend upon construction start dates, reservoir water surface elevations, contractor resources, weather, and construction activities associated with the proposed I-90 Phase 2A project. Table 2-12 illustrates the approximate schedule for constructing the different elements of *Alternative 3B – KKC South Tunnel Alignment*.

Table 2-12. *Alternative 3B – KKC South Tunnel Alignment* Construction Schedule and Sequencing

Year 1
Clear sites for I-90 Exit 62 and Keechelus Dam portals
Install Yakima River diversion cofferdam and temporary bypass
Excavate and line I-90 Exit 62 portal to tunnel depth
Excavate Yakima River intake
Start construction on Yakima River diversion and fish screen structure
Begin mining of starter tunnels and the Keechelus conveyance pipeline
Year 2
Continue mining and lining of Keechelus conveyance pipeline
Complete mining of starter tunnels for the I-90 Exit 62 portal
Complete Yakima River diversion
Continue fish screen and intake structure construction
Mobilize and install the TBMs for tunnel Segments A and B
Continue mining both the Segments A and B
Begin construction of Kachess Reservoir Portal
Begin construction of the deaeration chamber and tunnel receiving station at Keechelus Portal
Year 3
Complete mining both tunnel segments
Dismantle and remove the TBMs from the Keechelus and Kachess Reservoir portals
Complete construction of the Kachess Reservoir discharge structure
Complete construction of the I-90 Exit 62 portal structure, shaft portal lid, and access structure
Complete the Keechelus deaeration chamber and plunge pool
Complete construction of Keechelus portal structure
Install remaining mechanical, electrical, and control systems at the portals and Yakima River intake
Complete Keechelus and I-90 Exit 62 site work and site restoration

2.7.3 Typical Annual Operations

Operations would be the same as described for *Alternative 3A – KKC North Tunnel Alignment* (Section 2.6.3).

2.7.4 Maintenance Activities

Maintenance would be the same as described in Section 2.6.4 for *Alternative 3A – KKC North Tunnel Alignment*.

2.7.5 Bull Trout Enhancement

Alternative 3B includes the BTE identified in *Alternative 2A*, Section 2.4.5. Construction and operation would be the same as described in *Alternative 2A*.

2.7.6 Mitigation

Reclamation and Ecology would provide mitigation for impacts associated with *Alternative 3B – KKC South Tunnel Alignment.* Specific mitigation measures are described in Chapter 4 at the end of each resource section. Reclamation and Ecology would also comply with the environmental commitments for the Proposed Action as described in Section 4.30.

2.8 Alternative 4 – Combined KDRPP and KKC

Under *Alternative 4 – Combined KDRPP and KKC*, Reclamation would implement KDRPP and KKC together to provide more flexible water management. In addition to allowing Reclamation to reduce artificially high flows in the Keechelus Reach, combined operation of KDRPP and KKC would speed up refill of Kachess Reservoir after it has been drawn down in drought years under KDRPP.

The facilities, construction, and maintenance processes for each component would be the same as described in Sections 2.4 through 2.7 Construction of the two components could occur at the same time, and last approximately 3 years. The start date for construction is contingent upon the proposals receiving congressional authorization and funding, and completion of all permitting and consultation requirements.

Alternative 4 includes the BTE as identified in *Alternative 2A*, Section 2.4.5. Construction and operation would be the same as described in *Alternative 2A*. Reclamation and Ecology would provide mitigation for project impacts as described in Chapter 4 at the end of each resource section.   Reclamation and Ecology would also comply with the environmental commitments for the Proposed Action as described in Section 4.30.

2.8.1 Typical Annual Operations

Reclamation would operate KDRPP and KKC together to increase the frequency of refill of Kachess Reservoir after a drought year and continue to control flows in the Keechelus Reach to improve fish habitat.

KDRPP would be operated remotely from Reclamation's Yakima Operations Center, but local operational capabilities would be available. Reclamation would use KDRPP to supply water to proratable water users such KRD, RID, and WIP. KDRPP would be used in drought years and when needed to meet water supply requirements while Kachess Reservoir is refilling to a level above the gravity outlet. It would typically be used from about July 1 for 10 to 12 weeks. Depending on the duration and severity of the drought, it would be operated for that 10- to 12-week period a single year or multiple consecutive years. Reclamation would operate KDRPP when water supply falls below 70 percent of proratable water rights. As described in Section 1.3 of the Integrated Plan PEIS, 70 percent would provide a water supply sufficient to prevent severe economic losses to proratable water rights users (Reclamation and Ecology, 2012).

Typical operations for KDRPP are the same as described in Section 2.4.3. Section 4.3.8 describes expected reservoir levels under combined operation of KDRPP and KKC. Typical operations for KKC are the same as described in Section 2.6.3. The surface water elevation in Keechelus Reservoir would remain within the historical range with combined operation of KDRPP and KKC.

2.9 Estimated Cost of Alternatives

This section summarizes estimated costs of the alternatives included in the KDRPP and KKC Feasibility Design Reports (Reclamation and Ecology, 2014f and 2014g) and Economics Analysis Reports (Reclamation and Ecology, 2014c and 2014d). These estimates were prepared for each alternative and include field costs, noncontract costs, interest during construction, operations, maintenance, replacement, and power costs.

Field costs are defined as the capital costs from procurement to construction closeout. Field costs include mobilization by the construction contractor, materials, fabrication and installation. Field costs also include construction contingencies and sales tax. Noncontract costs include work or services provided, generally by agency personnel or other parties besides the construction contractor. Noncontract costs also include land or right-of-way acquisitions, field investigations, design and specifications, construction management, and environmental compliance, among other items. The interest-during-construction costs are interest costs charged on the field costs of construction contracts and noncontract costs during the construction period.

Operations, maintenance, replacement and power costs are long-term costs to operate and maintain. Some of these costs occur every year while others occur less frequently. These costs are added up over a 100-year time period.

In order to make short-term costs and long-term costs comparable, economists apply a present-value calculation. This takes into account the time value of money and converts future expenditures into the value of the expenditures as if they were all spent today. All of the costs discussed in this section have been expressed in present value terms. All values are expressed in uninflated, 2014 dollars.

The cost estimates are summarized in this section. Estimates were prepared using the same assumptions and unit prices. Additional specific information on methods and results of cost estimation are described in KDRPP and KKC Feasibility Design Reports (Reclamation and Ecology, 2014f and 2014g) and the KDRPP and KKC Economics Analysis Reports (Reclamation and Ecology, 2014c and 2014d).

2.9.1 Estimated Costs for the No Action Alternative

Under the No Action Alternative, no new facilities would be constructed and no construction costs would be incurred. Since neither KKC nor KDRPP would be in place, the construction, operations, maintenance, replacement, and power (OMR&P) cost for the No Action Alternative is considered to be zero. Reclamation would continue its OMR&P on existing facilities.

2.9.2 Estimated Costs for Action Alternatives

Table 2-13 lists the estimated total 100-year costs for *Alternative 2A – KDRPP East Shore Pumping Plant* and *Alternative 2B – South Pumping Plant*. Table 2-14 lists the estimated total 100-year costs for *Alternative 3A – KKC North Tunnel Alignment* and *Alternative 3B – KKC South Tunnel Alignment*. The values shown for *Alternatives 3A* and *3B* assume selection of Option B for the Yakima River to Keechelus Portal Conveyance (Section 2.6.2). All the action alternatives used the same assumptions and unit prices.

Cost estimate for the BTE projects are provided in BTE in Appendix C. The total cost for BTE is $12,010,000 and is added to the action alternative costs for KDRPP in Table 2-13 and KKC in Table 2-14.

Table 2-13. Estimated Costs of KDRPP *Alternatives 2A* and *2B*

Cost Categories	Alternative 2A – KDRPP East Shore Pumping Plant[1]	Alternative 2B – KDRPP South Pumping Plant[1]
Field Cost	282,660,000	248,580,000
Noncontract Cost	84,800,000	74,580,000
Subtotal: Construction Cost	**367,460,000**	**323,160,000**
Interest During Construction	**22,220,000**	**19,540,000**
O&M Cost (100 years)	6,700,000	6,570,000
Power Costs (100 years)	11,730,000	7,040,000
Replacement Cost (100 years)	14,270,000	12,390,000
Subtotal: OMR&P	**32,700,000**	**26,000,000**
BTE[2]	**12,010,000**	**12,010,000**
Total	**434,390,000**	**380,710,000**

[1]Reported in present value terms.
[2]The BTE would be implemented as a component of all alternatives and the costs would be the same.

Table 2-14. Comparison of Estimated Costs of KKC *Alternatives 3A* and *3B*

Cost Categories	Alternative 3A – KKC North Tunnel Alignment[1]	Alternative 3B – KKC South Tunnel Alignment[1]
Field Cost	151,100,000	175,380,000
Noncontract Cost	45,330,000	52,610,000
Subtotal: Construction Cost	**196,430,000**	**227,990,000**
Interest During Construction	**8,660,000**	**10,100,000**
O&M Cost (100 years)	3,430,000	3,550,000
Power Costs (100 years)	220,000	220,000
Replacement Cost (100 years)	570,000	570,000
Subtotal: OMR&P	**4,220,000**	**4,340,000**
BTE[2]	**12,010,000**	**12,010,000**
Total	**221,320,000**	**254,440,000**

[1]Reported in present value terms.
[2]The BTE would be implemented as a component of all alternatives and the costs would be the same.

2.10 Other Alternatives Considered but Eliminated from Detailed Study

Reclamation and Ecology considered other alternatives and designs for both KDRPP and KKC. However, because of technical problems, high costs, potentially severe environmental impacts, or inadequacy in meeting the purpose and need of the Proposed Action, Reclamation and Ecology did not carry the alternatives forward. These alternatives, and the specific reasons for eliminating them, are described below.

2.10.1 KDRPP Alternatives

Reclamation and Ecology considered several options for accessing the inactive storage water in Kachess Reservoir and conveying it to the Yakima River. This section describes proposals considered by Reclamation as part of YRBWEP Phase 1 and the gravity tunnel that was one of the options proposed in the Integrated Plan.

2.10.1.1 YRBWEP Phase 1 Proposals

Reclamation evaluated proposals for accessing the inactive storage water at Kachess Reservoir in the 1980s as part of YRBWEP Phase 1. These proposals included a floating pump station, a deep-cavity pump station, and a siphon intake, each of which was technically infeasible. The floating pump station option could not accommodate the large pumps and motors, power demands, and pipeline sizes required for the 1,000 cfs capacity needed; technical complexities and safety risks eliminated the deep-cavity pump station; and the siphon intake could not provide the needed 80-foot drawdown.

2.10.1.2 Gravity Tunnel

The Integrated Plan PEIS (Reclamation and Ecology, 2012) included a gravity tunnel option for KDRPP: a 4.6-mile-long, 13-foot-diameter tunnel between Kachess Reservoir and a discharge structure on the north (left) bank of the Yakima River approximately 6 river miles downstream of Lake Easton. After further investigation, Reclamation and Ecology (2013b) eliminated this option from further study because:

- The gravity tunnel would discharge downstream of the KRD intake, precluding the ability to supply water to the district. Supplying KRD would require continued releases from Keechelus Reservoir in combination with the gravity tunnel, an action that would not meet the purpose and need of reducing flows downstream from Keechelus Dam or benefit fisheries in the Keechelus Reach of the Yakima River.
- The long tunnel would entail extensive underground construction, with excessive risks due to rock quality and groundwater handling.
- The gravity tunnel alternative would require construction of a discharge structure on the previously undisturbed north (left) bank of the Yakima River.

2.10.2 KKC Alternatives

The Integrated Plan PEIS (Reclamation and Ecology, 2012) proposed an above-ground pipeline connecting the two reservoirs. A 2013 technical memorandum described the process used to assess the proposed pipeline as well as two other pipeline alignments and three tunnel alignments, as summarized below (Reclamation and Ecology, 2013c).

2.10.2.1 Integrated Plan Pipeline Alternative

The pipeline alternative proposed in the Integrated Plan would have disturbed wildlife and forest habitat along the proposed 5-mile corridor and crossed a wildlife migration corridor. It also would have restricted access to residences and recreation facilities during construction. Furthermore, it proved impractical to coordinate the location and construction of the pipeline with the nearby wildlife undercrossing of I-90 in WSDOT's existing plans (Reclamation and Ecology, 2013c).

2.10.2.2 Other Pipeline Alternatives

To avoid the sensitive areas noted above, Reclamation and Ecology developed a different pipeline alternative, called Alternative P2, to follow existing USFS roads to the extent possible (Reclamation and Ecology, 2013c). In addition to adding 9,000 feet to the length of the original pipeline, the P2 route would traverse high elevations, eliminating the possibility of a strictly gravity flow pipeline and would require pumping, which would add significantly to operational costs.

Reclamation and Ecology also considered an alternative pipeline route called Alternative P3. The route for Alternative P3 would be suitable for a gravity flow pipeline, would minimize habitat impacts near Keechelus Dam, and more closely parallel I-90 and previously disturbed areas. However, it would be 3,000 feet longer than the pipeline alternative presented in the Integrated Plan PEIS and does not avoid all impacts to sensitive environmental areas.

Ultimately, Reclamation and Ecology eliminated all pipeline alternatives from further consideration because of potential environmental impacts associated with open-trench construction.

2.10.2.3 Tunnel Alternatives

In order to avoid surface disturbance, Reclamation and Ecology evaluated three potential alternatives for a tunnel route between the two reservoirs called *Alternatives T1*, *T2*, and *T3*. *Alternatives T1* and *T2* followed the shortest distance between the Keechelus Reservoir outlet and the proposed portal site at Kachess Reservoir, the difference reflecting portal location: at the outlet to Keechelus Reservoir for *Alternative T1* and approximately 400 feet downstream of the outlet for *Alternative T2*.

Alternative T3 represented an alternative to diverting water directly from or immediately downstream from Keechelus Reservoir. Water would be diverted instead from the Yakima River at the permanently closed USFS Crystal Springs Campground. Despite a shorter route, the alternative would require a new diversion structure in the river. Reclamation and Ecology eliminated the alternative because of potential fish impacts, the foreshortened length of river reach that would benefit from reduced flow, and the failure to meet the KCC objective of improving fish habitat in the entire reach between Keechelus Dam and Lake Easton.

2.11 Comparison of Alternatives

Tables 2–15 and 2–16 summarize the facilities and construction requirements of *Alternatives 2A* and *2B* and *Alternatives 3A* and *3B*.

Table 2-15. Summary of KDRPP *Alternatives 2A* and *2B* Facilities and Construction

	Alternative 2A	Alternative 2B
Plant location	East shore of Lake Kachess	South shore of Lake Kachess
Intake elevation	1,989 feet	2,110 feet
Intake distance from dam	5,000 feet	3,200 feet
Intake tunnel size	610 feet long, 15 feet diameter	3,250 feet long, 15 feet diameter
Tunnel construction method	Rock mining	Tunnel boring machine
Primary pump unit elevation	2,088 feet	2,115 feet
Pumping plant area of disturbance	67 acres (58 acres restored)	42 acres (36 acres restored)
Surge tank size	110 feet diameter, 30 feet deep	50 feet diameter, 200 feet deep
Buried pipeline	7,755 feet long	none
Length of new access roads	2,425 feet	690 feet

Table 2-16. Summary of KKC *Alternatives 3A* and *3B* Facilities and Construction

	Alternative 3A	Alternative 3B
Yakima River diversion and intake location	South of Keechelus Dam and on the north bank of the Yakima River – facilities would be the same in the Keechelus Dam area	
Size of tunnel	21,400 feet (4 miles) long, 12 feet in diameter	26,090 feet (4.9 miles) long, divided into two segments, 12 feet in diameter
Number of portals	2 Keechelus and Kachess Lake Road	3 Keechelus, I-90 Exit 62, and Kachess Reservoir Road
Total area of disturbance	Option A – 12.5 acres (8.5 acres restored) Option B – 8.5 acres (4.5 acres restored)	Option A - 13 acres (11.5 acres restored) Option B - 9 acres (7.5 acres restored)
Portal and discharge structure location	Kachess Lake Road portal – from west of Kachess Lake Road and Kachess Reservoir	Kachess Reservoir portal – between Kachess Lake Road and Kachess Reservoir (south of Kachess Road Portal)
Tunnel construction method	Tunnel boring machine	Tunnel boring machine
Tunnel construction access	Kachess Lake Road portal	I-90 Exit 62 portal
Length of new permanent access roads	none	500 feet

2.12 Summary Comparison of Environmental Impacts of Alternatives

Table 2-17 compares the impacts associated with each of the alternatives. Chapter 4 provides additional information about potential impacts of all the alternatives.

Table 2-17. Summary Comparison of Impacts

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Earth					
Shoreline erosion, if any and seismic hazards would continue as under existing conditions.	Construction: Erosion during construction and seismic and slope stability risks not significant impacts. Operation: Increased risk of slope stability on the reservoir rim. Long-term erosion not significant.	Same as *Alternative 2A*.	Construction: Erosion during construction and seismic and slope stability risks not significant impacts. Operation: Long-term erosion not significant.	Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.
Surface Water Resources					
There would be a continued inadequacy of water supply for proratable irrigators in drought years. Summer streamflows in the Keechelus Reach would remain artificially high. When Keechelus Reservoir level falls below elevation 2,466, tributary access for bull trout would be adversely impacted for approximately 115 days in 81 percent of years. This would be a significant impact to fish passage. The pool elevation would remain within the current operating range of the reservoir.	Construction: Construction would not affect water resources. Operation: Water supply to proratable water users would be improved significantly by 19 to 23 percent in drought years, raising the proration to about 64 percent of entitlement. In multiple drought years, the improvement would be less. Keechelus Reservoir would be operated to help Kachess Reservoir refill following a drought. This would result in a slightly lower mean Keechelus Reservoir pool level, with a maximum reservoir drawdown of 15 feet in late summer. When Keechelus Reservoir level falls below elevation 2,466, bull trout access to tributaries is adversely impacted. This would at the same frequency as the No Action, but for a longer duration. However, the pool elevation would remain within the current operating range of the reservoir and would not significantly affect Keechelus Reservoir operations. Kachess Reservoir would be drawn down by as much as 80 feet below existing low pool conditions and take 2 to 5 years following a drought to refill. The drawdown of Kachess Reservoir would increase the occurrence and duration of reservoir pool levels below elevation 2,220. Below that elevation, fish cannot pass between the Kachess and Little Kachess basins, significantly impacting fish passage. Relative to *Alternative 1*, this would occur 5 percent more often and the duration would increase by 56 days during those years. The drawdown of Kachess Reservoir would increase the duration of reservoir levels below elevation 2,226—the level at which access for bull trout to tributary streams is significantly impacted. Frequency would be the same as *Alternative 1*, but duration would increase by 44 days (from means of 109 to 153) during those years. Streamflow changes in Yakima River reaches would not have significant effects because flow would	Same as *Alternative 2A*.	Construction: There would be no impacts from construction. Operation: *Alternative 3A* would yield a minimal improvement in water supply to proratable users in drought years, but not enough to be significant. During post-drought years, Keechelus Reservoir maximum pool elevations would be lower and minimum elevations higher. Keechelus Reservoir levels would fall below 2,466 in 10 percent fewer years than *Alternative 1* and for 15 fewer days during those years. This would be a significant benefit to fish passage. The pool elevation would remain within the current operating range of the reservoir, and would not significantly affect Keechelus Reservoir operations. Summer streamflows in the Keechelus Reach would be reduced by 400 cfs, greatly improving fish habitat conditions. Streamflow changes in other Yakima River reaches would not have significant effects because flow would remain within current operating ranges. Streamflow in the Kachess River would change, but would fall within current operating ranges; thus no significant effect would result. The BTE would improve streamflow in Gold and Cold creeks during late summer and fall, when Keechelus Reservoir water levels are at their lowest. The BTE would provide a surface water connection from the streams to the reservoir pools, providing better seasonal passage conditions for bull trout and significantly benefiting fish passage.	Same as *Alternative 3A*.	Construction: Construction would not affect water resources. Operation: Proratable water supply would be increase to about 66 percent of entitlement during single drought years. In multiple drought years, the improvement would be less. Keechelus Reservoir would be operated to help Kachess Reservoir refill following a drought. This would result in a slightly lower mean Keechelus Reservoir pool level, with a maximum reservoir drawdown of 15 feet in late summer. Keechelus Reservoir level would fall below elevation 2,466 approximately 130 days in 74 percent of years, significantly adversely impacting tributary access for bull trout. The pool elevation would remain within the current operating range of the reservoir and would not significantly affect Keechelus Reservoir operations. Kachess Reservoir would be drawn down by as much as 80 feet below existing low pool conditions. It would take 2 to 5 years following a drought for Kachess Reservoir to refill to normal operating levels. The drawdown of Kachess Reservoir would increase the occurrence and duration of reservoir pool levels below elevation 2,220. Below that elevation, fish cannot pass between the Kachess and Little Kachess basins, significantly impacting fish passage. Relative to *Alternative 1*, this would occur 5 percent more often and the duration would increase by 56 days during those years. The drawdown of Kachess Reservoir would increase the duration of reservoir levels below elevation 2,226—the level at which access for bull trout to tributary streams is significantly impacted. Frequency would be the same as *Alternative 1*, but duration would increase by 44 days during those years. Summer streamflows in the Keechelus Reach would be reduced by 400 cfs, significantly

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
	remain within current operating ranges. Streamflow in the Kachess River would change, but would be within current ranges; thus would not be significant. The BTE would improve streamflow in Gold and Cold creeks during late summer and fall, when Keechelus Reservoir water levels are at their lowest. The BTE would provide a surface water connection from the streams to the reservoir pools, providing better seasonal passage conditions for bull trout and significantly benefiting fish passage.				improving habitat conditions for fish. Streamflow changes in other Yakima River reaches and the Kachess River would be within current operating ranges.
Surface Water Quality					
No changes would occur to current reservoir operations, reservoir levels, or streamflows that would affect water quality. If a severe long-term drought occurs, or conditions worsen because of climate change, water levels in reservoirs could significantly drop and, with warmer air temperatures, affect long-term water quality conditions for such parameters as DO and water temperature.	<u>Construction</u>: During construction, oil, grease, total petroleum hydrocarbons, suspended sediment, nutrients, and construction wastewater could enter receiving water. With BMPs the potential for contamination would be minimized. <u>Operation</u>: Lower reservoir pool levels during drought and post-drought recovery periods could cause turbidity, temperature, and DO in the Kachess Reservoir to be out of compliance with State surface water quality standards. No long-term significant impacts would be expected because suspended material would be localized and settle out as the reservoir bed stabilizes. After a drought and its recovery, the potential for water heating and depressed DO concentrations would diminish. If a severe long-term drought occurs or conditions worsen because of climate change, water levels in the reservoir could drop significantly, affecting DO and water temperatures resulting in potentially significant impacts. Exceedance of the State standard for temperature and turbidity may occur at the outlet to Kachess River during extended drought and drought recovery. No long-term water quality impacts are expected from the BTE. Stream restoration may help to lower peak water temperatures and improve DO conditions by improving the depth and flow conditions in Gold Creek.	Same as *Alternative 2A*.	<u>Construction</u>: Same as *Alternative 2A*. <u>Operation</u>: Operations would not cause an increase in sedimentation, turbidity, temperature, nutrients, fecal coliform bacteria, or TDG, or a decrease in DO. If a severe long-term drought occurs or conditions worsen because of climate change, water levels in the reservoirs could drop, affecting long-term water quality conditions in Kachess Reservoir for DO and temperature. Water quality in Kachess Reservoir could be modified by the introduction of contaminants from Keechelus Reservoir inflow. No long-term water quality impacts are expected from operation of the BTE following construction. Stream restoration may help to lower peak water temperatures and improve DO conditions by improving the depth and flow conditions in Gold Creek.	Same as *Alternative 3A*.	<u>Construction</u>: Same as *Alternatives 2A* and *3A*. <u>Operation</u>: During nondrought conditions, water quality impacts would be similar to those described for *Alternative 3A*. During drought and drought recovery years, water quality impacts on Kachess Reservoir and Kachess River due to lower Kachess Reservoir pool levels would be similar to those described for *Alternative 2A*. Water quality impacts on the Keechelus Reach of the Yakima River would be similar to those described for *Alternative 3A*. During drought recovery, Keechelus Reservoir pool elevations may be lower than existing conditions, potentially resulting in more surface heating during the summer months as the reservoir pool level recovers. No long-term water quality impacts are expected from operation of the BTE following construction. Stream restoration may help to lower peak water temperatures and improve DO conditions by improving the depth and flow conditions in Gold Creek.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Groundwater					
Impacts to groundwater would be the same as under existing conditions.	Construction: Groundwater levels and wells would not be impacted. Inadvertent spills may affect groundwater quality but would be minimized by utilizing BMPs. Operation: Operation may result in decreased groundwater levels in aquifers adjacent to the reservoirs, potentially decreasing the water supply to wetlands, springs, streams, or wells.	Same as *Alternative 2A*.	Construction: There may be temporary impacts to groundwater levels or wells from dewatering. Inadvertent spills may affect groundwater quality but would be minimized by utilizing BMPs. Operation: Operation would not impact groundwater contributions to streams, springs, wetlands or wells.	Same as *Alternative 3A*.	Same as *Alternative 2A* and *3A*.
Fish					
Existing passage problems in the reservoirs would continue. Artificially high streamflows in the Keechelus Reach would continue to provide unsuitable habitat for anadromous fish. Climate change may influence prey availability, decrease habitat complexity and connectivity, increase river and reservoir temperatures, and may lead to less operational flexibility to meet instream flow requirements.	Construction: Construction would reduce shoreline vegetation adjacent to Kachess Reservoir. Temporary increases in turbidity would occur during construction. During construction, increased noise levels may disturb fish. Blasting may be required, thus noise levels could be significant. Operation: *Water temperature* – Reduction in Kachess Reservoir minimum pool elevation may increase water temperatures in Kachess Reservoir. *Turbidity* - Reduction in Kachess Reservoir minimum pool elevation would expose the lower reservoir bed to wave action and increase turbidity. *Food based prey* - Available prey would be reduced in both reservoirs. *Habitat complexity* - Reduction in Kachess Reservoir minimum elevation and lower Keechelus Reservoir levels after drought years would reduce shoreline vegetation and habitat complexity. Lower reservoir levels after drought years would reduce shoreline vegetation and habitat complexity within Keechelus Reservoir. *Habitat connectivity* - Reduction in Kachess Reservoir minimum pool elevation would reduce connectivity between reservoir habitats as well as between reservoir and tributary habitats. Lower Keechelus Reservoir levels after drought years would reduce connectivity between reservoir and tributary habitats. The BTE would increase habitat connectivity between reservoir and tributary habitat in Keechelus Reservoir. *Entrainment* - Increased risk of entraining resident fishes with small larval stages in the new intake in Kachess Reservoir.	Construction: Same as *Alternative 2A*, but noise disturbance would be less than *Alternative 2A*. Operation: Impacts to temperature, food based prey, habitat connectivity, and entrainment would be the same as *Alternative 2A*. *Habitat complexity* – Impacts the same as *Alternative 2A*, but the footprint of *Alternative 2B* is smaller.	Construction: During construction increased noise levels and turbidity may disturb fish. Operation: *Food based prey* - Available prey would be reduced in Kachess Reservoir, but would increase within Keechelus Reservoir. *Habitat complexity* - Greater fluctuations in Kachess Reservoir level would reduce shoreline vegetation and habitat complexity. Smaller fluctuations in Keechelus Reservoir level would increase shoreline vegetation and habitat complexity. *Habitat connectivity* - Lower reservoir levels would reduce connectivity between reservoir and tributary habitats in Kachess Reservoir. Reduced frequency and duration of passage impediments would increase connectivity between reservoir and tributary habitats in Keechelus Reservoir. The BTE would increase habitat connectivity between reservoir and tributary habitat in Keechelus Reservoir. *River flow* - Summer instream flows in the Yakima River would meet targets in most years and increase salmon production and resident fish habitat in the Keechelus Reach. *Transmission of disease or invasive species* - The conveyance of water would increase the risk of transmitting diseases and exotic species to Kachess Reservoir.	Same as *Alternative 3A*.	Construction: Same as *Alternatives 2A* and *3A*. Operation: *Temperature* – Reduction in Kachess Reservoir minimum pool elevation may increase water temperatures in Kachess Reservoir. Following drought years, reductions in Keechelus Reservoir pool elevation may increase water temperatures in Keechelus Reservoir. *Turbidly* – Reduction in Kachess Reservoir minimum pool elevation would expose the lower reservoir bed to wave action and increase turbidity. *Food based prey* - Available prey would be reduced in Kachess Reservoir but only available zooplankton prey would be reduced within Keechelus Reservoir. Impacts to habitat complexity, connectivity and entrainment would be the same as *Alternative 2A*. Impacts to nutrients and river flow, as well as impacts from transmission of disease or invasive species would be the same as *Alternative 3A*.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Vegetation and Wetlands					
There would result in a net benefit to wetlands and vegetation in the extended study area, associated with proposed mitigation for the I-90 Phase 2A project.	Construction: Temporary loss of riparian and upland vegetation would not be significant. Operation: Prolonged drawdown of Kachess Reservoir may result in establishment of invasive species and changes to wetland hydrology and vegetation communities during drought years. This would not be significant with the implementation of invasive species control and wetland mitigation. There would be a permanent loss of less than 1 acre of wetland, which would be mitigated to ensure no net loss. Permanent loss of riparian and upland vegetation would not be significant. The BTE would benefit up to 30 acres of wetlands in the Gold Creek drainage.	Same as *Alternative 2A*.	Construction: Temporary loss of riparian and upland vegetation would not be significant. There may be temporary impacts to wetlands from dewatering. Operation: No net loss of wetlands. Permanent loss of riparian and upland vegetation would not be significant. The BTE would have a beneficial impact on up to 30 acres of wetlands in the Gold Creek drainage.	Construction: Same as *Alternative 2A*. Operation: Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.
Wildlife					
Wildlife conditions would remain similar to existing conditions, but wildlife would benefit from the ongoing wildlife connectivity improvements of the I-90 Phase 2A project.	Construction: Impacts to habitat are significant for localized species with small home ranges and not significant for transient species that occupy the larger watershed. Permanent habitat loss would be 18 acres. Disturbances to wildlife from construction activities or noise are considered significant. Impacts from the BTE would be positive or negative depending on the species. Operation: Disturbance from noise, light or human activities are not significant.	Construction: Same as *Alternative 2A*, except habitat loss would be 8 acres. Operation: Same as *Alternative 2A*.	Construction: Same as *Alternative 2A*, except habitat loss would be 4 acres. Operation: Same as *Alternative 2A*.	Construction: Same as *Alternative 2A*, except habitat loss would be 1.5 acres. Operation: Same as *Alternative 2A*.	Construction: Same as *Alternative 2A* and *3A*, except habitat loss would be 8 to 22 acres, depending on which combination of KDRPP and KCC is chosen. Operation: Same as *Alternative 2A*.
Threatened and Endangered Species					
Habitat conditions would be similar to existing conditions. Climate change could exacerbate existing negative bull trout habitat conditions as well as limit Reclamation's flexibility to meet instream flow requirements for bull trout and MCR steelhead. Habitat connectivity improvements associated with the I-90 Phase 2A project would improve conditions for bull trout and northern spotted owl.	Construction: There would be significant loss of habitat that supports the northern spotted owl. *Alternative 2A* would have the largest area of vegetation removal. Increased noise is not expected to result in harm or injury to northern spotted owl; however, it may cause disturbance behaviors. Turbidity from construction may negatively impact bull trout and MCR steelhead. Operation: The BTE would improve habitat for bull trout. There would be no other operational impacts on threatened and endangered species.	Same as *Alternative 2A*, except vegetation loss and noise impacts would be less.	Same as *Alternative 2A*, except vegetation loss and noise impacts would be less than *Alternatives 2A* and *2B*.	Same as *Alternative 2A*, except vegetation loss and noise impacts would be less than *Alternatives 2A*, *2B*, and *3A*.	Same as *Alternative 2A* and *3A*.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Visual Quality					
There would be no changes to visual quality.	Construction: There would be no significant impacts from construction. Operation: Kachess Reservoir drawdowns during drought years would have significant impacts due to changes in overall landscape character and desirability from a recreation perspective. The drawdown would potentially conflict with scenic integrity and visual quality objectives. The east shore pumping plant would have a significant impact because it would substantially contrast with and interrupt the visual character and integrity of the landscape.	Construction: There would be no impacts from construction. Operation: Kachess Reservoir drawdowns during drought years would have significant impacts due to changes in overall landscape character and desirability for recreation. The drawdown would potentially conflict with scenic integrity and visual quality objectives. New facilities would not contrast with or interrupt the visual character and integrity of the landscape.	Construction: There would be no significant impacts from construction. Operation: New facilities would not contrast with or interrupt the visual character and integrity of the landscape.	Same as *Alternative 3A*.	Same as *Alternative 2A*, *2B*, *3A*, or *3B* depending on which combination of KDRPP and KKC is chosen.
Air Quality					
Impacts to air quality would not increase over existing conditions.	Construction: Construction would result in increased emissions and fugitive dust throughout construction, but would not be significant. Operation: Emissions and fugitive dust would not have a significant impact on sensitive receptors.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternatives 2A* and *3A*.
Climate Change					
There would be no significant production of GHGs. Climate change could adversely impact operation of the reservoirs because of changes in runoff timing and volume.	Construction: There would be no significant production of GHGs. Operation: There would be no significant production of GHGs. Climate change predictions indicate that Reclamation would need to increase operation of KDRPP. This is not considered a significant impact because KDRPP would still contribute to increasing water supply. The effects of climate change would decrease winter, spring, and fall attainment of instream flow targets. Summer attainment of instream flow targets in the Keechelus Reach of the Yakima River would be improved by the effects of climate change. These impacts are not considered significant. Climate change effects could offset some of the potential benefits of the BTE, but also increase the need for the BTE.	Same as *Alternative 2A*.	Construction: There would be no significant production of GHGs. Operation: Same as *Alternative 2A*, except summer attainment of instream flow targets would be unchanged.	Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Noise					
There would be no increase in noise over existing conditions.	<u>Construction</u>: Construction would result in increased noise throughout the construction period. Impacts are not considered significant because noise would remain below Class A noise levels at existing noise sensitive receptors. Ground-borne vibration could be an occasional nuisance during construction hours, but would not be significant. <u>Operation</u>: There would be no noise impacts from operation.	Same as *Alternative 2A*.	<u>Construction</u>: Construction would result in increased noise throughout the construction period. Noise levels could potentially exceed maximum permissible levels, but noise would be intermittent and well below the pain threshold levels that affect human health. Ground-borne vibration could be an occasional nuisance during construction hours, but impacts would not be significant. <u>Operation</u>: No noise impacts are anticipated.	Same as *Alternative 2A*.	Same as *Alternatives 2A* and *3A*.
Recreation					
Similar to existing conditions. Continued increased demand, boat launches would remain inaccessible at certain times of the year and climate change may negatively affect opportunities. Construction of I-90 Phase 2A would temporarily impact recreation.	<u>Construction</u>: Construction would impact usability and quality of recreation at adjacent undeveloped recreation sites, but the impacts would be minor as the majority of the reservoir shore would remain available. Construction for the BTE would impact recreation at the Gold Creek Pond Picnic Area and John Wayne Pioneer Trail. <u>Operation</u>: Impacts from reservoir drawdown would be significant because the boat launch at Kachess Campground would be inaccessible more often than with *Alternative 1*. Loss of fishing opportunities would also be significant due to loss of boating access and impacts on fish species. The drawdown of Kachess and Keechelus reservoirs would significantly impact usability and quality of recreation during drought years and as the reservoir refills because of the extent and slope of the exposed reservoir bed. Recreational use would be restored following construction of the BTE actions, but the character of recreation at these sites would change.	Same as *Alternative 2A*.	<u>Construction</u>: Construction could disrupt quality of recreation, but the impact would not be significant. <u>Operation</u>: There would be no significant impact. Recreational use would be restored following construction of the BTE, but the character of recreation at these sites would change.	Same as *Alternative 3A*.	Same as *Alternative 2A* and *3A*.
Land and Shoreline Use					
Current trends would continue and there would be an increased potential for the prorationing of irrigation water due to climate change. Long-term negative changes in land use could potentially result from these indirect impacts on water reliability.	<u>Construction</u>: There would be temporary disruption of land use. <u>Operation</u>: Some property easements or acquisitions would be necessary for the pumping plant site and possibly for the transmission line, and the BTE. Improved reliability of proratable water supply would be provided.	<u>Construction</u>: Same as *Alternative 2A*. <u>Operation</u>: Some property easements or acquisitions may be necessary for the transmission line and the BTE. There would be improved reliability of proratable water supply.	<u>Construction</u>: Same as *Alternative 2A*. <u>Operation</u>: Some property easements or acquisitions may be required for KKC facilities and the BTE.	Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.

<table>
<tr><th>No Action Alternative</th><th>Alternative 2A</th><th>Alternative 2B</th><th>Alternative 3A</th><th>Alternative 3B</th><th>Alternative 4</th></tr>
<tr><td colspan="6">Utilities</td></tr>
<tr><td>There would be no impacts to utilities.</td><td><u>Construction</u>: Interruption of services is not anticipated.

<u>Operation</u>: There would be no impacts to electricity, wastewater, or telecommunications.</td><td>Same as Alternative 2A.</td><td>Same as Alternative 2A.</td><td>Same as Alternative 2A.</td><td>Same as Alternative 2A.</td></tr>
<tr><td colspan="6">Transportation</td></tr>
<tr><td>Similar to existing conditions, except construction traffic on I-90 and there would be long-term beneficial effects resulting from the I-90 Phase 2A project.</td><td><u>Construction</u>: Construction would result in a more-than-moderate increase in vehicle traffic time and is considered significant.

The increase would not affect the ability of emergency personnel to respond to an incident or interrupt school bus routes, because the delays would be intermittent and of short-term duration.

No road closures are planned.

No changes are anticipated to existing access for pedestrians, snowmobiles, or bicycles along local roadways. There is no anticipated impact to existing parking areas.

Safety risks and deterioration of roads are not considered significant.

<u>Operation</u>: Impacts would not be significant because there would be minimal increases in traffic delays; no interruption to other means of transportation; no interruption to emergency vehicle response time; no parking impacts; and no deterioration of roads.</td><td>Same as Alternative 2A.</td><td>Same as Alternative 2A.</td><td>Same as Alternative 2A.</td><td>Same as Alternative 2A.</td></tr>
<tr><td colspan="6">Cultural Resources</td></tr>
<tr><td>Similar to existing conditions.</td><td><u>Construction</u>: Construction at Kachess Reservoir could damage or alter the identified NRHP-eligible site and potential additional sites that have not yet been identified.

The Cold Creek passage improvements would permanently change the John Wayne Pioneer Trail, but trail use would continue.

<u>Operation</u>: The additional 80-foot drawdown of Kachess Reservoir would expose large portions of shoreline, potentially exposing cultural resources to degradation, looting, or vandalism.</td><td>Same as Alternative 2A.</td><td><u>Construction</u>: Construction at Keechelus Reservoir could damage or alter the identified NRHP-eligible site and potential additional sites that have not yet been identified.

The Cold Creek improvements would change the John Wayne Pioneer Trail, but trail use would continue.

<u>Operation</u>: The additional 15-foot drawdown of Keechelus Reservoir would expose large portions of shoreline, potentially exposing cultural resources to degradation, looting, or vandalism.</td><td>Same as Alternative 3A.</td><td>Same as Alternative 2A and 3A.</td></tr>
<tr><td colspan="6">Indian Sacred Sites</td></tr>
<tr><td>There would be no impacts.</td><td>To date, Reclamation has identified no Indian sacred sites in the study area. No impacts are anticipated.</td><td>Same as Alternative 2A.</td><td>Same as Alternative 2A.</td><td>Same as Alternative 2A.</td><td>Same as Alternative 2A.</td></tr>
</table>

No Action Alternative	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Indian Trust Assets					
There would be no impacts.	To date, Reclamation has identified no Indian trust assets in the study area. No impacts are anticipated.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*.	Same as *Alternative 2A*
Socioeconomics					
No impacts are anticipated and existing trends would continue.	Construction: Direct impacts on income and employment would be generally positive, but not significant. Workers may displace customary recreational visitors during summer, but would offset lost recreation related business. Operation: As a result of improved water supply, agricultural output during drought years would be significantly higher.	Same as *Alternative 2A*.	Construction: Impacts would be the same as *Alternative 2A*, but to a lesser degree. Operation: Direct impacts on income, employment, lodging, would be generally positive, but not significant. There would be no impact on agricultural output.	Same as *Alternative 3A*.	Construction: Impacts would be the same as *Alternative 2A*, but to a greater degree. Operation: Direct impacts on income, employment, lodging, would be generally positive, but not significant. As a result of improved water supply, agricultural output during drought years would be significantly higher relative to *Alternative 1* and more than KDRPP alone.
Environmental Justice					
No impacts are anticipated.	Construction: No significant impacts. Operation: No disproportionate impacts to minority or low-income populations. Impacts to fish species in Kachess Reservoir could cause a significant impact to subsistence living.	Same as *Alternative 2A*.	Construction: No significant impacts. Operation: No disproportionate impacts to minority or low-income populations.	Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.
Environmental Health and Safety					
There would be no increase in environmental health and safety risks over existing conditions.	Construction: There would be no impacts from hazardous sites or construction traffic. Operation: Full drawdown would expose areas with steep slopes around Kachess Reservoir which would increase the risk from falling.	Same as *Alternative 2A*.	Construction: There would be no impacts from hazardous sites or construction traffic. Operation: No impacts are anticipated.	Same as *Alternative 3A*.	Same as *Alternatives 2A* and *3A*.

CHAPTER 3 – AFFECTED ENVIRONMENT

Chapter 3 Affected Environment

3.1 Introduction

This chapter describes the environmental setting of Kachess and Keechelus reservoirs and the surrounding areas that could be affected by the Proposed Action, which includes the KDRPP and KKC proposals. Chapter 4, Environmental Consequences, discusses potential effects of the Proposed Action on the environmental resources described in this chapter. For each environmental resource, this chapter defines a primary study area and an extended study area. Their boundaries vary and are described separately for each resource. Generally the primary study area comprises the areas near the reservoirs and the Proposed Actions while the extended study area includes the larger Yakima River basin. To help the reader, the footer at the bottom of each page identifies which resource is being discussed.

Reclamation and Ecology referenced the *Yakima River Basin Integrated Water Resource Management Plan Final Programmatic EIS* (Integrated Plan PEIS) (Reclamation and Ecology, 2012) for much of the background information described in this chapter. Additional information sources include studies prepared by Reclamation and Ecology on the Proposed Action (see the Kachess Drought Relief Pumping Plant (KDRPP) and Keechelus-to-Kachess Conveyance (KKC) web sites[1]), published environmental and planning documents, books, web sites, journal articles, and communications with technical experts.

When Federal and State regulations directly relate to the analysis of impacts, the resource sections include a description of the regulatory setting. Section 3.15, Land and Shoreline Use, includes a description of Federal, State and local regulations and policies that relate to the primary study areas. Section 1.9 and Chapter 5 describe other regulations with which Reclamation and Ecology must comply to implement the Proposed Action.

[1] http://www.usbr.gov/pn/programs/eis/kdrpp/index.html
http://www.usbr.gov/pn/programs/eis/kkc/index.html

3.2 Earth

Earth resources refer to geology and soils. For the purposes of this DEIS, this section focuses on the geologic and soil resources of the proposed areas of disturbance. The primary study area for earth resources includes the following areas:

- Kachess Reservoir from the current maximum pool elevation of 2,262 to the proposed operational minimum pool elevation of 2,110
- Locations that would be impacted by proposed facilities and other construction activities associated with KDRPP (pumping plant facilities, Kachess River discharge, transmission line) and KKC (tunnel alignments, Keechelus portal, Keechelus diversion and intake structures, Kachess portal and discharge, and support facilities)
- Keechelus Reservoir and surrounding areas that would be impacted by Bull Trout Enhancement (BTE) restoration activities

The extended study area generally includes the entire Yakima River basin and is described within a regional geologic context. Both regional and local conditions are identified as well as the potential geologic and seismic hazards present in this region. Much of the information below relies on geotechnical memoranda prepared for this DEIS, including summaries of geotechnical data collected in the area over the years (Reclamation and Ecology, 2014l; 2014m).

Kachess and Keechelus reservoirs are located in the northwest portion of the Yakima River basin on the eastern side of the Cascade Range in south-central Washington. The general topography is one of mountains, ridges, and peaks, with deep glacially carved valleys. The basin is bounded on the west by the Cascade Range, on the north by the Wenatchee Mountains, on the east by the Columbia River drainage, and on the south by the Horse Heaven Hills.

The information in this subsection is based on geologic units in the primary study area as mapped by Tabor et al. (2000) and summarized below. Detailed mapping was also performed by Reclamation for areas south of Kachess Reservoir in 1911 (Reclamation, 1911a and b) and south of Keechelus Reservoir in 2001 (Reclamation, 2001), and is included in the summaries below as applicable.

3.2.1 Regulatory Setting

3.2.1.1 National Pollutant Discharge Elimination System – Construction Activity

The National Pollutant Discharge Elimination System (NPDES) process, established by the Clean Water Act, is intended to meet the goal of preventing or reducing pollutant runoff. Projects involving construction activities (e.g., clearing, grading, or excavation) with land disturbance greater than 1 acre must file a notice of intent to indicate compliance with the State General Permit for Storm Water Discharges Associated with Construction Activity (General Permit). This permit establishes conditions to minimize sediment and pollutant loading and requires preparation and implementation of a stormwater pollution prevention plan (SWPPP) before construction. The SWPPP typically contains best management practices (BMPs), which include erosion control measures. Because the Proposed Action would include grading that would disturb more than 1 acre, construction would need to comply with the State's general permit for construction.

3.2.1.2 Earthquake Hazards Reduction Act

In October 1977, the U.S. Congress passed the Earthquake Hazards Reduction Act to "reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program". To accomplish this, the act established the National Earthquake Hazards Reduction Program. The National Earthquake Hazards Reduction Program Act (NEHRPA) significantly amended this program in November 1990 by refining the description of agency responsibilities, program goals, and objectives. The NEHRPA designates the Federal Emergency Management Agency as the lead agency of the program and assigns it several planning, coordinating, and reporting responsibilities. Other NEHRPA agencies include the National Institute of Standards and Technology, the National Science Foundation, and U.S. Geological Survey. Because the Proposed Action would include permanent improvements that may be subject to earthquake hazards, seismic design would be required to adhere to applicable NEHRPA requirements.

3.2.2 Regional Geology

The Kachess and Keechelus reservoirs are located in the Roslyn basin of the larger Yakima River basin, in an area comprised largely of Mesozoic (252 to 66 million years ago) metamorphic rocks and Tertiary (65 to 1.8 million years ago) volcanic deposits. The geology in this area is extremely complex because of seismic forces, with extensive areas of crushed and jumbled rocks, and plates of rock thrust over each other, as can be seen in Figure 3-1 (Tabor et al., 2000). In the valley floor of each of the reservoirs, basin-fill deposits consist of alluvial, lacustrine (lake), and glacial deposits. Pleistocene (approximately 2.6 million to 11,000 years ago) glaciation significantly affected the valleys by the movement of the glacial ice and the deposition of materials as they advanced and then retreated. Advance deposits, such as glaciolacustrine, outwash and till, and glacial deposits, such as glaciolacustrine, outwash and till, and ice-contact sediment, are located throughout the area (Reclamation and Ecology, 2014m). The basement rock in the area is the Easton Schist, primarily comprised of metamorphosed greenschist and blueschist, but with interbedded Darrington Phyllite. The Easton Schist is overlain by the Naches Formation, which consists primarily of volcanics with interbedded sandstone, siltstone, shale, conglomerate, and coal (Reclamation and Ecology, 2014m). East of the inactive Straight Creek fault, the Easton Schist is overlain by the Swauk Formation, which consists primarily of sandstone and siltstone with coal seams. Additional detail about geologic units located in the study area is provided in the subsections below.

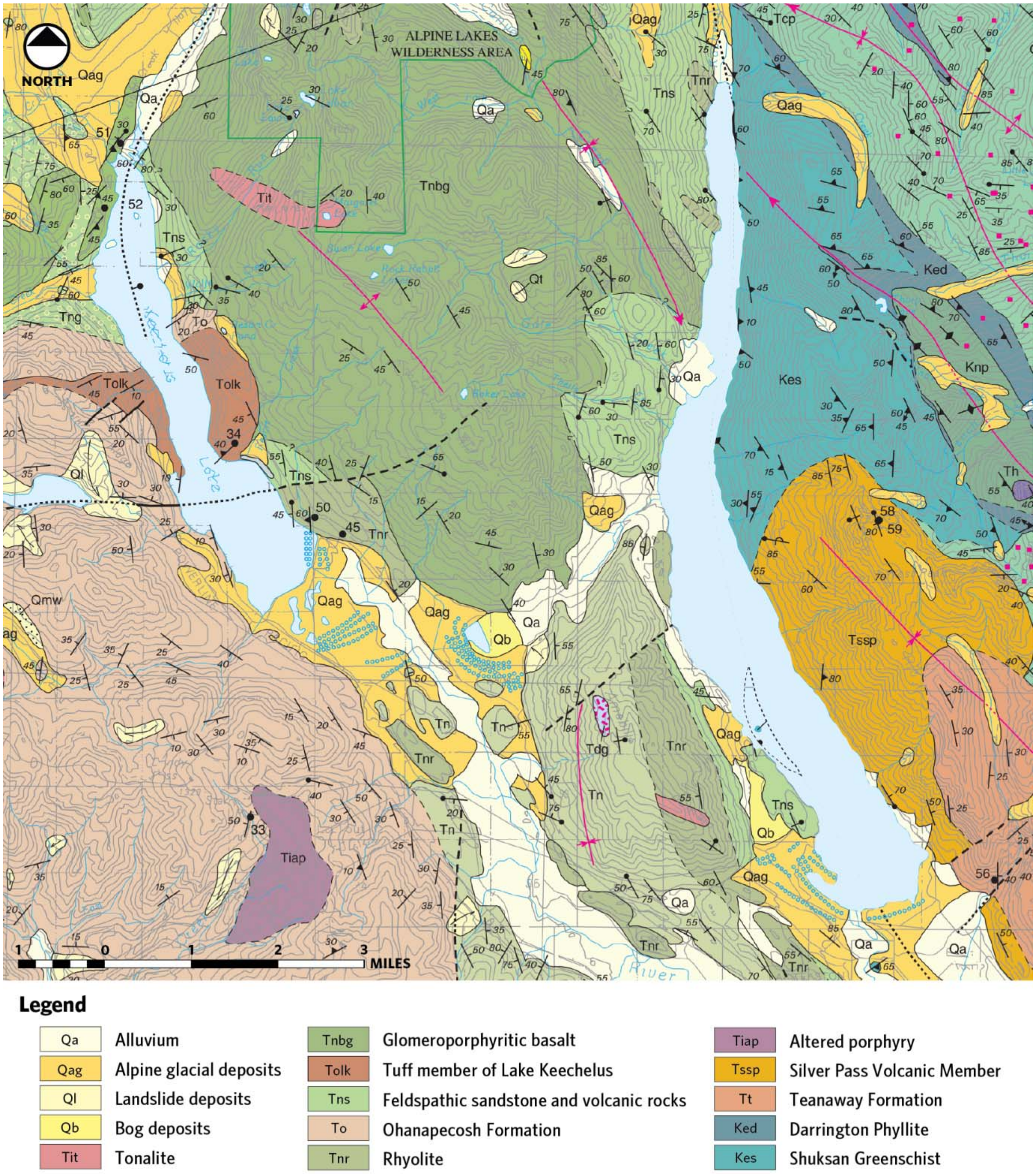

Figure 3-1. Surface Geologic Units near the Kachess and Keechelus Reservoirs
(Source: Tabor et al., 2000)

The soil conditions in the region are comprised largely of glacial deposits, post-glacial alluvial colluvial deposits, and lacustrine deposits. In general, denser compacted soils are less susceptible to erosion. However, many other factors - particularly the erosive forces being generated - determine the susceptibility of soils to erosion. For example, heavy periods of precipitation can create runoff patterns that greatly affect the amount and extent of erosion by concentrating runoff in areas of exposed soils. For example, heavy periods of precipitation can create runoff patterns that greatly affect the amount and extent of erosion by concentrating runoff in areas of exposed soils.

3.2.2.1 Quaternary River Alluvium and Quaternary Alpine Glacial Deposits

Quaternary-age (approximately 2.5 million years ago to the present) river alluvium and alpine glacial deposits are the dominant materials in the river valleys south of Kachess and Keechelus reservoirs (Tabor et al., 2000). River alluvium is composed of highly permeable deposits of silt, sand, gravel, cobbles, and boulders deposited by the Yakima River. Alpine glacial deposits have variable permeability because they include a variety of materials ranging from clay to boulders. Reclamation soil borings conducted for Kachess Dam construction encountered gravel, sand, and clay south of Kachess Reservoir (Reclamation, 1911a). This material is likely glacial till and would correspond with alpine glacial deposits described in Tabor et al. (2000). The glacial till is expected to have low permeability. There is also the presence of “compact gravel” and “gravel” in the valley south of Kachess Reservoir, which is likely glacial outwash (Reclamation, 1911a). Groundwater is expected to travel through glacial outwash quickly because it is very permeable. South of Keechelus Dam, Reclamation mapping divides the alpine glacial deposits of Tabor et al. (2000) into the following five categories: glacial till, glacial outwash, wetland and bog deposits, alluvial deposits, and alluvial fan deposits (Reclamation, 2001). The permeability of these materials varies greatly; however, glacial till and wetland or bog deposits are expected to have low permeability and glacial outwash, alluvial deposits, and alluvial fan deposits are thought to have medium to high permeability.

3.2.2.2 Quaternary Lacustrine Deposits

Lacustrine sediments are fine-grained sand, silt, and clay deposited during periods when glacial lakes were present. They generally impede groundwater flow because of their low permeability. Reclamation (2001) mapped lacustrine sediments underlying glacial outwash in three borings drilled near Keechelus Dam ranging in depth from 48 to 78 feet (below ground surface [bgs] elevation 2,413 to 2,435) and in one boring drilled 500 feet east of the dam to a depth of 62 feet (bgs 2,415).

3.2.2.3 Tertiary Naches Formation

The Tertiary-age Naches Formation is part of the Green River-Cabin Creek fault block, and comprises the majority of outcropping bedrock between Kachess and Keechelus reservoirs and north and west of Keechelus Reservoir. The Naches Formation is composed of rhyolite basalt and sedimentary members which are expected to have low permeability, although locally higher permeability is possible in areas where weathering and fracturing have developed or where faulting and folding have occurred (Tabor et al., 2000). The basalt member covers a large area between the two reservoirs, but directly abuts only a small amount of shoreline. The bedrock on the east and northwest shorelines of Keechelus Reservoir is composed primarily of rhyolite and sedimentary members of the Naches Formation. These are the likely bedrock geologic formations that underlie the Quaternary deposits in the valley downstream from Keechelus Reservoir.

Naches Formation bedrock also outcrops on the western edge of Kachess Reservoir, in the form of feldspathic sandstone and rhyolite. The Reclamation borings indicate sandstone is present (Reclamation, 1911a). Sandstone under the sedimentary deposits in the valley below Kachess Dam is likely feldspathic sandstone (Tabor et al., 2000). The permeability of this formation is unknown, but is likely low to medium.

3.2.2.4 Tertiary Ohanapecosh Formation

The Tertiary-age Ohanapecosh Formation comprises the bedrock on the southwest shoreline and a portion of the east shoreline of Keechelus Reservoir. The bedrock is of low permeability and is not anticipated to convey significant rates of groundwater, although locally higher permeability is possible in areas where weathering and fracturing has developed or where faulting and folding have occurred.

3.2.2.5 Tertiary Silver Pass Member of Swauk Formation

The Tertiary-age Silver Pass Member of the Swauk Formation is a part of the Teanaway River fault block, and comprises the bedrock on the southeast shoreline of Kachess Reservoir and the north wall of the Yakima River valley downstream from Kachess Reservoir. The Silver Pass Member includes dacitic and andesitic volcanic rocks (Tabor et al., 2000). The bedrock is of low permeability and is not anticipated to convey significant rates of groundwater, although locally higher permeability is possible in areas where weathering and fracturing has developed or where faulting and folding have occurred.

3.2.2.6 Cretaceous Shuksan Greenschist of Easton Metamorphic Suite

The Cretaceous-age (approximately 145 to 66 million years ago) Shuksan Greenschist is a member of the Easton Metamorphic Suite, and comprises the bedrock on the northeast shoreline of Kachess Reservoir (Tabor et al., 2000). The Shuksan Greenschist also appears adjacent to Naches Formation rocks on the south wall of the Yakima River valley approximately 2 miles downstream from Kachess Reservoir. The greenschist is metamorphic rock of low permeability and is not anticipated to convey significant rates of groundwater, although locally higher permeability is possible in areas where weathering and fracturing has developed or where faulting and folding have occurred.

3.2.3 Kachess Reservoir Area

Lake Kachess, which was artificially impounded to form Kachess Reservoir in 1911, was originally a natural lake impounded by a terminal glacial moraine (an accumulation of unconsolidated glacial debris that typically includes a mixture of clay, silt, sand, gravel, and boulders). The moraine ranges in depth from 45 to 100 feet and may be as deep as 200 feet in places beneath the dam (Reclamation, 2014a). Geotechnical drilling conducted in fall 2014 encountered glacial outwash of relatively high permeability at about 80 feet below the top of the dam (Laprade, 2014). The glacial outwash is below the lower permeable morainal material. The drilling did not encounter bedrock in explorations to 240 feet below the top of the dam.

The topography around the Kachess Reservoir varies and includes steep-sided mountains with bedrock outcroppings within the coniferous forest. Around the edge of the current reservoir high water level, the ground is inclined at 0 to 10 degrees, but then drops steeply at inclinations ranging from 20 to 60 degrees. Most of the steep submerged slopes range from about 20 to 40 degrees until flattening out for a relatively level lake bottom. The slopes on the east side of the reservoir are generally inclined between 20 and 40 degrees, with scattered steeper areas. The west shoreline has broad gently sloping areas where the inclination is flatter than 10 degrees. Slopes steeper than about 40 degrees are likely to be submerged bedrock outcrops, whereas the flatter slopes are probably glacial soils.

Around the rim of Kachess Reservoir, 31 creeks flow into the reservoir from the uplands. Twenty-two creeks flow into the Little Kachess basin. A ridge cuts across the lowland between Kachess and Little Kachess basins. When the water level is high, the reservoir is continuous, but when the water level is lower, the two basins are connected by a river. Therefore, the side slopes of the Little Kachess reach have been exposed numerous times when the reservoir has been drawn down.

3.2.3.1 Soil Deposits

Published public-domain geologic maps show little to no specificity about soil deposits around and in the reservoir. Knowledge of soil conditions is based on geotechnical work performed for and by Reclamation (Shannon & Wilson, 2014a; Reclamation and Ecology, 2013a; Reclamation, 1996).

Based on these references, the following soils were identified:

- Glacial till – glacially compacted, dense to very dense, heterogeneous mixture of clay, silt, sand, gravel, and cobbles. These soils typically exhibit very low permeability with relatively high strength, and are relatively resistant to surface erosion.
- Glacial advance outwash – glacially compacted, stratified silt, sand, gravel, and boulders deposited by glacial meltwater streams with generally less than 20 percent fines. Typically exhibits moderately to highly permeable stratified beds with well-sorted, clean sand and gravel interbeds that are highly permeable. Able to stand steeply on dry slope, but its strength is reduced by saturation. Susceptible to surface erosion owing to a lack of cohesion.
- Advance glaciolacustrine deposits – glacially compacted, laminated, very stiff to hard, silt and clay with fine sand lenses deposited in the lake in front of the glacial ice. Exhibits very low to low vertical permeability, but slightly higher horizontal permeability on fine sand or silt layers. Able to stand at steep slope angles for short periods of time, but commonly weakens with exposure or introduction of water in joints, and then fails on moderate slopes.
- Recessional ice-contact deposits – heterogeneous mixture of silt, sand, gravel and cobbles deposited against or adjacent to glacial ice as the ice retreated or wasted. Exhibits low to moderate permeability, depending on the percentage of silt in the matrix. Low to moderate strength.
- Recessional glaciolacustrine deposits – laminated, soft to stiff, silt and clay with fine sand lenses deposited in the lake as the ice retreated and wasted. Exhibits very low to low vertical permeability, but slightly higher horizontal permeability on fine sand or silt layers. Unable to stand on steep slopes and, susceptible to failure during rapid drawdown.
- Older river alluvium – older deposits of silt, sand, gravel, cobbles, and boulders deposited by the Kachess River. Coarse-grained with little fine sand or silt and 2 to 7 percent fines. Typically exhibits very high permeability.
- Lacustrine deposits – very soft to medium stiff, fine sand, silt, and clay with fine organic debris deposited in the lake since the end of Pleistocene glaciation. Typically

exhibits low permeability, and has very low to low strength. Unable to stand on slopes.

Reclamation's studies at and near the Kachess dam site indicate that a thick deposit of till underlies the dam site (Reclamation, 1996), and topography and the geologic map indicate that other recessional moraines underlie the reservoir to the north of the dam. A thin layer of till was also identified along the reservoir shoreline overlying bedrock near the proposed outlet of the KKC tunnel (Shannon & Wilson, 2014b).

The other deposits are known only from excavations made by Reclamation for the dam and its appurtenances. Reclamation encountered recessional glaciolacustrine deposits, consisting of nonplastic silt, overlying till, during excavation of the intake channel (Reclamation, 1996). Profiles prepared by Golder (Reclamation and Ecology, 2013a) indicate that the bottom of the reservoir is covered with a thick layer of fine-grained sediment (lacustrine silt and clay), and the slopes are comprised of unstratified sediments (perhaps ice-contact deposits). Part of the slope on the southwestern end of profile 17 may be underlain by stratified sediments (alluvium or outwash). A profile prepared by Shannon & Wilson (2014a), shows that the slope of the reservoir is underlain by ice-contact deposits ranging from about 10 to 40 feet bgs. This deposit is underlain by other recessional deposits and then till before encountering bedrock. One boring at the southeast shore of the reservoir for a proposed water intake structure indicated that there was 20 feet of very soft silt (lacustrine deposit) underlain by recessional lacustrine deposits to a depth of 44 feet.

3.2.3.2 Landslides and Slope Failure in the Kachess Watershed

Slope failures, commonly referred to as landslides, include phenomena that involve the downslope displacement and movement of material, triggered either by static (i.e., gravity) or dynamic (i.e., earthquake) forces. A slope failure is a mass of rock, soil, and debris displaced downslope by sliding, flowing, or falling. Landslides may occur on slopes of 15 percent or less; however, the probability of failure is greater on steeper slopes. The rate of rock and soil movement can vary from a slow creep over many years to a sudden mass movement.

The geology, structure, and amount of groundwater in the slope affect slope failure potential, as do external processes (i.e., climate, topography, slope geometry, and human activity). The factors that contribute to slope movements include those that decrease the resistance in the slope materials and those that increase the stresses on the slope.

Earthquake motions can induce significant horizontal and vertical dynamic stresses in slopes and can trigger failure. Earthquake-induced landslides can occur in areas with steep slopes that are susceptible to strong ground motion during an earthquake. In an assessment of landslides for the Kachess watershed, the Washington Department of Natural Resources (DNR) evaluated 5,722 acres characterized by mountainous areas that rise from a flat glacial plain at the south end of Kachess Reservoir, elevation 2,178, to the top of Kachess Ridge, elevation 5,552 (Powell, 2005). Bedrock units within the study area consisted of steeply dipping (inclined) sedimentary and volcanic rocks. Bedrock composition, structural integrity, and tectonic history have resulted in significantly greater numbers of landslides west of Kachess Reservoir than east of the reservoir. The study identified 158 landslides (30 percent shallow, 27 percent debris flow, and 43 percent deep-seated). Of all the landslides in the inventory, only two are adjacent to the reservoir. One of the landslides is listed as questionable and the other as probable. Neither is active and neither appears to be related to any geologic processes on the reservoir.

There is no information available for existing landslides within or around the rim of the reservoir and none have ever been reported. No information is available for the reservoir slopes between elevations 2,190 and 2,110 feet, as the reservoir has not been drawdown that low since its original filling in 1911. Therefore, the materials assumed to comprise that slope for the glacial Lake Kachess are interpreted based on the geotechnical information produced in 2013 and 2014 at the south end of the reservoir, but are generally considered unknown.

3.2.4 Keechelus Reservoir Area

Keechelus Reservoir was originally a natural lake created by a moraine impoundment following the last glaciations (Kinnison and Sceva, 1963). Construction of Keechelus Dam, an earthfill dam, was completed by Reclamation in 1920 (Kinnison and Sceva, 1963). Beginning in 2003, the dam was reconstructed for safety modifications. The surface geology near Keechelus Dam is primarily glacial material, although lacustrine deposits and peat soils have been found adjacent to the reservoir (WSDOT and FHWA, 2005).

Bedrock in the vicinity of the dam is rhyolite of the Naches Formation, which crops out on the north (left) side of the spillway and provides the foundation for the spillway structure and the north (left) abutment of the dam (Reclamation, 2014b). Two Quaternary-age glacial units that extend across the Yakima River valley floor form most of the foundation for the dam embankment. The older and more extensive unit is Quaternary glacial drift, deposited in a terminal moraine to unknown depths. Quaternary outwash sediments overlie a portion of the glacial drift and form the shallow foundation of the dam, to a maximum known thickness of 42 feet. Both units are generally dense, which would affect the approach taken for excavation (Reclamation, 2014b).

Several creeks also drain into Keechelus Reservoir, including Gold and Cold Creeks, which are part of the BTE. There are no site-specific data, but because of close proximity to Keechelus Reservoir, these areas are generally considered to be underlain by similar glacial materials, lacustrine deposits, alluvial deposits, and the Naches Formation.

3.2.5 KKC Alignment

According to the preliminary technical memorandum (Reclamation and Ecology, 2014m), geologic mapping along the KKC tunnel alignment was based on subsurface exploration at seven locations near the proposed Kachess Road portal and three locations near the Keechelus portal. At the east portal, the surface geology is mapped as recent colluvium deposits and undifferentiated glacial till overlying bedrock. Exposed bedrock consists of andesite and dacite. West portal surface geology is determined from Reclamation's Geologic Design Data Report (Reclamation, 2001). The exposed bedrock consists of rhyolite.

Surficial deposits near the area of the proposed I-90 Exit 62 shaft and portal area are anticipated to consist of alpine glacial alluvium deposits (Reclamation and Ecology, 2014m). The anticipated soil types include a range of grain sizes from poorly graded gravel with silt to well-graded sand with silt. Fine-grained lacustrine deposits may be present at greater depths. Bedrock of the Naches Formation is anticipated at depths ranging from 110 to 150 feet bgs. Groundwater in the area of the shaft is anticipated at depths as shallow as 25 feet bgs (Reclamation and Ecology, 2014m).

3.2.6 Seismicity in the Extended Study Area

Seismic activity in Washington is dominated by the Cascadia Subduction Zone (CSZ), created by the northeastward subduction of the oceanic Juan de Fuca Plate and possibly the Explorer Plate beneath the continental North America plate. The CSZ extends approximately 683 miles northward from the Mendocino fault off the coast of northern California to the Nootka fault west of central Vancouver Island in British Columbia (URS, 2012).

Two seismic sources are identified in the CSZ: the megathrust and the Wadati-Benioff zone. Megathrust earthquakes are generated at the interface between the subducting and overriding plates. There are no historical North American accounts of great megathrust earthquakes on the CSZ, but geologic evidence indicates they occurred at an average interval of about 500 to 600 years in the Holocene period (URS, 2012). Great megathrust earthquakes are generally measured Magnitude 9 or greater on the Richter magnitude (M) scale.

The Wadati-Benioff zone, or intraslab, earthquakes occur within the subducting Juan de Fuca Plate due in part to downdip tensional forces. Numerous historical Wadati-Benioff zone earthquakes have occurred within the CSZ and have concentrated in the Puget Lowland region to the west of the study area. These Wadati-Benioff zone earthquakes develop above active subduction zones as a result of bending and extension of the plate as it is pulled into the mantle and tend to originate at great depths.

Richter magnitude is a measure of the size of an earthquake as recorded by a seismograph, a standard instrument that records groundshaking at the location of the instrument. The reported Richter magnitude for an earthquake represents the highest amplitude measured by the seismograph at a distance of 100 kilometers from the epicenter. Richter magnitudes vary logarithmically, with each whole number step representing a ten-fold change in the amplitude of the recorded seismic waves. Earthquake magnitudes are also measured by their Moment

Magnitude (MMS), which is related to the physical characteristics of a fault including the rigidity of the rock, the size of fault rupture, and movement or displacement across a fault.

Notable earthquakes recorded within the region of the extended study area include the 1872 earthquake and a pronounced cluster of microseismicity between the southern end of Lake Chelan and Entiat approximately 45 miles northeast of the two reservoirs (URS, 2012). The December 15, 1872, earthquake was one of the strongest historical earthquakes to occur in the Pacific Northwest, with estimates running from M 6.5 to 7.2 (URS, 2012). A large event also occurred near the Washington-Oregon state line in 1936. Known as the Milton-Freewater earthquake, this M 6.4 event occurred on July 15, 1936 and caused substantial damage in Milton-Freewater area and in Walla Walla. Another notable earthquake for the northwest occurred on May 28, 1981, at a depth of about 4.3 miles beneath the Goat Rocks Wilderness Area in the southern Washington Cascades.

A north-south regional strike-slip structure, called the Straight Creek fault, divides the North Cascades into contrasting eastern and western portions. The Straight Creek Fault passes through the Kachess Reservoir and Yakima River valleys (Reclamation and Ecology, 2014l). The Straight Creek fault is not considered an active fault because there is no evidence for surface fault rupture and no definitive evidence for Quaternary activity anywhere along this structure (URS, 2012). However, other fault sources could potentially cause groundshaking within the study area.

3.2.7 Soil Erosion in the Extended Study Area

Erosion is the wearing away of soil and rock by processes such as mechanical or chemical weathering, mass wasting, wave action, wind forces, and underground water. Excessive soil erosion can eventually lead to damage of construction improvements or instability of exposed slopes. Typically, the soil erosion potential is reduced once the soil is graded and covered with vegetation, concrete, structures, asphalt, or slope protection. Wave action from constant waves and swells created by winds can loosen soil particles on shorelines and cause erosion, especially along points and other areas exposed to wind. Soils within the study area have a range of susceptibility to erosion, with the loose, fine sediments along the reservoir banks likely being the most susceptible.

3.3 Surface Water Resources

This section provides information on water bodies that could be affected by the KDRPP, KKC, and BTE. It also describes the operations of Keechelus and Kachess reservoirs because they would be affected by the proposals. Operation of the remainder of the Yakima Project is described in detail in Section 3.3.5 of the Integrated Plan PEIS (Reclamation and Ecology, 2012). The following subsections focus on the operational requirements that determine how much water is retained in and released from the two reservoirs and the timing of those releases.

The KDRPP and KKC would affect operations of Keechelus and Kachess reservoirs as well as flows in the mainstem Yakima River and Kachess River. The primary study area is defined as the Kachess and Keechelus reservoir areas, Kachess River, Keechelus reach of the Yakima River (between Keechelus Dam and Easton), and Yakima River reaches between Easton and the Sunnyside Diversion Dam. The primary study area also includes the area around the Keechelus Reservoir tributaries Gold Creek and Cold Creek, which the BTE would impact. The extended study area is the Yakima River basin as a whole.

The KDRPP and KKC could affect flow in the Yakima River from Keechelus Dam (RM 214.5) to Wapato Diversion Dam (RM 106.7), a distance of 107.8 miles. The largest effects would occur in the upper Yakima River to the confluence with the Cle Elum River (RM 185.6), a distance of 28.9 miles. Downstream from Cle Elum River, the effects of the proposals would be increasingly less because of large volumes released from Cle Elum Reservoir to supply irrigation entitlements in the middle reach of the Yakima River (these impacts are described in Section 4.3). The existing conditions in these water bodies are described below. River reaches discussed in this DEIS are listed in Table 3-1 and depicted in Figure 3-2.

Table 3-1. Yakima River Reaches

Reach Name	Yakima River Mile Location	Length (miles)
Upper Yakima River	**214.5 to 127.9**	**86.6**
Yakima River from Keechelus Dam to Easton (Keechelus Reach)	214.5 to 202.5	12.0
Yakima River from Easton to Cle Elum River (Easton Reach)	202.5 to 185.6	16.9
Yakima River from Cle Elum River to Roza Dam (Ellensburg Reach)	185.6 to 127.9	57.7
Middle Yakima River	**127.9 to 47.1**	**80.8**
Yakima River from Roza Dam to Naches River	127.9 to 116.3	11.6
Yakima River from Naches River to Roza Powerplant Return	116.3 to 113.3	3.0
Yakima River from Roza Powerplant Return to Wapato Diversion Dam	113.3 to 106.7	6.6
Yakima River from Wapato Diversion Dam to Sunnyside Diversion Dam	106.7 to 103.8	2.9
Yakima River from Sunnyside Diversion Dam to Marion Drain	103.8 to 82.8	21.0
Yakima River from Marion Drain to Prosser Dam	82.8 to 47.1	35.7
Lower Yakima River	**47.1 to 0.0**	**47.1**
Yakima River from Prosser Dam to Chandler Canal Return	47.1 to 35.8	11.3
Yakima River from Chandler Canal Return to Columbia River	35.8 to 0.0	35.8

Source: Reclamation and Ecology, 2012

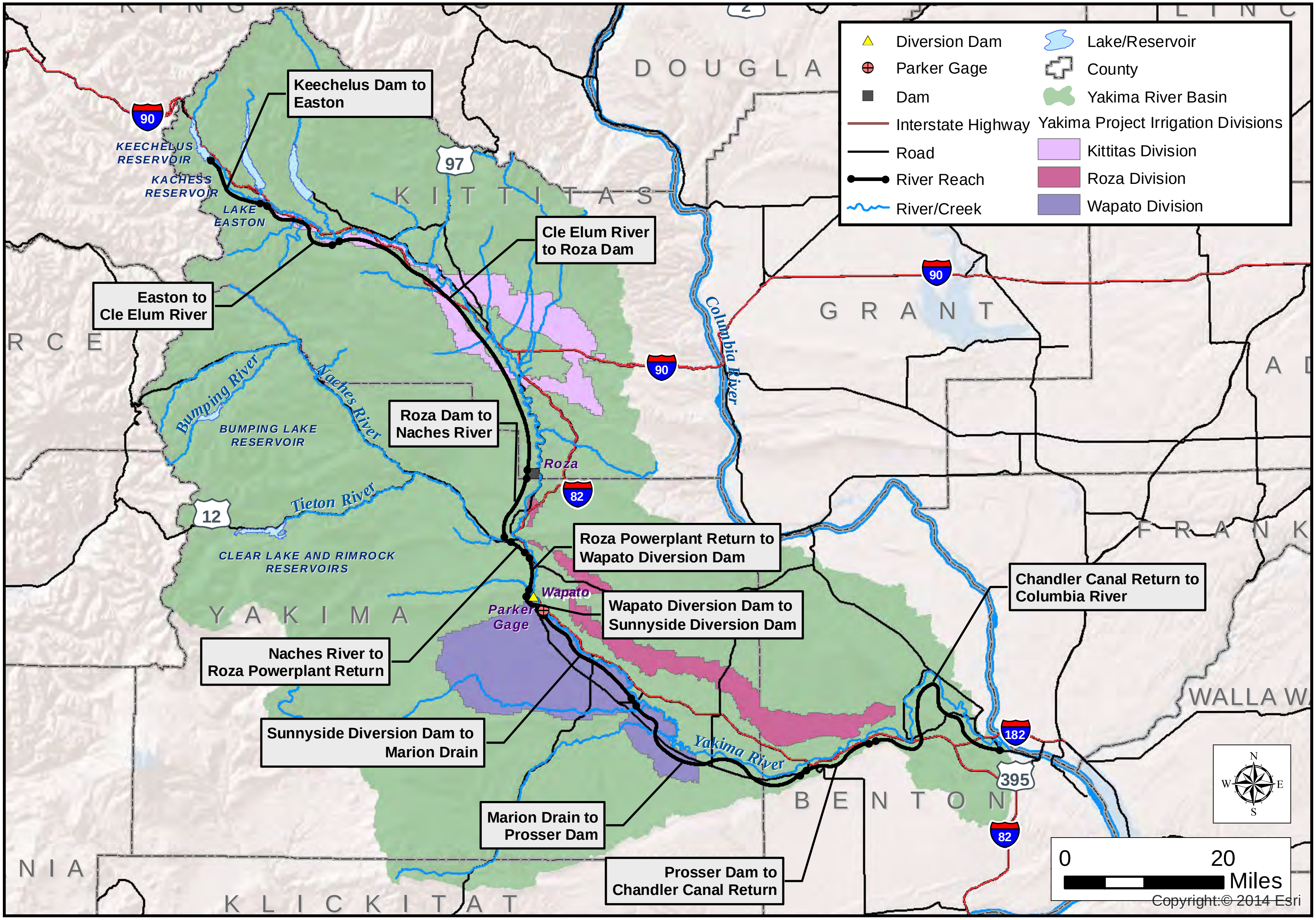

Figure 3-2. Yakima River Reaches

3.3.1 Project Operations

Within its Yakima Project, Reclamation operates five reservoirs in a coordinated manner to provide for the surface water needs of the system as a whole. The releases from each reservoir are balanced to meet systemwide irrigation and water demands in conjunction with natural runoff and return flow available in the basin. No single reservoir is designated to supply the needs of any particular area, irrigation district, or Yakima Project division. The major storage facilities store runoff during the winter, spring, and early summer seasons. This water is released during low-flow periods in late spring, summer and fall for irrigation when natural runoff cannot meet irrigation demands. This period is known as the storage control period.

Keechelus, Kachess, and Cle Elum reservoirs are used to meet mainstem Yakima River water entitlements from the beginning of the storage control period, generally about June 24 of each year. Keechelus and Kachess reservoirs supply irrigation water for the Kittitas Reclamation District (KRD), which diverts flow at the dam impounding Lake Easton. KRD has entitlements of 336,000 acre-feet and diverts a peak of approximately 1,200 cfs during July and August. The two reservoirs, in coordination with releases from Cle Elum Dam, also provide supply to meet mainstem Yakima River water entitlements between the Cle Elum River confluence (RM 179.6) and Sunnyside Diversion Dam (RM 103.8). These entitlements amount to approximately 1.46 million acre-feet to supply diversions, mostly from Roza Diversion Dam downstream, including Roza Division, Wapato Irrigation Project (WIP), and Sunnyside Division. A peak of approximately 4,000 cfs for irrigation is moved through the Yakima River down to Roza Dam, also in July or August. About two-thirds of that flow is released from Cle Elum Dam and the remainder is natural flow from tributaries and releases from Keechelus and Kachess reservoirs.

Figure 3-3 illustrates flows experienced in a typical year in the Yakima River Keechelus reach and Ellensburg reach (from Cle Elum River to Roza Dam). The hydrographs shown in Figure 3-3 were obtained from the results of hydrologic modeling performed for the Integrated Plan and updated for this project. All of the flows, reservoir elevations and water supply metrics described in Chapters 3 and 4 are based on the hydrologic modeling. For consistency, Reclamation used hydrologic modeling instead of historic information to compare existing conditions to future conditions with the alternatives. The hydrologic modeling reflects current (actual) operations of the Yakima Project versus the historic information, which uses target flows that have changed throughout the historic operation of the Yakima Project.

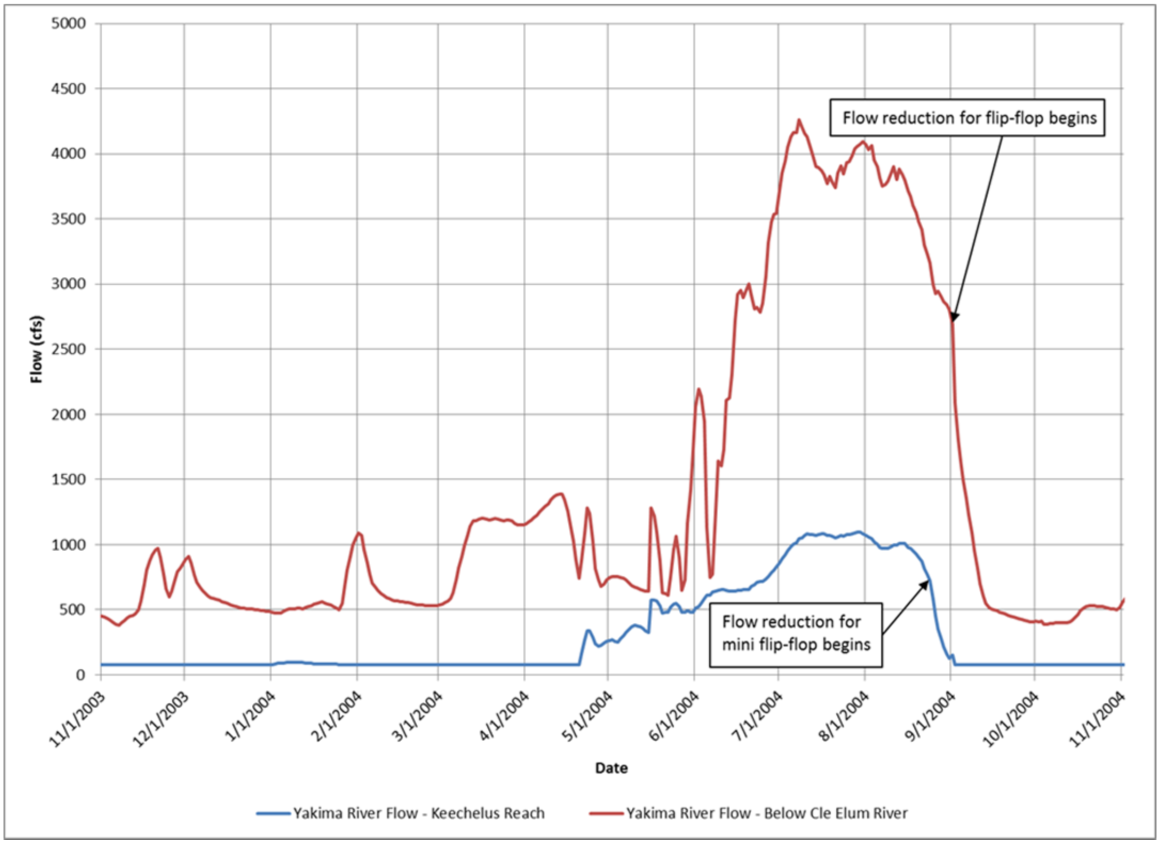

Figure 3-3. Typical Streamflow Conditions in Upper Yakima River

3.3.1.1 Flip-Flop and Mini Flip-Flop

On or prior to September 1, Cle Elum Reservoir releases are reduced substantially over a 10- to 20-day period, and releases from Rimrock Reservoir are increased substantially to meet the September and October irrigation demands downstream from the confluence of the Naches and Yakima rivers. Referred to as "flip-flop", Reclamation instituted this operation to protect spring Chinook salmon and to conserve winter runoff in storage. Specifically, flip-flop encourages spring Chinook to spawn at lower streamflows that require Reclamation to release less stored water during the egg incubation period to protect spawning nests (redds). Affected spring Chinook spawning reaches are the Cle Elum River downstream from the dam and the Yakima River downstream from the Cle Elum River to the City of Ellensburg. Figure 3-3 illustrates flow in the Yakima River downstream from Cle Elum River during the flip-flop period. Flows fall from a peak of approximately 4,000 cfs in August to approximately 400 cfs in mid-to-late September.

A similar operation, referred to as "mini flip-flop," is performed for similar reasons between Keechelus and Kachess reservoirs in years of sufficient water supply. In June through August, irrigation releases from Keechelus Reservoir are greater than those from Kachess Reservoir. In September and October, irrigation releases are decreased from Keechelus Reservoir and correspondingly increased from Kachess Reservoir. The affected reach for the spring Chinook spawning reaches are the Yakima River from Crystal Springs downstream to the Cle Elum River confluence. Figure 3-3 illustrates the flow in the Keechelus Reach during the mini flip-flop period. Flows fall from a peak of approximately 1,000 cfs in August to approximately 100 cfs in mid-to-late September during that period.

3.3.1.2 Carryover Storage

Conserving water during the summer and fall period of operations helps maximize reservoir storage at the end of the irrigation season (typically October 21). The storage remaining in the reservoirs at the end of the irrigation season is termed “carryover” storage. The Yakima basin storage system is designed to store only the current year’s runoff and deliver it as needed for irrigation from April through October. If only minimal storage is left on October 21, the upcoming water year’s operations are more likely to result in lower base river flows and tighter control over reservoir releases. In general, more carryover storage in the system reservoirs on October 21 leads to better flow and water supply conditions in the following water year, particularly if the following year turns out to be a dry year. Good carryover storage also helps assure sufficient spring Chinook incubation flow in the Yakima River below Keechelus and Kachess reservoirs.

3.3.1.3 Target Flows

Formal target flows were established through the Title XII legislation in 1994 (see Section 3.3.1.4) for the lower Yakima River during the irrigation season. Additionally, Reclamation has been directed by the Federal Court to consider fisheries in project operations. The System Operation Advisory Committee (SOAC, see Section 1.5.2) has provided Reclamation with feedback about fish-related flow needs since 1981. Reclamation has modified fall and winter reservoir release protocols to provide flows that protect salmon redds and overwintering juveniles, while also storing and providing water for irrigation. Table 3-2 presents current flow targets with an emphasis on fall and winter flows in the Upper Yakima River. All of the targets in Table 3-2 are minimum flows. Flows described at the Yakima River at Crystal Springs and at Cle Elum confluence are incidentally met through minimum releases at the storage dams and unregulated flow contributions upstream of these locations.

Table 3-2. Yakima River Target Flows

River Reach	Fall Minimum Target Flow and Dates	Winter Minimum Target Flow and Dates[1]
Keechelus Reservoir Outflow	80-100 cfs Sep 1-Oct 20	80-100 cfs Oct 21-Mar 31
Yakima River – Crystal Springs to Lake Easton	80-100 cfs Sep 1-Oct 20	80-100 cfs Oct 21-Mar 31
Kachess Reservoir Outflow	Not Applicable (NA)	15-50 cfs Oct 21-Mar 31
Yakima River – Easton Dam to Cle Elum River	180-300 cfs Sep 10-Oct 20	180-300 cfs Oct 21-Mar 31
Yakima River – Cle Elum River to Teanaway River	400-800 cfs Sep 10-Oct 20	300-700 cfs Oct 21-Mar 31
Yakima River – Roza Dam to Wenas Creek	300 cfs minimum Jul 1-Oct 20	400-500 cfs Power subordination target – all year
Yakima River at Parker	300-600 cfs Mar 15-Oct 21 (irrigation season Title XII flow)	300-600 cfs Mar 15-Oct 21 (spring and summer target flow)

[1] Winter target flow would be carried past March 31 if supplemental flows are still needed to reach target.
Source: Reclamation, 2002 (modified by Lynch, 2014)

3.3.1.4 Title XII Target Flows

Phase II of the Yakima River Basin Water Enhancement Project (YRBWEP) was authorized by Title XII of the Act of October 31, 1994 (108 Stat. 4550, Public Law 103-434). Title XII established instream flow targets to be maintained by Reclamation below the Sunnyside and Prosser Diversion Dams during the irrigation season, using criteria based on total water supply available (TWSA). As shown in Table 3-3, Title XII streamflow targets range from 300 cfs to 600 cfs, depending on the estimated TWSA.

Table 3-3. Title XII Target Flows

TWSA (million acre-feet)				Parker and Prosser Flows (cfs)	Title XII Minimum Flow Past Parker Gage July-September Demand (acre-feet)
Apr-Sept	May-Sept	Jun-Sept	Jul-Sept		
3.20	2.90	2.4	1.9	600	117,000
2.90	2.65	2.2	1.7	500	100,000
2.65	2.40	2.0	1.5	400	84,000
Less than line 3 water supply				300	68,000

Phase II of the YRBWEP provides that, as conservation measures are implemented and irrigation water demands thereby reduced; the target flows would be increased by 50 cfs for each 27,000 acre-feet of diversion reduction during nonprorated water years. As of July 2014, the estimate of conserved water under YRBWEP has resulted in an increase of 119 cfs in Title XII target flows during nonprorated water years at the Parker gage.

3.3.1.5 Prorationing

Irrigation entitlement diversions (existing contractual obligations) for the Yakima Project are divided into two classes – nonproratable and proratable. Nonproratable entitlements, generally held by water users that existed before the Yakima Project, are to be served first from TWSA (Reclamation, 2008c). All other Yakima Project water rights are proratable, which means they are of equal priority. Any shortages that may occur are shared equally by the proratable water users (Reclamation, 2008c). Table 3-4 lists the Yakima Project irrigation districts and their Yakima Project water rights divided into nonproratable water rights (priority date prior to May 10, 1905) and proratable water rights (priority date of May 10, 1905).

Table 3-4. Yakima Project Irrigation District Water Rights (acre-feet per year)

District	Nonproratable Water Rights	Proratable Water Rights	Total Water Rights
Wapato Irrigation Project	305,613	350,000	655,613
Sunnyside Division	289,646	157,776	447,422
Roza Irrigation District	0	393,000	393,000
Kittitas Reclamation District	0	336,000	336,000
Yakima-Tieton Irrigation District	75,865	30,425	106,290
Kennewick Irrigation District	18,000	84,674	102,674

Source: Reclamation and Ecology, 2012

Sunnyside Valley Irrigation District and Yakima-Tieton Irrigation District have proratable entitlements, but have stated that they do not foresee needing additional water at this time (Reclamation and Ecology, 2011h). Roza Irrigation District, WIP, and KRD are severely affected by prorationing during droughts. Therefore, consideration of drought-year shortfalls focuses on these three districts. Kennewick Irrigation District (KID), although having proratable entitlements, has not been impacted to the same level as Roza Irrigation District, WIP and KRD because the KID is located downstream from Parker gage near the downstream end of the Yakima River basin. Most of their water supply is derived from return flow from upstream irrigation districts, which improves the reliability of their supply.

Prorationing has been imposed an average of about once every 4 years in the last 20 years. Proratable water users received 58 percent of their proratable entitlement in 1992, 67 percent in 1993, and 37 percent in 1994. In 2001, proratable water users received a 37 percent supply and in 2005 a 42 percent supply (Reclamation, 2008c).

3.3.2 Keechelus Dam and Reservoir Operations

Keechelus Dam was constructed at the lower end of a natural lake on the Yakima River and is located just east of Snoqualmie Pass. Completed in 1917, this dam is 128 feet high and impounds 157,800 acre-feet at elevation 2,525 (Reclamation, 2002). Table 3-5 provides additional data on its size and operations.

Table 3-5. Keechelus Dam and Reservoir Data

Reservoir Drainage Area (square miles)	54.7
Maximum Depth (feet)	310
Mean Depth (feet)	96
Active Storage Capacity (acre-feet)	157,800
Average Annual Runoff (acre-feet)	244,000
Ratio of Runoff to Capacity	1.55:1
Sept 30 Minimum Historical Storage (acre-feet)	4,800 (1931)
Sept 30 Average Historical Storage (acre-feet)	41,000
Sept 30 Maximum Historical Storage (acre-feet)	126,900 (1949)

Note: Mean depth calculated by dividing total storage capacity by surface area of reservoir

Keechelus Reservoir is operated to meet irrigation demands, provide flood control, and maintain instream flows for fish. The prime flood control season extends from mid-November through mid-June.

Water releases from Keechelus Reservoir are greatest in July and August, with a maximum typically not over about 1,350 cfs. To support spawning in the upper Yakima River, the release from Keechelus Reservoir is reduced during the mini flip-flop operation in September to a minimum flow of 80 to 100 cfs.

Keechelus Reservoir typically reaches its lowest elevation in October, when the irrigation season ends and before fall rains begin and inflows increase. In the winter months, water is released to meet target flows and to maintain flood control space. In the spring, water is stored to regulate downstream flows for flood control and to store water for irrigation demands later in the year. The highest reservoir elevations generally occur from May to July, depending on the annual water supply. Figure 3-4 illustrates the No Action condition (historic modeled flows with current operating conditions) water level in Keechelus Reservoir for the period of November 1, 1998, to November 1, 2003. The graph includes the drought year of 2001 along with years more representative of average and wet runoff conditions. Pool levels fluctuated 85 feet between approximate elevation 2,517 and 2,432 during this time period, with the lowest level occurring during the 2001 drought year. Table 3-6 provides data on reservoir elevations for the period of 1925 to 2009 and for two recent drought years (1994 and 2001).

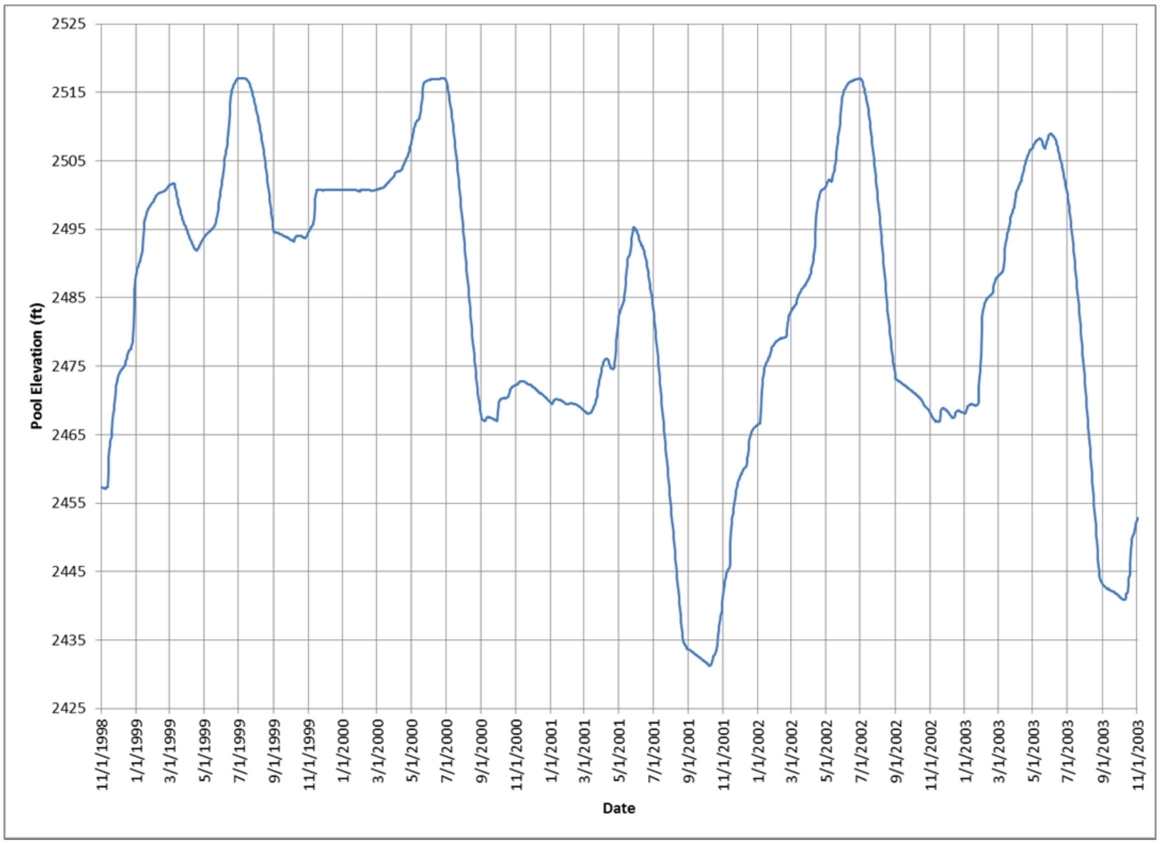

Figure 3-4. Keechelus Reservoir Operating Elevations

Table 3-6. Keechelus Reservoir Operating Elevations

	Elevation
Mean (1925-2009)	2,482.0
Mean of Annual Maximum (1925-2009)	2,510.3
Mean of Annual Minimum (1925-2009)	2,448.3
Drought Years	
Mean (1994)	2,452.0
Maximum (1994)	2,487.6
Minimum (1994)	2,430.0
Mean (2001)	2,465.4
Maximum (2001)	2,495.3
Minimum (2001)	2,431.3

3.3.2.1 Gold Creek above Keechelus Reservoir

Gold Creek has a drainage area of approximately 14 square miles and flows into Keechelus Reservoir at the head of the Yakima River. The construction of Keechelus Reservoir raised water levels at the mouth of Gold Creek by over 60 feet, which seasonally inundates the lower reaches of Gold Creek. When Keechelus Reservoir is drawn down in summer to supply water for the Yakima Project, the creek's lower reaches are exposed but experience low flows and fish passage problems (USFS, 2011b). Flows in Gold Creek have been affected by low rainfall, Gold Creek Pond, timber harvest, and road and residential developments (Haring, 2001). In a 2013 assessment, the length of dewatered stream channel was 1.24 miles (Natural Systems Design, 2013). Two mechanisms are believed to be causing low flow and dewatered reaches in Gold Creek. First, Gold Creek Pond has modified the groundwater gradient, negatively affecting flow in sections of Gold Creek. Second, stream widening has increased groundwater infiltration. Other contributing factors include a buried drainage line and a small gravel borrow pit (Heli's Pond).

3.3.2.2 Cold Creek above Keechelus Reservoir

Cold Creek drains a watershed of approximately 5.2 square miles, most of which is contained within Forest Service land. The headwaters of the creek flow out of four small lakes on the north slopes of Tinkham Peak into the Twin Lakes. From the outlet of Twin Lakes, Cold Creek flows approximately 2 miles before entering the west side of Keechelus Reservoir.

The only streamflow measurements found for Cold Creek were obtained by the Service (Service, 2001). Stream discharge was measured in Cold Creek on 23 occasions between June 6 and November 30, 2001. Streamflow peaked in mid-June at 105 cfs and steadily declined to a low measured at 0.6 cfs to 1.0 cfs between August 16 and September 5, 2001. Following the low-flow period, streamflows in Cold Creek increased significantly, but varied widely from 1.9 cfs on September 28 to 26.3 cfs on October 20, 2001. More stable flows were observed after the latter date with an average discharge of about 7.0 cfs to the end of November (Service, 2001).

3.3.3 Upper Yakima River between Keechelus Reservoir and Lake Easton

The Keechelus Reach of the Yakima River spans the 11 miles between Keechelus Reservoir and Lake Easton. Discharge from the reservoir is the largest contributor to flow in this reach, especially in summer when natural runoff from tributaries that enter this reach (Cedar, Cabin, Mosquito, Stampede creeks and other smaller streams) recedes. Figure 3-5 illustrates the No Action condition flow in the Keechelus Reach of the Yakima River for the period of November 1, 1998 to November 1, 2003. The graph includes the drought year of 2001 along with years more representative of average and wet runoff conditions.

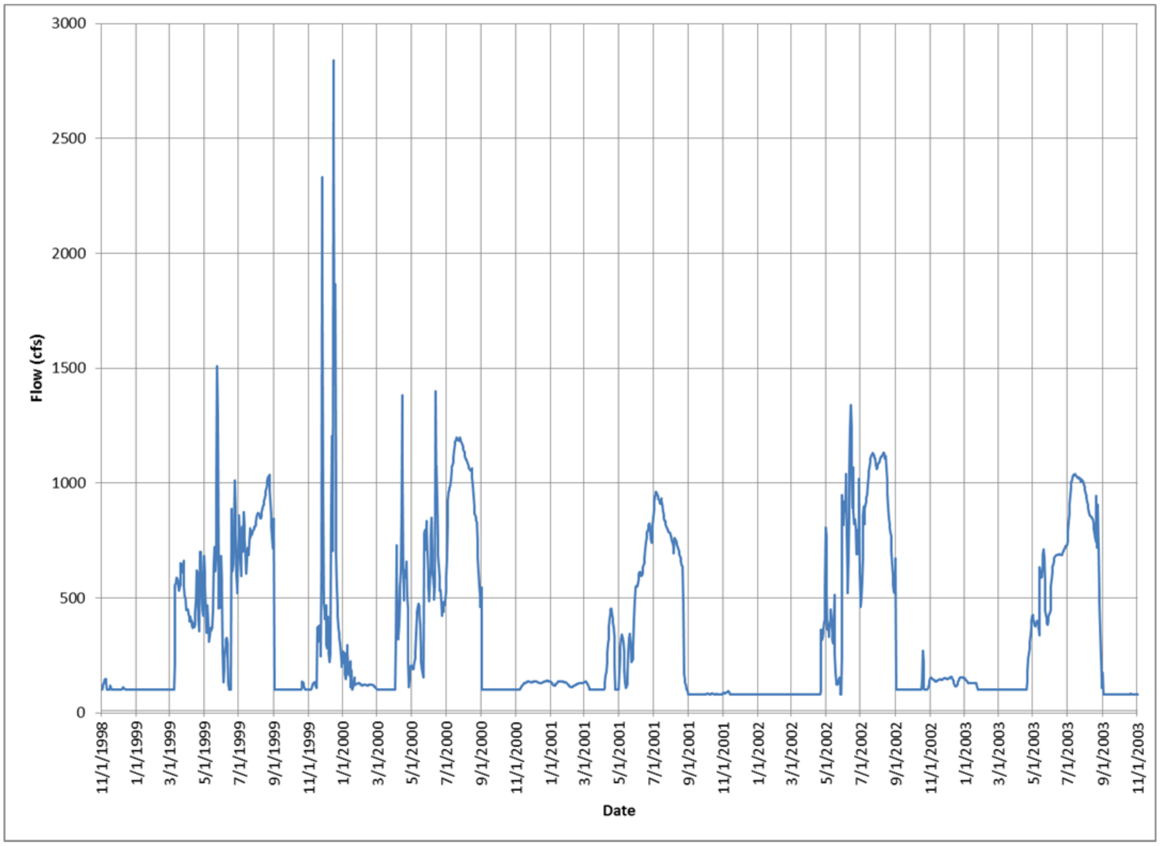

Figure 3-5. Keechelus Reach Flow Patterns

Currently, flows are high from July through mid- to late- August when juvenile Chinook and steelhead (and potentially coho if reestablished) are rearing in this reach. The recommended high flow in July in this reach is 500 cfs (Reclamation and Ecology, 2011c). However, flows often exceed 1,000 cfs in July and August. Juvenile salmon seek protection against high-velocity flows to avoid being pushed downstream into less desirable habitat and minimize energy expenditures. The high water velocities of summer flows thus reduce the amount of suitable salmonid rearing habitat. This negative effect occurs in the reach during all water year types, but is most significant in wet years when flow releases from Keechelus Reservoir are highest.

During winter, flows are lower than desired by fish biologists, and flow pulses needed to support juvenile outmigration are usually absent in the spring because runoff is captured by Keechelus Reservoir. In dry years, low flows reduce available rearing and overwintering habitat throughout the fall and winter, and into early spring. Flow pulses in spring are needed to mimic natural conditions and support juvenile outmigration. Increasing base flows could increase available juvenile rearing and overwintering habitat in the Keechelus Dam to Lake Easton reach (Reclamation and Ecology, 2011c).

3.3.4 Kachess Dam and Reservoir Operations

Kachess Dam is 115 feet high and was built at the lower end of a natural lake, creating a reservoir with an active capacity of 239,000 acre-feet at elevation 2,262 (Reclamation and Ecology, 2011c). Table 3-7 provides data on its size and operations.

Table 3-7. Kachess Dam and Reservoir Data

Reservoir Drainage Area (square miles)	63.6
Depth (feet)	Max - 430
Active Storage Capacity (acre-feet)	239,000
Average Annual Runoff (acre-feet)	213,398
Ratio of Runoff to Capacity	0.9:1
Sept 30 Minimum Historical Storage (acre-feet)	20,100
Sept 30 Average Historical Storage (acre-feet)	107,200
Sept 30 Maximum Historical Storage (acre-feet)	227,200

The reservoir impoundment inundated two lakes: the downstream historical Kachess Lake and the upstream historical Little Kachess Lake. The two lakes had been connected by the Kachess River at about elevation 2,220. The top of the inactive storage pool in Kachess Reservoir is elevation 2,192.75.

Kachess Reservoir is operated primarily to meet irrigation demands, while also providing flood control in the winter and spring, and storage water for instream flows for fish in summer. Water releases from Kachess Reservoir are greatest in September and October, reaching a maximum of about 1,200 cfs. The highest discharge occurs during that time period because of the mini flip-flop operation, which reduces discharge from Keechelus Reservoir and requires a greater supply from Kachess Reservoir to satisfy KRD and other downstream demands. The release from Kachess Reservoir is reduced after irrigation season to 35 cfs to over 100 cfs throughout winter and early spring.

Kachess Reservoir typically reaches its lowest elevation in October, when the irrigation season ends. In the winter and spring, water is stored in the reservoir for irrigation demands later in the year. The highest reservoir elevations generally occur in May to July, depending on the annual water supply. Full pool is at elevation 2,262. Figure 3-6 illustrates the No Action condition water level in Kachess Reservoir for the period of November 1, 1998 to November 1, 2003. The graph includes the drought year of 2001 along with years more representative of average and wet runoff conditions. During this time period, pool levels fluctuated 60 feet between approximate elevations 2,262 and 2,202 feet, with the lowest level occurring during the 2001 drought year. Table 3-8 provides data on reservoir elevations for the period of 1925 to 2009 and for two recent drought years (1994 and 2001).

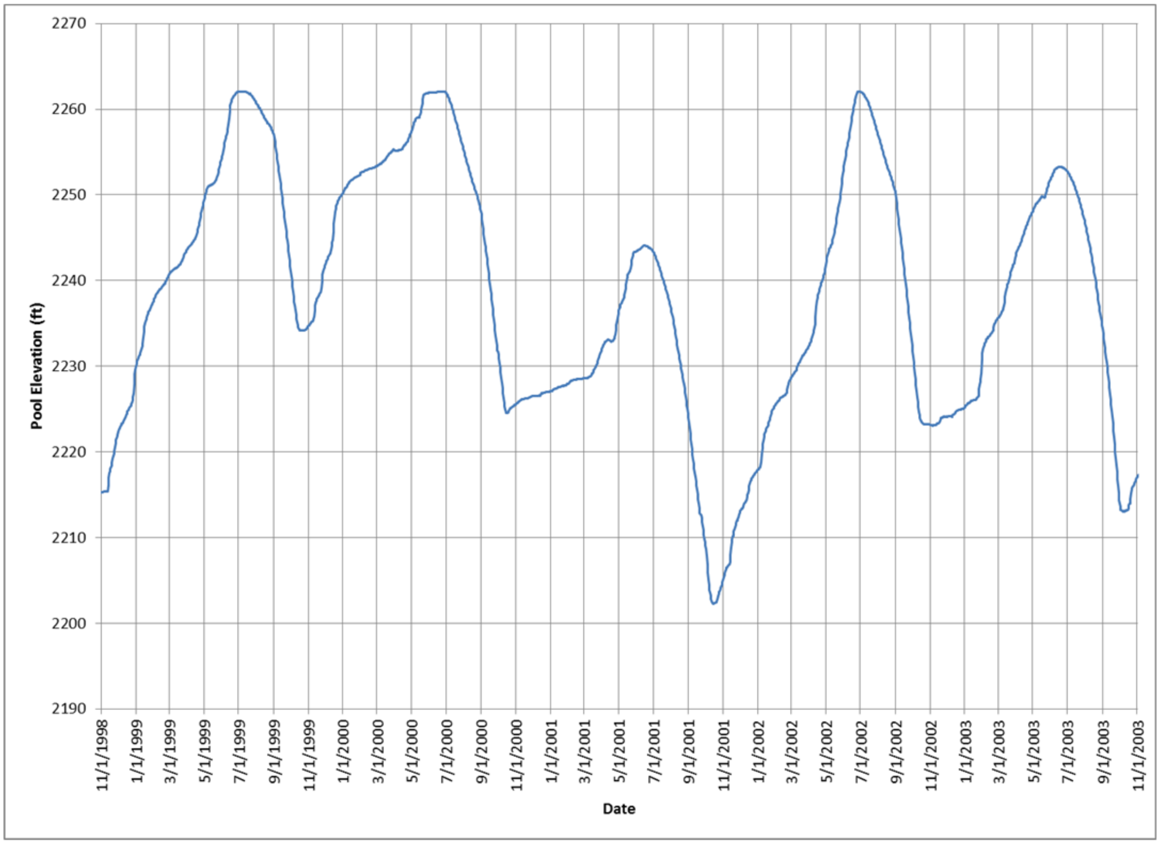

Figure 3-6. Kachess Reservoir Operating Elevations

Table 3-8. Kachess Reservoir Operating Elevations

Baseline	
Mean (1925-2009)	2,236.8
Mean of Annual Maximum (1925-2009)	2,254.8
Mean of Annual Minimum (1925-2009)	2,212.2
Drought Years	
Mean (1994)	2,211.6
Maximum (1994)	2,230.8
Minimum (1994)	2,195.8
Mean (2001)	2,228.9
Maximum (2001)	2,244.1
Minimum (2001)	2,202.3

3.3.4.1 Box Canyon Creek

Box Canyon Creek flows into Kachess Reservoir. Although no quantitative streamflow information was found for Box Canyon Creek, high streamflows occur through the winter, spring, and early summer, and low streamflows occur through late summer and fall (Haring, 2001). When Kachess Reservoir is drawn down during drought years, Box Canyon Creek flows onto a wide alluvial fan that is typically submerged. Flows partially go subsurface and a defined channel is not present, impairing fish passage into Box Canyon Creek. Reclamation has constructed temporary fish passage channels during drought years to provide passage from the reservoir into the creek upstream of the alluvial fan.

3.3.5 Kachess River

The Kachess River is 0.9 miles long and flows between Kachess Reservoir and Lake Easton, fed from Kachess Reservoir outflow. Figure 3-7 illustrates the baseline condition flow in the Kachess River for the period of November 1, 1998 to November 1, 2003. The graph includes the drought year of 2001 along with years more representative of average and wet runoff conditions. Section 3.3.4 describes the operation of Kachess Reservoir, which results in high flows in September and October (over 1,200 cfs) and low flows until spring (50 to 100 cfs).

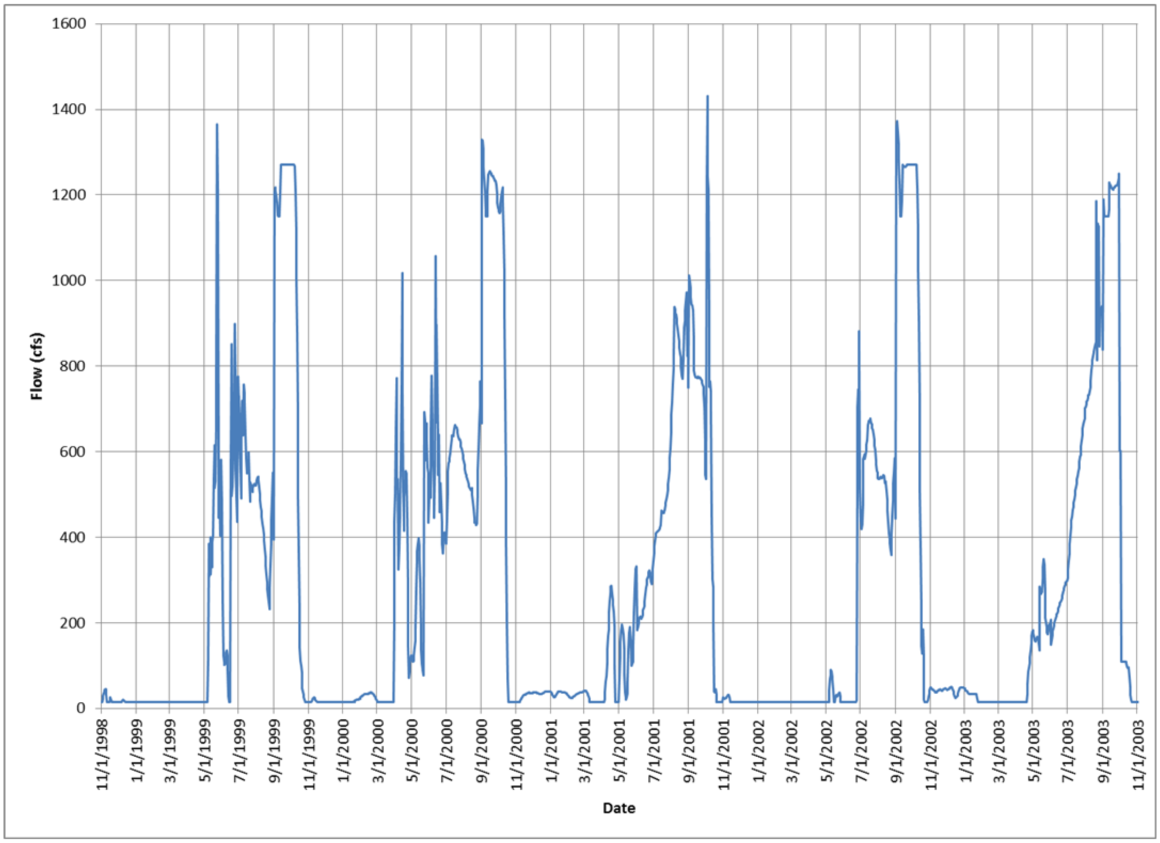

Figure 3-7. Kachess River Flow Conditions

3.3.6 Lake Easton

Lake Easton Diversion Dam, located at RM 202.5 on the Yakima River, is a concrete gravity dam 10 feet high impounding a small lake of about 3,000 acre-feet. The purpose of the dam is to provide hydraulic head for the diversion of irrigation water supply into the KRD main canal. The capacity of the main canal headworks is 1,320 cfs. The Yakima River flows through Lake Easton and over the diversion dam.

3.3.7 Yakima River Downstream of Lake Easton

The KDRPP and KKC may also affect streamflow in the Yakima River from Lake Easton to the Wapato Diversion Dam, a distance of 95.8 miles. The largest change in streamflow would occur in the 16.9-mile Easton Reach between Lake Easton and the Cle Elum River. Current streamflow conditions in the Easton Reach are affected by releases for irrigation in summer and mini flip-flop operations starting in September. Figure 3-8 illustrates the baseline condition flow in the Easton Reach for the period of November 1, 1998 to November 1, 2003. The graph includes the drought year of 2001 along with years more representative of average and wet runoff conditions.

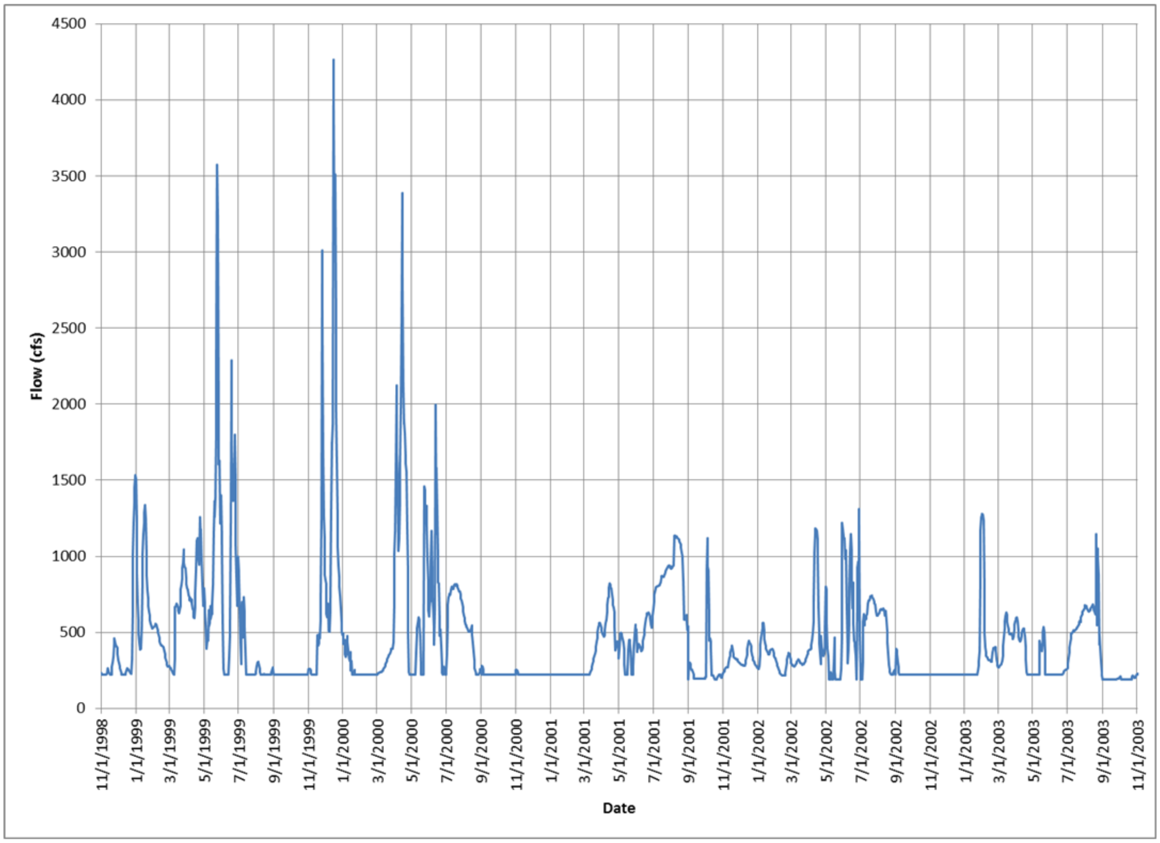

Figure 3-8. Yakima River at Easton Flow Conditions

Currently, flows are low (about 180 to 220 cfs) starting during mini flip-flop operations and extending into spring, unless natural flow from tributaries enters the reach. During spring, natural flows increase river flows and provide some variability. Summer releases from Keechelus and Kachess reservoirs increase flow in this reach to a range of about 400 to 1,000 cfs. Flows in drought years may be higher during summer as water is conveyed downstream to proratable water users from the upper reservoirs to mitigate the effects of inadequate storage in other Yakima Project reservoirs.

Downstream of the confluence with the Cle Elum River, flows are very high during the summer to supply water to users in the middle Yakima River. The high flows are created by releases from Cle Elum Dam. Flows in the Yakima River from the Cle Elum River down to the Roza Dam can exceed 4,500 cfs during summer. High summer flows and high water velocities reduce the amount of suitable rearing habitat for juvenile Chinook, steelhead, and coho.

In the reach of Yakima River between Roza Dam and Naches River, summer flows are lower than upstream because of diversions at Roza Dam. Flows in summer are typically in the range of 2,000 to 3,000 cfs. After the irrigation season, flows drop to a minimum flow of 400 cfs, except when augmented by natural flows from tributaries in the upper Yakima River reach or when the Roza Powerplant is shut down for maintenance. The low flows reduce quality and quantity of rearing habitat for spring Chinook, steelhead, and coho. The low flows also impair migration of adult salmonids, mostly coho, migrating through this reach mid-September through mid-December on their way to spawning grounds in the upper Yakima River basin, but also spawn in this reach during the fall and early winter. Low spring flows also limit spring smolt outmigration.

Downstream of the Naches River to Sunnyside Dam, flows in the Yakima River are higher because of Naches River flow contribution. Summer flows are higher than natural to supply irrigation entitlements down to Sunnyside Dam but lower in other seasons because of regulation by Yakima Project reservoirs.

3.4 Surface Water Quality

This section describes the existing water quality of the water bodies located within the project boundaries and in the vicinity of the project. The KDRPP and KKC would affect the water level operations of Keechelus and Kachess reservoirs as well as flows in the mainstem Yakima River and Kachess River. The BTE would affect Gold Creek and Cold Creek. The primary study area is defined as the Kachess Reservoir area, Kachess River, Keechelus Reservoir area and tributaries (including Gold Creek and Cold Creek), Keechelus Reach of the Yakima River (between Keechelus Dam and Easton), and Lake Easton. These changes in operations have the potential to influence water quality of these water bodies. The extended study area is the Yakima River basin.

3.4.1 Regulatory Setting

The following Federal, State and local regulations address water quality and stormwater management. Section 1.12 and Table 1-2 provide additional information.

3.4.1.1 Clean Water Act

The Federal Clean Water Act (CWA) requires the identification and cleanup of polluted surface waters and establishes water quality standards for surface waters throughout the United States. In addition, it regulates discharges to surface waters and requires NPDES permits for discharges to receiving waters from municipal, industrial, and other regulated point and nonpoint (diffused and dispersed across the landscape) sources. In the State of Washington, specific sections of the CWA require preparation of a list of impaired waters (Section 303(d)), and permit approvals, such as Section 401 Water Quality Certifications ensuring CWA standards are met. In Washington State, NPDES permits and Section 401 Water Quality Certifications are administered by Ecology. Surface water quality standards for the State of Washington are established by Ecology in Chapter 173-201A of the Washington Administrative Code (WAC) (Ecology, 2012b). The purpose of the standards is to identify designated beneficial uses, establish specific criteria, and establish antidegradation policies to protect the State’s surface water bodies.

State Water Quality Assessment and 303(d) List

Section 303(d) of the CWA requires all States to prepare a water quality assessment and develop a list of surface waters (marine and freshwater) that are impaired. In Washington State, Ecology prepares this list and submits it to the EPA for review and approval. At the time this report was written, Ecology is in the process of updating the freshwater listing, with EPA approval expected in winter 2014 - 2015 (Ecology, 2014e). The Section 303(d) list identifies five categories of water quality impairment:

- Category 1 – Meets tested standards for clean waters
- Category 2 – Waters of concern
- Category 3 – Insufficient data
- Category 4 – Polluted waters that do not require a total maximum daily load (TMDL) limit of targeted pollutant(s) to enable achieving the surface water quality standards. Three subcategories are:
  - Category 4a – Has a TMDL
  - Category 4b – Has a pollution control program
  - Category 4c – Is impaired by a nonpollutant
- Category 5 – Polluted waters that require a TMDL

The most recent EPA-approved Section 303(d) Category 5 listing for fresh waters is from 2012 (Table 3-9) and other category designations are listed in Table 3-10.

Table 3-9. Summary of 2012 303(d) Category 5 Listed Water Bodies within Extended Study

Body of Water	Location	Contaminant	303(d) listed Status
Keechelus Reservoir		Dioxins in fish tissue	Category 5
Keechelus Reservoir		PCBs in fish tissue	Category 5
Meadow Creek	Tributary to Keechelus	Temperature	Category 5
Gale Creek	Tributary to Kachess Reservoir	Temperature	Category 5
Yakima River	Inlet of Lake Easton	Temperature	Category 5
Yakima River	Outlet of Lake Easton	pH	Category 5
Yakima River	Outlet of Lake Easton	Dissolved oxygen	Category 5
Yakima River	Upriver of Cle Elum	Temperature	Category 5
Yakima River	Upriver of Cle Elum	Dissolved oxygen	Category 5
Yakima River	At Umtanum Creek	PCBs in fish tissue	Category 5
Yakima River	At Umtanum Creek	Chlordane in fish tissue	Category 5
Yakima River	At Umtanum Creek	Dioxin in fish tissue	Category 5
Yakima River	Upriver of Yakima	pH	Category 5

Source: Ecology, 2014e

Table 3-10. Summary of Other Designated Categories 2012 303(d) Water Bodies within Extended Study

Body of Water	Location	Contaminant	303(d) Category
Kachess River	Outflow of Kachess Reservoir	Dissolved Oxygen	Category 2
Yakima River	At Umtanum Creek	Temperature	Category 2
Yakima River	At Umtanum Creek	Dieldrin	Category 2
Yakima River	Upriver of Yakima	Ammonia-N	Category 2
Yakima River	Upriver of Yakima	Bacteria	Category 2
Yakima River	Upriver of Cle Elum	Dieldrin in Fish Tissue	Category 4a
Yakima River	At Umtanum Creek	4,4′-DDT in Fish Tissue	Category 4a
Yakima River	At Umtanum Creek	4,4′-DDE in Fish Tissue	Category 4a

Total Maximum Daily Load

The CWA requires states to establish TMDL programs for parameters not meeting applicable surface water quality standards as identified on their Section 303(d) water quality impaired lists. A TMDL specifies the maximum amount of a pollutant that a waterbody can receive and still meet the water quality standards. Furthermore, a TMDL identifies the sum of the allowable loads of a single pollutant from all point and nonpoint sources and determines a margin of safety to ensure that the waterbody can be protected from unknown pollutant sources or unforeseen events that may impair water quality.

Ecology has established TMDLs for the upper Yakima River for dieldrin, DDT, suspended sediment, and turbidity. The mainstem Yakima River, lower Kachess River, and lower Cle Elum River are not included in the forthcoming temperature TMDL because they will be addressed in later studies (Ecology, 2014g). Ecology’s 2003 *Technical Report on the Temperature TMDL for Wenatchee National Forest* includes data from the Gale Creek tributary to Kachess Reservoir. Both Yakima River and the Wenatchee National Forest TMDLs emphasize maximizing effective shade by the forest canopy in order to keep temperature lower in forest streams (Ecology, 2003; 2014b).

Ecology is developing a TMDL for temperature in the upper Yakima River basin. This TMDL would address tributaries to the Yakima River and to Keechelus and Kachess reservoirs. Ecology expects to submit this TMDL to the EPA for approval in November 2014 and it will target potential system shade levels as an approach to address peak water temperatures. This TMDL will include both 303(d)-listed and non-303(d)-listed waters.

Ecology is also in the process of updating the lower Yakima River suspended sediment TMDL that includes DDT to include targets for human health (Ecology, 2012a). Ecology expects to issue a draft of the updated Lower Yakima River TMDL in 2015.

3.4.1.2 Washington State Antidegradation Policy

The CWA requires that State water quality standards protect existing uses by establishing the maximum level of pollutants allowed in State waters. The standards must also protect those waters whose existing water quality is higher than the standards. The antidegradation policy helps prevent lowering of water quality, and provides a framework to identify waters designated as an “outstanding resource” by the State. The State’s antidegradation policy (WAC 173-201A) follows Federal regulation guidelines, and has three tiers of protection, with Tier III providing the highest level of protection. All three tiers have provisions that protect and maintain existing and designated uses and do not allow water quality degradation:

- If waters are not consistent with water quality standards, problems should be corrected to ensure that water quality criteria are met
- If waters have water quality higher than assigned criteria, steps must be taken to ensure that there is no measureable degradation of water quality
- If an action results in a measureable lowering of water quality, an analysis must be conducted to determine whether it is in the overriding interest of the public

3.4.1.3 State Water Quality Standards (WAC 172-201A)

Ecology’s Water Quality Standards for Surface Waters list use designations with water quality requirements for lakes and rivers (Ecology, 2012b; Table 3-11). The aquatic life use criteria related to salmonid life history and habitat require the following conditions to be met in each of the water bodies:

- Temperature
    - Not to exceed 12°C (Char Spawning and Rearing: Keechelus Reservoir; Little Kachess) or 16°C (Core Summer Salmonid Habitat: Kachess Reservoir, Lake Easton) due to human activities
    - When natural conditions exceed the maximum temperature, no temperature increases are allowed which would raise water temperature by more than 0.3°C
- Dissolved oxygen (DO)
    - Not to drop below 9.5 mg/L
    - When natural conditions lower the DO below minimum or within 0.2 mg/L of the criterion, human actions considered cumulatively may not cause DO to decrease more than 0.2 mg/L
- Turbidity
    - Not to exceed 5 nephelometric turbidity units (NTU) over background when the background is 50 NTU or less, or a 10 percent increase in turbidity when the background turbidity is more than 50 NTU
- Total dissolved gas
    - Not to exceed 110 percent of saturation at any point of sample collection
    - The total dissolved gas criterion may be adjusted to aid fish passage over hydroelectric dams when consistent with a department-approved gas abatement plan
- pH
    - Not to vary from the range of 6.5 to 8.5, with a human-caused variation within the above range of less than 0.2 units

Table 3-11. Use Designations of Water Bodies within Extended Study Area (WAC 173-201A-600)

Body of Water	Aquatic Life Use			Extraordinary Primary Contact	Domestic, Industrial, and Agricultural Water	Stock Watering	Wildlife Habitat	Harvesting Commerce/ Navigation	Boating	Aesthetic Values
	Char Spawning/ Rearing	Salmonid Spawning, Rearing, and Migration	Core Summer Salmonid Habitat							
Keechelus Reservoir	X			X	X	X	X	X	X	X
Little Kachess basin (narrowest point dividing Kachess Reservoir from Little Kachess basin) and all tributaries	X			X	X	X	X	X	X	X
Kachess Reservoir		X	X	X	X	X	X	X	X	X
Lake Easton		X	X	X	X	X	X	X	X	X
Yakima River mainstem from mouth to Cle Elum River			X	X	X	X	X	X	X	X
Yakima River from Cle Elum River to and including Cedar Creek			X	X	X	X	X	X	X	X
Yakima River upstream of Cedar Creek	X			X	X	X	X	X	X	X

Source: WAC 173-201A-602

The extraordinary primary contact recreation use criterion requires the following conditions to be met:

- Bacteria
  - Fecal coliform organism levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when fewer than 10 sample points exist) obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.

Ecology has established Toxic Substances Criteria to prevent toxic substances from being introduced above natural background levels in waters of the State (WAC 173-201A-240).

- Dieldrin/aldrin[2]
  - Acute: 2.5 µg/L (instantaneous concentration not to be exceeded at any time)
  - Chronic: 0.0019 µg/L (24-hour average not to be exceeded)
- DDT (and metabolites)
  - Acute: 1.1 µg/L (instantaneous concentration not to be exceeded at any time)
  - Chronic: 0.001 µg/L (24-hour average not to be exceeded)
- Polychlorinated biphenyls (PCBs)
  - Acute: 2.0 µg/L (24-hour average not to be exceeded)
  - Chronic: 0.014 µg/L (24-hour average not to be exceeded)

The State's use designations require that toxic, radioactive, or deleterious material concentrations be below those with the potential, either singularly or cumulatively, to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health. Aesthetic values must not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

Existing and designated uses of waters must be maintained and protected in accordance with identified use designations per WAC 173-201A-602 and the CWA (Table 3-11). These provisions prohibit the degradation of water quality standards within waters that are currently meeting the water quality standards for their designated uses.

WAC 173-201A-230 outlines the guidelines for establishing lake nutrient criteria. To date, lake specific nutrient criteria have not been established for Keechelus Reservoir, Kachess Reservoir, or Lake Easton. Table 3-12 summarizes the criteria guidelines.

Table 3-12. Lake Nutrient Criteria Guidelines

Trophic State	If ambient total phosphorus (micrograms/liter) range of lake is:	Then Criteria Should be Set at:
Ultra-oligotrophic	0 to 4	4 or less
Oligotrophic	>4 to 10	10 or less
Lower Mesotrophic	>10 to 20	20 or less
Upper Mesotrophic	>20 to 35	35 or less
	Action Value >35	Lake-specific study may be Initiated

Source: WAC 173-201A-230

[2] Aldrin is metabolically converted to dieldrin. Therefore, the sum of the aldrin and dieldrin concentrations is compared with the dieldrin criteria.

3.4.1.4 Stormwater Management Manual for Eastern Washington

Kittitas County has adopted Ecology's Stormwater Manual developed for Eastern Washington (Ecology, 2004). The manual specifies stormwater runoff treatment and flow control requirements for new and redevelopment projects, and requirements for water resource protection during construction. The goal of the manual is:

> *to provide a commonly accepted set of technical standards, in addition to presenting new design information and new approaches to stormwater management. The Department of Ecology believes that when the standards and recommendations of this Manual are properly applied, stormwater runoff should generally comply with water quality standards and protect beneficial uses of the receiving waters.*

3.4.2 Surface Water Permits and Approvals

3.4.2.1 Construction Stormwater NPDES Permit

Ecology administers the NPDES construction general permit. Coverage for this permit is obtained by submitting a Notice of Intent (NOI) with Ecology. As described in Section 3.2.1.1, coverage under this general permit is required for construction activities that disturb at least 1 acre of land and discharge stormwater to surface waters of the State. This requirement also applies to construction activities that disturb smaller sites that are part of a larger common plan of development and that discharge stormwater runoff to surface waters of the State (Ecology, 2014a). In addition, coverage under this permit is required if construction activity of any size discharges to waters of the State and Ecology either determines the site to be a significant contributor of pollutants or reasonably expects the construction to cause a violation of any water quality standard.

The general permit requirements include implementation of the following measures during construction: preparation and implementation of a Surface Water Pollution Prevention Plan (SWPPP) for all construction activity, water quality monitoring, and record-keeping and reporting protocols. For certain construction projects with higher risk of surface water quality impairment, Ecology requires an individual NPDES permit for construction activity. Individual NPDES construction stormwater permits typically require a greater extent of water quality monitoring, but otherwise the conditions are similar to the general permit.

3.4.2.2 Section 401 Water Quality Certification and Section 404 Authorization

CWA Section 401 requires that actions subject to Federal permits that result in a discharge of pollutants into waters of the United States obtain a State certification that the action complies with all applicable water quality standards. Ecology issues Section 401 Water Quality Certifications in Washington. A CWA Section 404 permit or authorization is required for certain types and amounts of discharges of dredged, excavated, or fill materials into waters of the United States. This permit or authorization is issued by the U.S. Army Corps of Engineers (Corps). Typically, inwater projects trigger the need for a Section 404 permit, which in turn triggers applicability of a Section 401 Water Quality Certification. The Section 401 Water Quality Certification would outline requirements to ensure that inwater elements of the project do not impact water quality. In addition, the 401 Certification for a project affecting waters listed as impaired under CWA Section 303(d) (Category 5) may include conditions or a compliance plan to address the project's impacts on the impairment (Pickett, 2014).

3.4.3 Existing Surface Water Quality Conditions

The Proposed Action area is located in eastern Kittitas County in the upper Yakima River Watershed Resource Inventory Area (WRIA) 39. Water resources in the primary study area include Keechelus Reservoir and tributaries, Kachess Reservoir and tributaries, Kachess River, Lake Easton, the Yakima River from Keechelus Reservoir to Lake Easton, and the Yakima River downstream from Lake Easton (Figure 3-9). In addition, numerous named and unnamed tributaries flow into these water bodies.

3.4.3.1 Keechelus Reservoir and Tributaries

Keechelus Reservoir is an unproductive oligotrophic (nutrient-poor and oxygen-rich) lake that stratifies in the summer with the thermocline developing at a depth of approximately 50 to 60 feet (EPA, 2014a). The reservoir shows inverse stratification in the winter (i.e., the cold water is on top of warmer water). The reservoir is well oxygenated at all depths during the entire year and generally freezes over in the winter. The reservoir has steep side slopes with little shoal area and is cold, clear, and relatively deep (310 feet) (WSDF, 1967).

> **Thermocline**
>
> In lakes, transition layer between the mixed layer at the surface and the deep water layer. In the thermocline, temperature decreases rapidly from the mixed layer to the colder deep water layer.

Ecology 303(d) Water Quality Listing

Keechelus Reservoir is not listed as water quality limited for water or sediment. However, Keechelus Reservoir is 303(d)-listed as Category 5 for dioxins and PCBs in fish tissue (Ecology, 2014e).

Ecology Lake Water Quality Assessment Program

Based on the most recent data collected by Ecology, Keechelus Reservoir is oligotrophic (Ecology, 1995). Ecology also ranked lakes by need for management of eutrophication-related concerns. Keechelus Reservoir was considered low priority for restorative action based on this analysis (Ecology, 1995).

Ecology surveyed water chemistry at Keechelus Reservoir during in 1993. This is the most recent information available from Ecology. On June 1, 1993, total phosphorus was 13 µg/L in the epilimnion (topmost layer of the reservoir) composite sample and 92 µg/L in the hypolimnion (bottom layer) composite sample. On August 29, 1993, total phosphorus was measured at 8 µg/L in the epilimnion composite. Total nitrogen ranged from 0.10 to

0.12 mg/L across dates and strata. Chlorophyll *a* concentration in the epilimnion composite samples was 1.8 µg/L in June and 2.6 µg/L in August. Fecal coliform bacteria were sampled at two sites in June and August. The reservoir had one colony/100 mL or results were below detection limits during these sampling events.

Reclamation Water Quality Sampling

Based on a STORET database retrieval results (search date August 21, 2014), Reclamation collected water quality data in 1999, 2002, 2005, 2008, 2011, and 2012 in the reservoir (100 meters [328 feet]) upstream of the dam and at the outlet during June, July and August at various depths throughout the water column (EPA, 2014a). These sampling results indicate water quality in the reservoir is generally good and met State water quality criteria except for temperature and DO. At the outlet station, one exceedance of State surface water criterion was recorded for water temperature.

Reservoir. During sampling, reservoir waters were clear (average Secchi disk depth of 7.3 meters [23 feet]) with low average turbidity, low fecal coliform counts, and an average pH (at 1 meter) of 7.3. Summer peak water temperatures above the State surface water quality criteria of 12°C for char spawning and rearing were reported at depths of 1, 3, 5, 7, 9, and 11 meters (3.3, 9.8, 16.4, 23, 29.5, and 36.1 feet, respectively) (Figure 3-10). A peak water temperature of 21.6°C was recorded in August 1998 at the surface. Water temperatures decreased with depth, indicating the presence of a summer thermocline. Based on one reservoir profile by Reclamation (August 1998), the temperature decreased in the hypolimnion of the reservoir, with a temperature 4.1°C at the reservoir bottom (81 meters [266 feet]) (Reclamation, 1999).

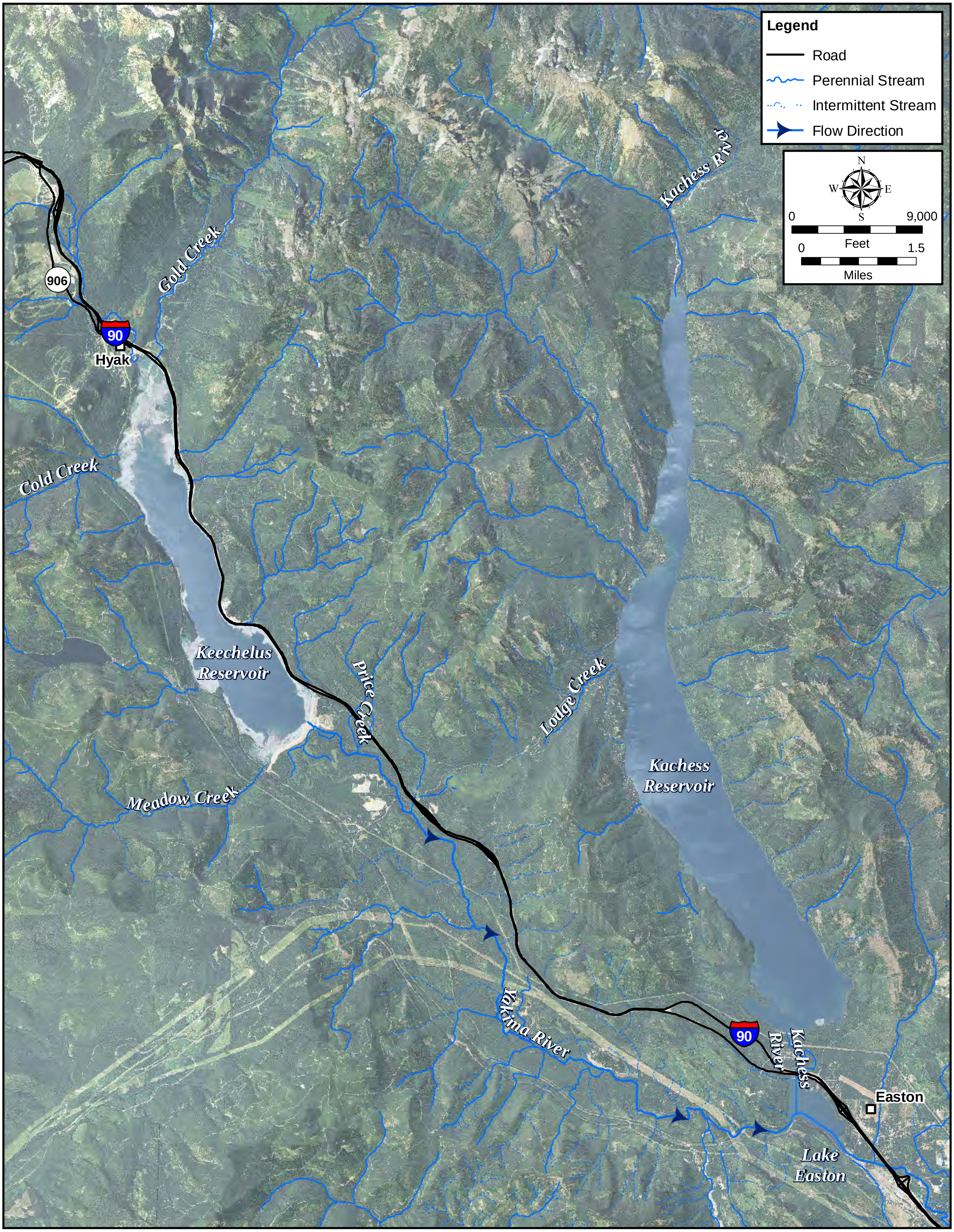

Figure 3-9. Water Bodies Located within the Primary Study Area

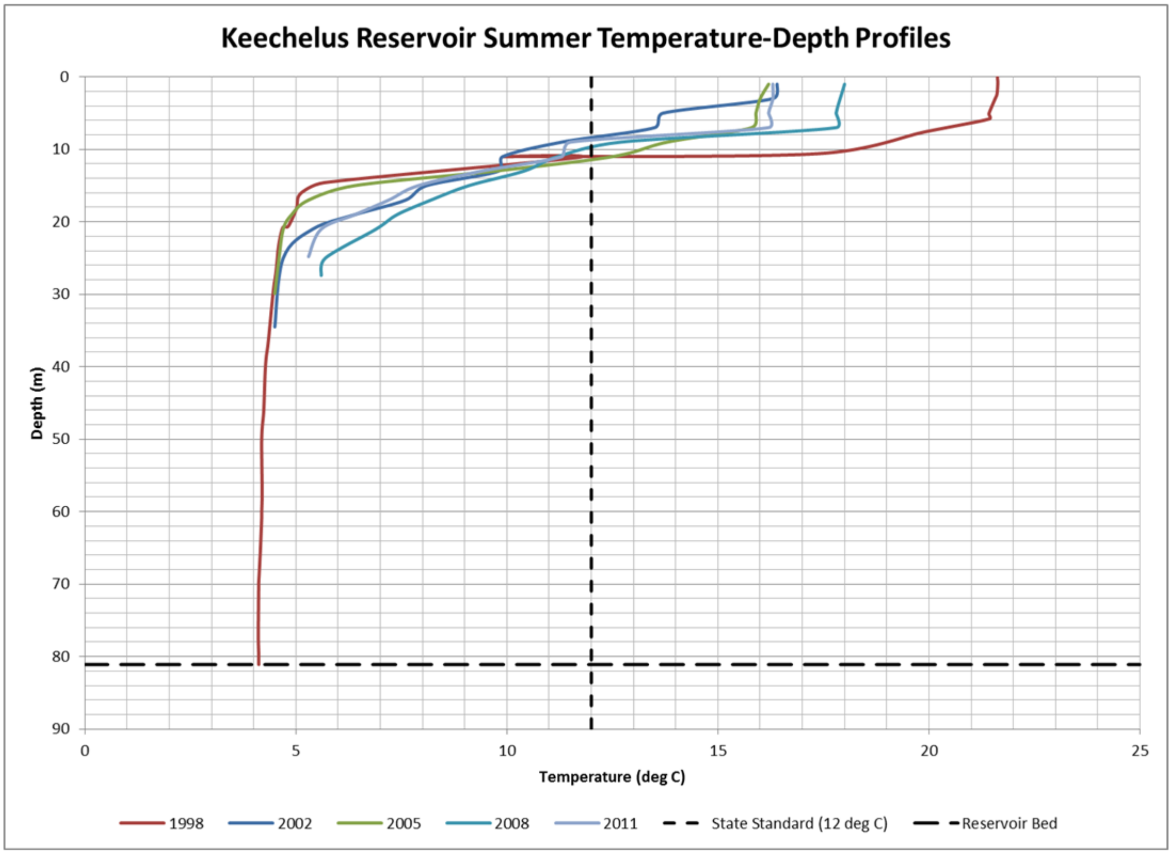

Figure 3-10. Keechelus Reservoir Summer Temperature-Depth Profiles
Source: Reclamation,1999 and EPA, 2014a

Dissolved oxygen concentrations increased with depth through the thermocline (Figure 3-11). For example, the average of four measurements at 1 meter (3.3 feet) depth was 9.1 mg/L and increased at depth to an average of over 11.2 mg/L at 21 meters (68.9 feet). Dissolved oxygen concentrations below the State surface water quality criteria (standard set to ensure DO greater than the criterion of 9.5 mg/L) were recorded at depths up to 7 meters (22.9 feet). Based on one reservoir profile by Reclamation, the DO concentration decreased near the bottom of the reservoir, with a concentration of 8.2 mg/L at the reservoir bottom (81 meters [266 feet]) indicating the reservoir was not anoxic during sampling (Reclamation, 1999).

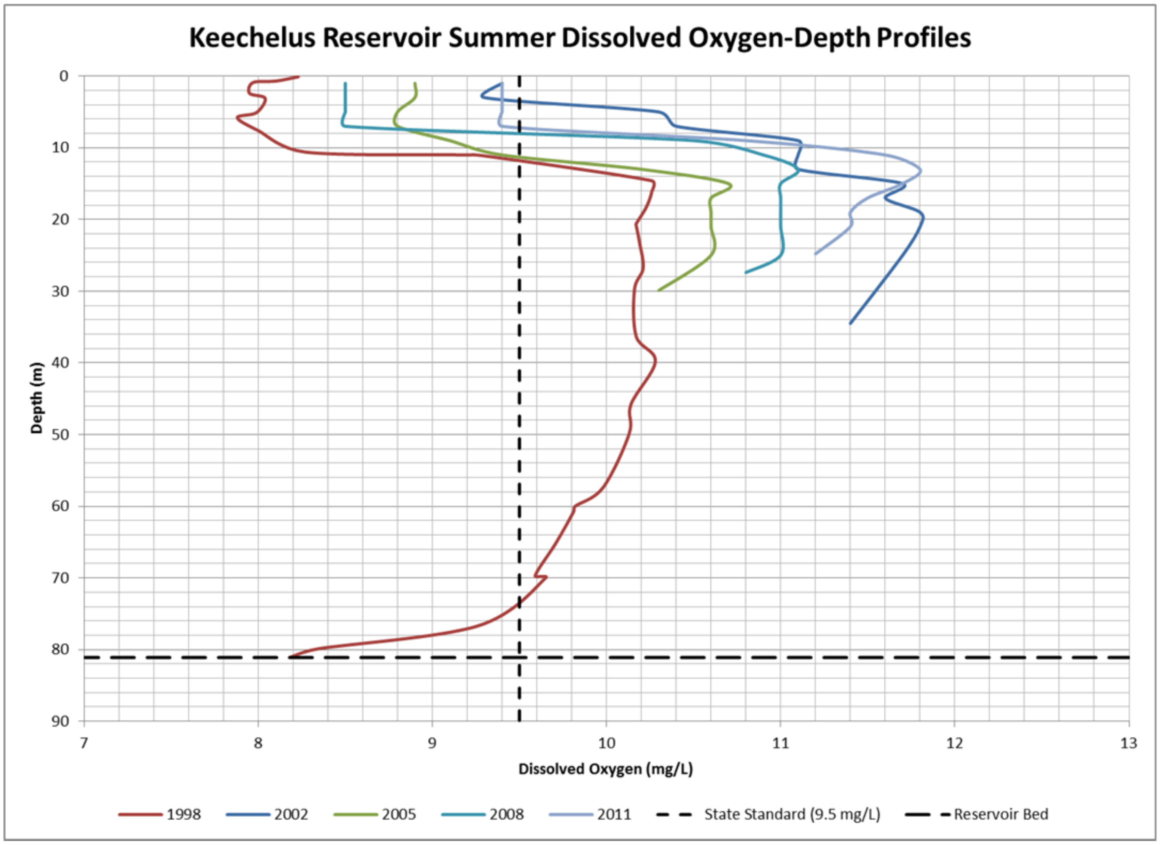

Figure 3-11. Keechelus Reservoir Summer Dissolved Oxygen-Depth Profile
Source: Reclamation,1999 and EPA, 2014a

When detected, fecal coliform counts were no higher than 2 colonies per 100 mL, meeting the State surface water quality criteria. Orthophosphate concentrations were low, ranging from 0.003 to 0.009 mg/L for samples collected at all depths. Total phosphorus concentrations ranged from below detection (<0.01 mg/L) to 0.027 mg/L (at a depth of 37.5 meters [123 feet]).

Dam Outlet. Sampling results indicate water quality at the reservoir outlet is good. During sampling, the river was cool and well oxygenated, with low turbidity, low total suspended solids concentrations, and low fecal coliform counts. The reservoir outlet is located at elevation 2,459. The average pH was 7.1. One water temperature measurement of 17.6°C exceeded the surface water quality temperature criterion of 16°C. During sampling, the average water temperature was 12.6°C, and the average DO concentration was 10 mg/L. Orthophosphate concentrations were low, with concentrations reported below detection (0.003 mg/L). Total phosphorus concentrations measured in August 2012 ranged from below detection (<0.01 mg/L) to 0.016 mg/L.

Reclamation also conducted water quality sampling of its five Yakima basin reservoirs in August 1998 and summarized results in a draft progress report (Reclamation, 1999). Reclamation collected water quality samples at the inflow area, reservoir mid-point, and outlet area of Keechelus Reservoir. Samples were analyzed for nitrogen, phosphorus, chlorophyll *a*, and phytoplankton. In addition, bathymetry surveys were conducted. During sampling, at the midpoint, the surface temperature was 21.6°C and the temperature at the bottom was 4.1°C at 81.1 meters (266 feet).

Results showed that Keechelus Reservoir had generally had low nutrient levels. Ortho-phosphate was below detection at the three stations (<0.005 mg/L). Total phosphorus ranged from below detection (<0.005 mg/L) at the inflow to 0.019 mg/L at the midpoint. Nitrate + nitrite nitrogen was below detection at all three stations (0.030 mg/L). Total Kjeldahl nitrogen ranged from 0.07 mg/L (inflow area and midpoint) to 0.11 mg/L (outlet). Ammonia was below detection in all three stations (<0.010 mg/L). The chlorophyll *a* mean ranged from 0.90 mg/m^3 to 1.83 mg/m^3. Zooplankton samples were also collected and analyzed by dry weight for cladocera, copepoda, rotifera and total zooplankton. The dominant phytoplankton was *Genodinium neglectum*, a dynoflagelate associated with oligiotrophic lakes.

3.4.3.2 Ecology Chlorinated Pesticides, PCBs, and Dioxins Fish Tissue Study

Ecology completed a study in 2006 that analyzed chlorinated pesticides, PCBs and polychlorinated dioxins and furans (PCDDs and PCDFs) in the Yakima River and reservoir fish tissue (Ecology, 2007). The purpose of this study was to assess progress in meeting TMDL targets for DDT and dieldrin and to verify 303(d) listings for other organochlorine compounds (Ecology, 2007). Study results show mean sample fish tissue concentrations collected in Keechelus Reservoir exceeded the human health criteria for total PCBs (5.3 µg/kg) in sucker, pikeminnow, kokanee, cutthroat, and whitefish. Mean sample concentrations for dieldrin, and alpha-BHC were below detection. The mean sample concentration of 2,3,7,8-TCDD (dioxin) in sucker fish tissue exceeded the human health criterion (0.07 µg/kg). Mean sample concentrations of DDE detected in the five species sampled and ranged from 0.61 to 2.6µg/kg. The results of this study supported the fish tissue Category 5 303(d) listings in the reservoir.

3.4.3.3 Keechelus Reservoir Tributaries

Meadow Creek

Meadow Creek, a tributary to Keechelus Reservoir, is 303(d)-listed as Category 5 for temperature (Ecology, 2014e; Table 3-9). Meadow Creek is addressed in the current draft implementation plan (Ecology, 2014g). The basis for Meadow Creek's 303(d) listing is 12 single-day-maximum excursions beyond the criterion sampled at the National Forest Boundary in 1994 (Ecology, 2014e). The Service investigated hydrology and water temperatures of tributaries to Keechelus Reservoir in a 2001 report. Water temperatures in Meadow Creek were suitable for all salmonid species throughout the study period (summer of 2000) although daily maximums did reach levels, which were higher than in Gold Creek and Cold Creek (Service, 2001). The warmest water temperatures occurred during the last

2 weeks of July with 7-day mean temperatures of 13.4 and 13.5°C. The highest single-day mean water temperature was 14.7°C on July 31. Daily maximum water temperatures exceeded 18.0°C on 4 days during the period.

Gold Creek

In a Central Washington University study, Gold Creek had an average daily water temperature that ranged from a high of 13°C in late July to a low of 3.5°C in November (Meyer, 2002). Variation in daily temperature ranged from less in 1°C in November to 3.5°C in July (Meyer, 2002). Gold Creek is not included in the current draft TMDL implementation plan for temperature (Ecology, 2014g). Ecology notes that despite Gold Creek showing four excursions beyond the criterion as sampled by EPA in June 1994, the increased temperatures are considered naturally occurring and not caused by anthropogenic sources at the location or upstream (Ecology, 2014e).

The Service (2001) investigated hydrology and water temperatures of tributaries to Keechelus Reservoir. Water temperatures in upper and in lower Gold Creek were suitable for all salmonid species throughout the study period (summer of 2000). The warmest water temperatures in upper Gold Creek occurred during 2 weeks beginning on July 27 and ending on August 9 with 7-day mean temperatures of 10.3 and 10.5°C. Daily maximum water temperatures ranged from 11.3 to 13.8°C, the latter value reached only once. In lower Gold Creek, the warmest water temperatures occurred during 4 weeks in August when 7-day mean temperatures ranged from 12.1 to 12.7°C. Single-day mean water temperatures ranged from 11.7 to13.2°C during the period. Daily maximum water temperatures were between 12.3 and 15.1°C, the latter value reached twice. Although the lower Gold Creek watershed has been impacted by development, the daily range of water temperatures observed during summer was the narrowest of all the creeks studied, possibly the result of groundwater influences in this alluvial reach (which would moderate temperatures).

Cold Creek

Cold Creek in not included in the current draft TMDL implementation plan for temperature (Ecology, 2014g). The Service's 2001 study of Keechelus Reservoir tributaries included Cold Creek (Service, 2001). Results show water temperatures in Cold Creek were suitable for all salmonid species throughout the summer of 2000. The warmest water temperatures occurred during the last week of July through the first week of August with 7-day mean temperatures of 13.6 and 14.0°C. The highest single-day mean water temperature during these 2 weeks reached 14.9°C on two consecutive days. The daily range of water temperatures observed in Cold Creek during summer was narrow, likely due to the mostly undisturbed nature of the riparian corridor of Cold Creek.

3.4.4 Kachess Reservoir and Tributaries

Kachess Reservoir is an unproductive oligotrophic body of water that stratifies in the summer (EPA, 2014a). Thermoclines develop at approximately 50 feet, and the reservoir shows inverse stratification in the winter. The reservoir is well oxygenated at all depths during the entire year, though the Little Kachess basin displays somewhat reduced oxygen levels in the hypolimnion during the summer and fall (EPA, 2014a). Kachess Reservoir has steep side slopes with little shoal areas and is cold, clear, and relatively deep (415 feet maximum pool depth) (WSDF, 1967).

3.4.4.1 Reclamation Reservoir Water Quality Sampling

Reclamation collected water quality data in the reservoir (100 meters upstream of the dam) during June, July, and August at various depths throughout the water column. The reservoir outlet is located at elevation 2,192**.** Based on an EPA STORET database retrieval results (search date August 21, 2014), these data were collected in 1999, 2002, 2005, 2008, 2011, and 2012 (EPA, 2014a). These sampling results indicate water quality in the reservoir is moderate to good. Samples met State water quality standards except for temperature and DO.

During sampling, reservoir waters were clear (average Secchi disk depth of 8.5 meters [27.9 feet]) with low turbidity, low fecal coliform counts, and an average pH of 7.4 at a depth of 1 meter (3.3 feet). Summer peak water temperatures exceeded the State surface water quality criterion of 16°C at depths of up to 11 meters (36.1 feet). A peak water temperature of 21.3°C was recorded in August 2012 at a depth of 1 and 3 meters (3.3 and 9.8 feet). Water temperatures decreased with depth, indicating the presence of a summer thermocline (Figure 3-12).

Based on one reservoir profile by Reclamation (August 1998), a maximum temperature of 22.1°C was recorded at the surface and decreased in the hypolimnion of the reservoir, with a temperature 4.0°C at the reservoir bottom (122 meters[400 feet]) (Reclamation, 1999).

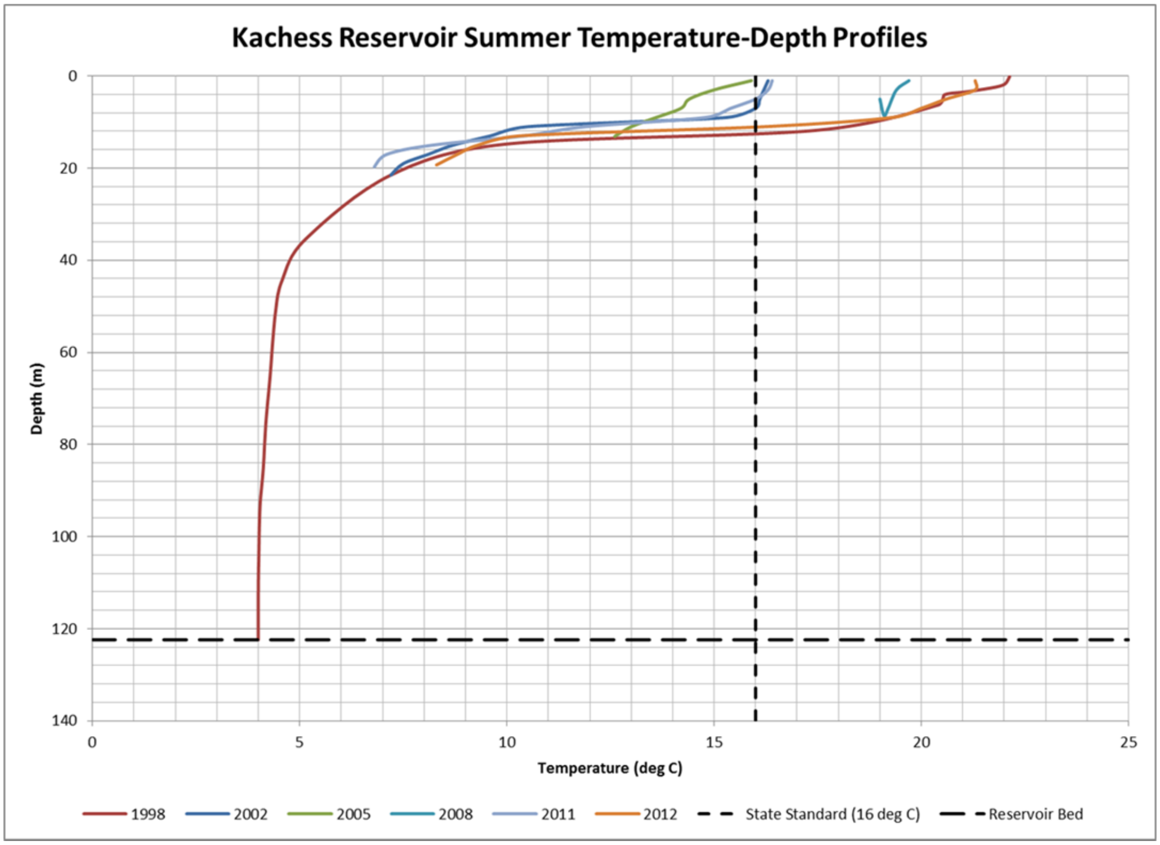

Figure 3-12. Kachess Reservoir Summer Temperature-Depth Profiles

Dissolved oxygen concentrations increased with depth (Figure 3-13). The average concentration at 1 meter (3.3 feet) depth was 9.0 mg/L (based on five measurements) and increased at depth where an average of 11.mg/L was recorded at 19 meters (62.3 feet) (based on three measurements). Dissolved oxygen concentrations below the State surface water quality criteria (standard set to ensure DO greater than the criterion of 9.5 mg/L) were recorded at depths up to 19 meters (62.3 feet). Based on one reservoir profile by Reclamation, the DO concentration decreased near the bottom of the reservoir, with a concentration of 9.4 mg/L (122 meters[400 feet]), indicating the reservoir was not anoxic during the summer sampling (Reclamation, 1999)**.** Fecal coliform counts did not exceed 2 colonies per 100 mL, meeting the State surface water quality standard. Orthophosphate concentrations were low, with most readings at or below detection (0.003 mg/L). Total phosphorus concentrations ranged from below detection (< 0.01 mg/L) to 0.023 mg/L (at a depth of 21.5 meters [70.5 feet]).

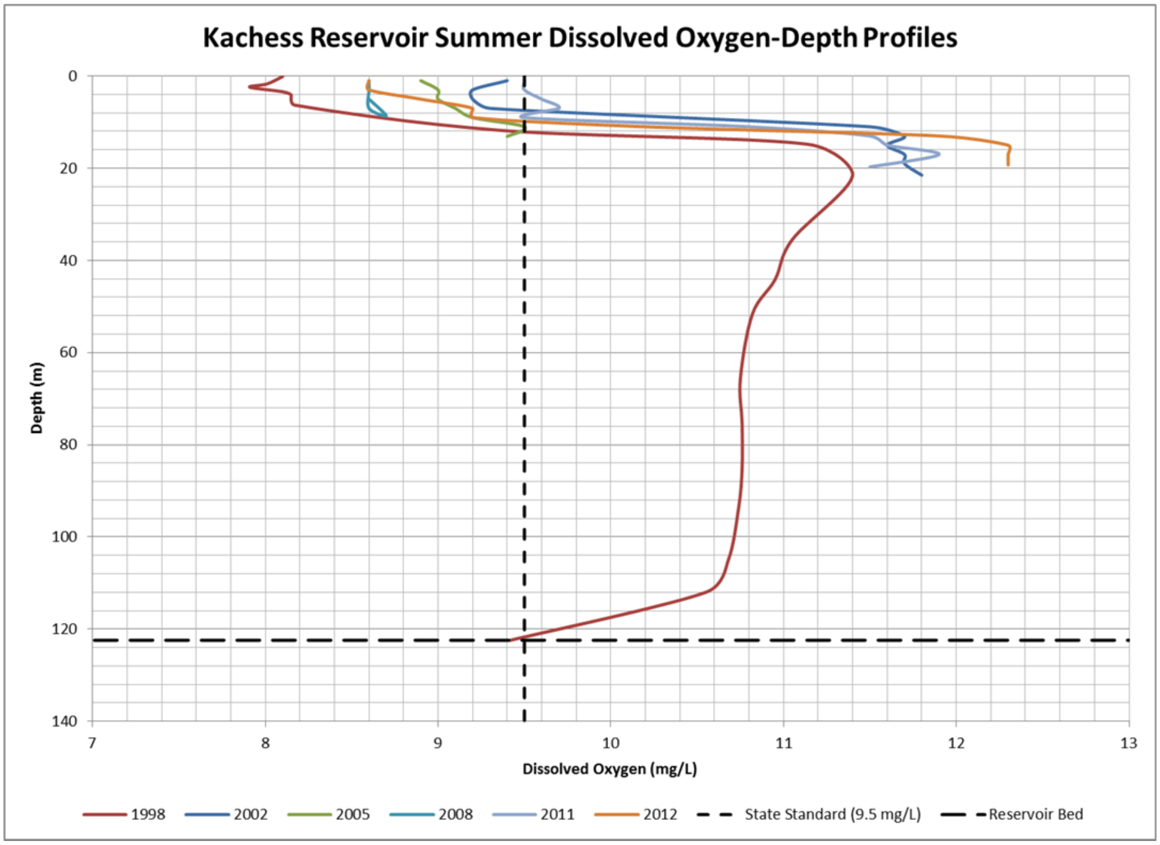

Figure 3-13. Kachess Reservoir Summer Dissolved Oxygen versus Depth Profile
Source: Reclamation, 1999 and EPA, 2014a

Reclamation's 1999 reservoir water quality sampling included Kachess Reservoir (Reclamation, 1999). Reclamation collected water quality samples in August 1998 at the following: Kachess Reservoir inflow area, reservoir mid-point, and outlet area. Samples were analyzed for nitrogen, phosphorus, chlorophyll *a*, and phytoplankton and zooplankton. In addition, bathymetry surveys of the reservoirs were conducted. During sampling, the surface temperature was 21.1°C and the temperature at the reservoir bottom was 4°C (122.4 meters [400 feet]) with a Sechhi disk depth of 13.8 meters (45 feet) (the deepest of all the reservoirs in the sampling session).

Sampling results showed that Kachess Reservoir had low nutrient levels. Orthophosphate was below detection at all three stations (<0.005 mg/L). Total phosphorus ranged from below detection (<0.005 mg/L) at the inflow to 0.006 mg/L at the midpoint. Nitrate + nitrite nitrogen was below detection at all three stations (<0.030 mg/L). Total Kjeldahl nitrogen ranged from 0.08 mg/L (inflow) to 0.24 mg/L (outlet). Chlorophyll *a* mean ranged from 0.10 mg/m^3 (midpoint) to 0.61 mg/m^3 (inflow). Zooplankton samples were also collected and analyzed by dry weight for cladocera, copepoda, rotifera, and total zooplankton. Kachess Reservoir had a high total zooplankton biomass with *Holopedium* species dominant. These types of zooplankton are associated with cool waters low in calcium (Reclamation, 1999).

3.4.4.2 Ecology 303(d) Water Quality Listing

Kachess River at the outflow of Kachess Reservoir is listed as Category 2 (Waters of Concern) in Ecology's 2008 Water Quality Assessment for DO (Table 3-9), meaning that there is some evidence of a water quality problem but not enough to require development of a water quality improvement project (Ecology, 2014e).

Gale Creek (a tributary to Kachess Reservoir) is 303(d)-listed as Category 5 for temperature (Table 3-9) in Ecology's 2008 Water Quality Assessment, meaning that it is polluted enough to require a TMDL or water quality improvement (WQI) project (Ecology, 2014e).

In a 2000 study, Kachess River upstream of Kachess Reservoir had an average daily water temperature that ranged from a high of 12°C in early August to a low of 1.3°C in November (Meyer, 2002). Variation in daily temperature ranged from less than 1°C in November to 4°C in July.

Reports of a sulfurous smell were listed in the Scoping Summary Report for this DEIS (Reclamation and Ecology, 2014i). This observation was presumed to be due to anaerobic activity in the reservoir, which would be related to DO levels. Available water quality data do not indicate anaerobic activity in Kachess Reservoir. This unknown source of odor could also be due to algal growth.

3.4.4.3 Ecology Chlorinated Pesticides, PCBs, and Dioxins Fish Tissue Study

Ecology completed a study in 2006 that analyzed chlorinated pesticides, PCBs and PCDDs and PCDFs in Yakima River fish tissue (Ecology, 2007). The purpose of this study was to assess progress in meeting TMDL targets for DDT and dieldrin, and to verify 303(d) listings for other organochlorine compounds (Ecology, 2007). Sucker and pikeminnow tissue was sampled from reservoir fish. Results of this study determined mean tissue samples collected in Kachess Reservoir pike minnow (16 µg/kg) exceeded the human health criteria of 5.3µg/kg for total PCBs. Mean concentrations for dieldrin (0.40 µg/kg), total chlordane (0.40 µg/kg), and alpha-BHC (0.40 µg/kg), and 2,3,7,8-TCDD (dioxin) (0.030 µg/kg) were reported as being below detection limits. Mean concentrations of DDE in both the sucker fish and pikeminnow were below the human health criterion of 32 µg/kg.

3.4.5 Lake Easton

Based on the most recent and available water quality data collected by Ecology, Lake Easton appears to have good water quality. The lake is generally well oxygenated with generally low levels of nutrients and fecal coliform bacteria (Ecology, 1995; 1996).

3.4.5.1 Ecology Lake Water Quality Assessment Program

Based on the most recent data collected by Ecology, Lake Easton is oligotrophic (Ecology, 1995). Lake Easton was considered a low-priority lake for restorative action based eutrophication issues (Ecology, 1995).

Ecology surveyed water chemistry at Lake Easton during onsite visits in 1993. This is the most recent available data set available from Ecology. On June 1, 1993, they found total phosphorus to be below detection in the epilimnion composite sample. On August 29, 1993, they found total phosphorus to be 17 μg/L in the epilimnion composite sample. Total nitrogen was 0.05 mg/L in June and 0.12 mg/L in August. Chlorophyll *a* concentration was 0.6 μg/L in June in the epilimnion composite and 0.7 μg/L in August. Fecal coliform bacteria were sampled at two sites in June and August. The lake water had 2 colonies/100 mL or was below detection limits during these sampling events.

3.4.5.2 Ecology 303(d) Water Quality Listing

Lake Easton is not listed as water quality limited on Ecology's 303(d) Water Quality Limited List.

3.4.5.3 Kachess River

Reclamation collected water quality data in Kachess River 300 meters downstream of the Kachess Reservoir dam (station YKA001) during June, July and August. Based on a STORET database retrieval results (search date August 21, 2014), these data were collected in 1999, 2002, 2005, 2008, 2011, and 2012 (EPA, 2014a). Sampling results indicate water quality in the river is moderate to good. During sampling, the river was cool and well oxygenated, with low turbidity, low total suspended solids concentrations, and low fecal coliform counts. However, DO and water temperature exceeded State surface water quality criteria. Water temperatures exceeded the State surface water quality criterion of 16°C on two occasions. During sampling, the average water temperature was 12.6°C. Dissolved oxygen measurements below the State surface water quality criteria were measured on two occasions (standard set to ensure DO criterion greater than 9.5 mg/L). The average DO during sampling was 9.8 mg/L, which meets the State water quality criteria.

3.4.6 Yakima River

Downstream of the Keechelus and Kachess reservoirs, the Yakima River has moderate water quality. The river is listed on Ecology's 303(d) water quality list as Category 5 (polluted) for temperature, pH, and DO (see discussion below) (Ecology, 2014e). A TMDL is already in place for dieldrin, DDT, suspended sediment, and turbidity.

3.4.6.1 Ecology Ambient Water Quality Monitoring Data (Station 39A090)

Ecology maintains a long-term water quality monitoring station on the Yakima River near RM 191, downstream of Lake Easton. Ecology rates the overall Yakima River water quality as of moderate concern (Ecology, 2014d). Based on data collected in 2012, DO and fecal coliform exceeded State water quality criteria at this station.

3.4.6.2 Ecology 303(d) Water Quality Listing

The Yakima River at the inlet of Lake Easton (downriver of Keechelus Reservoir) is 303(d)-listed as Category 5 for temperature (Ecology, 2014e). At the outlet of Lake Easton, the river is 303(d)-listed as Category 5 for pH and DO. Farther downstream, the Yakima River is listed for various contaminants in fish tissue, as well as temperature (Category 5), pH (Category 5), DO (Category 5), dieldrin (Category 2), ammonia-N (Category 2), and bacteria (Category 2).

3.4.6.3 Total Maximum Daily Load

Ecology has an EPA-approved TMDL in the upper Yakima River for dieldrin, DDT, suspended sediment, and turbidity. As of 2006 and 2007, monitoring results showed that the TMDL implementation had resulted in water quality improvement (Ecology, 2014g). Scheduled for completion in 2016, the TMDL sets water column targets for pesticides and turbidity. Pesticide targets were set for Cherry Creek and Wipple Wasteway, both of which are located downstream near Ellensburg. Turbidity targets were set for tributaries (90^{th} percentile not to exceed 5 NTU) and the mainstem (90^{th} percentile at RM 139.8 and RM 121.7 not to exceed 5 NTU above 90^{th} percentile at RM 191). In 2006, Ecology and partner organizations found that most of the interim turbidity targets were met; in 2011, they found that many but not all of the final TMDL targets for turbidity were being met.

3.4.6.4 Ecology Chlorinated Pesticides, PCBs, and Dioxins in Fish Tissue

Ecology's 2006 study that analyzed chlorinated pesticides, PCBs and PCDDs and PCDFs in the Yakima River including sampling at five sites along the Yakima River: Cle Elum, Yakima Canyon, Wapato, Prosser, and Horn Rapids (Ecology, 2007). Sampling results show DDE and dieldrin exceeded human health criteria in one or more species at all the sites except Cle Elum. Total PCBs exceeded the human health criterion in at least one species at all sampling sites. Total chlordane also exceeded the human health criterion in carp at Prosser.

3.5 Groundwater

This section describes the groundwater resources found in the primary study area for the KDRPP, KKC and BTE. The primary study area for KDRPP includes the following:

- The area in the immediate vicinity of construction
- The area within 2 miles of the Kachess Reservoir shoreline
- The narrow valley filled with alluvial and glacial deposits south of the Kachess Dam

The primary study area for KKC and BTE includes the following:

- The area in the immediate vicinity of construction
- The area within 2 miles of the Keechelus Reservoir shoreline

- Gold and Cold creek tributaries

The pipeline area is included because of potential influences on groundwater due to construction dewatering. Most of the KKC tunnel east of I-90 would be constructed at a deep elevation in low-permeability bedrock using a tunnel boring machine (TBM) and would not require dewatering. Therefore, the KKC analysis focuses on the area west of I-90 where groundwater dewatering is likely to be required.

Figure 3-14 and Figure 3-15 show the primary study areas. The extended study area is the Yakima River basin (Figure 1-1).

The occurrence and quantity of groundwater is greatly influenced by geology in the primary study area. The information in this subsection is based on geologic units in the primary study area as mapped by Tabor et al. (2000) and described in Section 3.2. Detailed mapping was also performed by Reclamation for areas south of Kachess Reservoir in 1911 (Reclamation, 1911a) and south of Keechelus Reservoir in 2001 (Reclamation, 2001), and is described in Section 3.2.

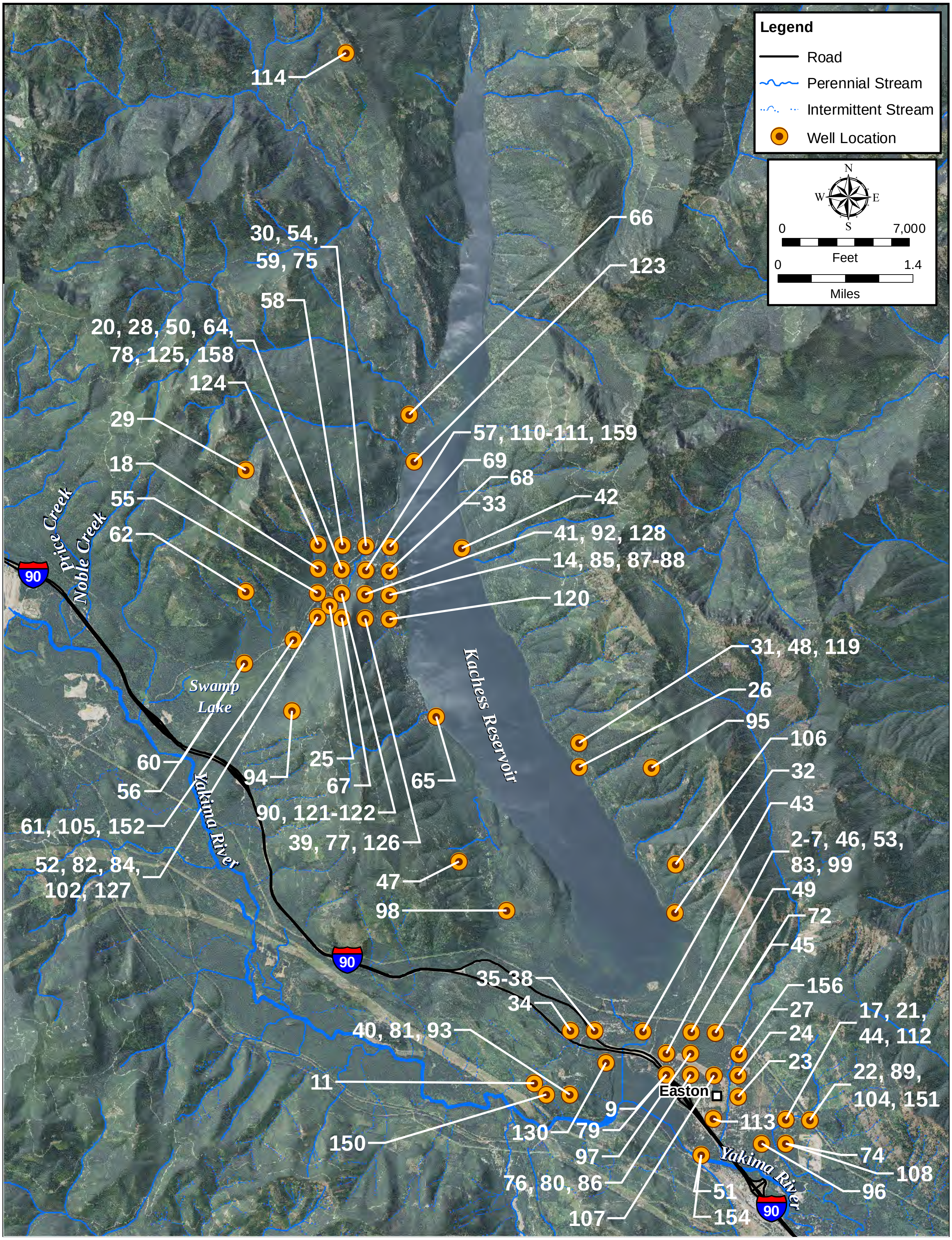

Figure 3-14. Kachess Reservoir Groundwater Study Area

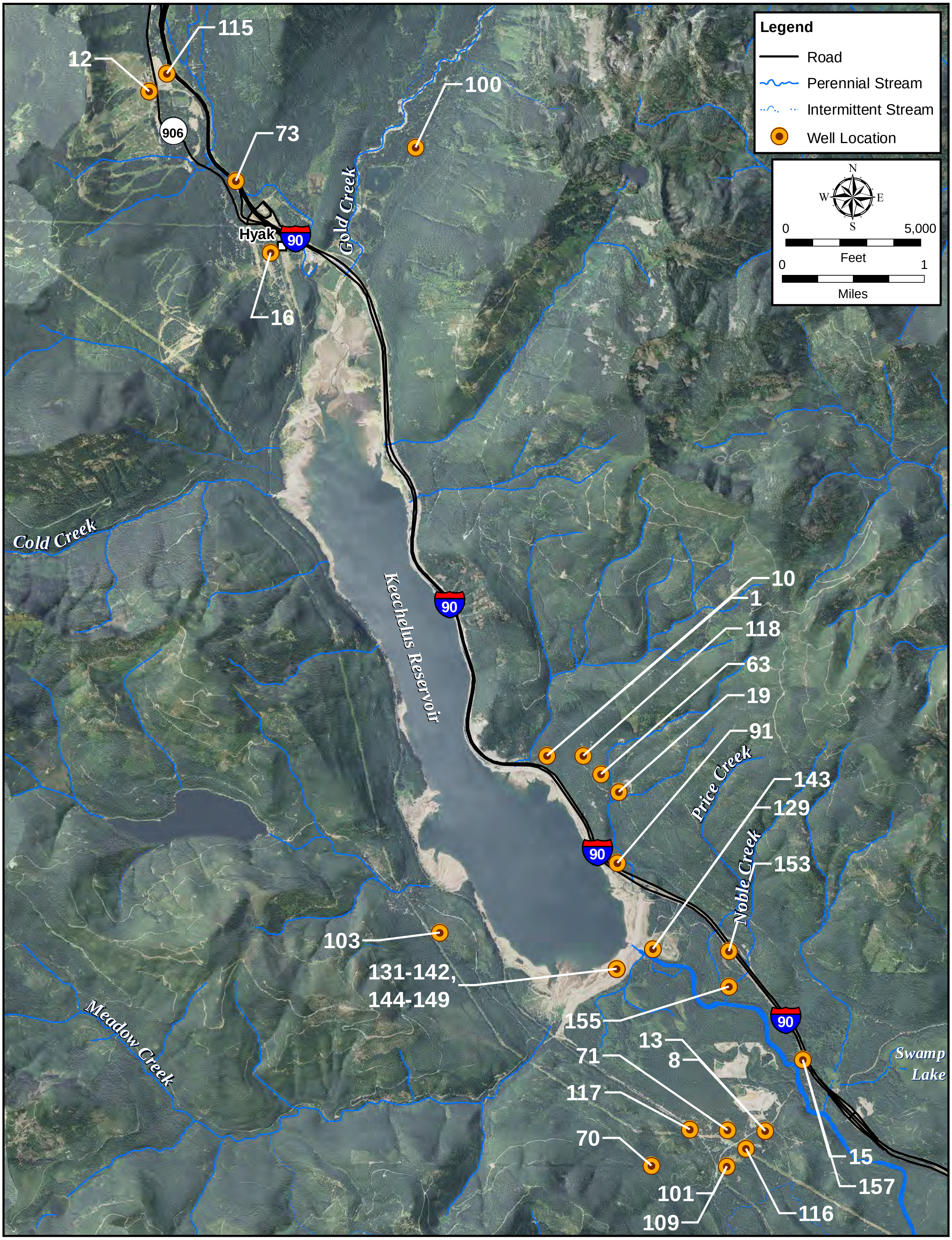

Figure 3-15. Keechelus Reservoir Groundwater Study Area

3.5.1 Regulatory Setting

Groundwater use is regulated by Ecology in the State of Washington. Groundwater pumping wells require a water right permit (WAC 173-152). In upper Kittitas County, groundwater withdrawals are subject to the Ecology Upper Kittitas County Groundwater Rule (WAC 173-539A), which was enacted in January 2011. This rule places a moratorium on the development of new unmitigated groundwater withdrawals in upper Kittitas County. Under the rule, water withdrawals must be obtained from a senior water right or from an existing water purveyor. Further, a water budget neutral certificate must be obtained from Ecology to confirm that the new use of groundwater does not exceed the existing senior water right. Groundwater quality is regulated under WAC 173-200. The Washington State administrative rules for groundwater use are found in WAC 173-100.

3.5.2 Kachess Reservoir Area

3.5.2.1 Hydrogeology

The alluvial and glacial deposits south of Kachess Reservoir form a high-permeability unconfined aquifer up to 90 feet thick (Reclamation, 1911a). This aquifer is underlain by sandstone bedrock that is expected to be low permeability and is unlikely to convey significant quantities of groundwater. Reclamation design plans for Kachess Dam show that a low-permeability cut off wall was installed to a depth of 20 to 30 feet below grade (Reclamation, 1911b). This wall likely partially blocks seepage from the reservoir. Soil boring lithology data and a physical reconnaissance of the dam site and alluvial valley south of the dam indicate that it is likely that groundwater is close to the ground surface near the dam. Groundwater likely flows south from the dam within the unconsolidated deposits and discharges to the Yakima River downstream from the dam.

Well logs were obtained from Ecology for an area within 2 miles of Kachess Reservoir (Ecology, 2014h). The locations of the wells were mapped to the nearest quarter section using the well log data (Figure 3-14). There are 107 wells are located within 1 mile of the reservoir and eight additional wells are located between 1 to 2 miles from the reservoir. The majority are domestic wells and supply seasonal and year-round homes around the reservoir. Based on information in the well logs, well depths range from 15 to 500 feet, with an average depth of 190 feet. Approximately 46 wells are less than 100 feet deep and most of these are located in sedimentary deposits (sand or gravel). The remaining wells are deeper and mostly located in bedrock.

3.5.2.2 Groundwater Quality

Groundwater quality in the study area was evaluated by examining water quality records maintained by the Washington State Department of Health (WSDOH, 2014) and Ecology (Ecology, 2014b). No records indicating adverse groundwater quality within the primary study area were discovered. However, because the area is remote and there is little industrial or commercial land use, and because the aquifer receives a large amount of recharge from precipitation and from through-flow from the Yakima River, it is anticipated that groundwater quality is very good.

3.5.3 Keechelus Reservoir Area

3.5.3.1 Hydrogeology

The river alluvium and glacial outwash deposits south of Keechelus Dam form a high-permeability unconfined aquifer up to 40 to 50 feet thick. This aquifer is underlain by a confining unit of lacustrine and glacial till deposits. The underlying bedrock around the dam and under the river valley is expected to be of low permeability and is not likely to convey significant quantities of groundwater.

Well logs were obtained from Ecology for an area within 2 miles of Keechelus Reservoir (Ecology, 2014h). The well locations were mapped to the nearest quarter section using the well log data (Figure 3-15). Forty-four wells are located within 1 mile of the reservoir, approximately 20 which are dewatering wells Reclamation uses for groundwater control south of the reservoir. The remaining 22 wells are mainly residential wells for seasonal or public water supply. Of these 22 water supply wells, approximately six wells are less than 100 feet deep and these are located in sand or gravel. The remaining 16 wells are 100 to 400 feet deep and are located in bedrock.

3.5.3.2 Groundwater Quality

Groundwater quality in the study area was evaluated by examining water quality records maintained by WSDOH (2014) and Ecology (2014b). No records indicating adverse groundwater quality within the primary study area were discovered. However, because the area is remote and there is little industrial or commercial land use, and because the aquifer receives a large amount of recharge from precipitation and from through-flow from the Yakima River, it is anticipated that groundwater quality is very good.

3.5.4 KKC Alignments

3.5.4.1 Hydrogeology

The following hydrogeology description focuses on the west end of the pipeline within the Yakima River alluvial valley where sedimentary units have relatively high permeability and groundwater control (dewatering) during construction may affect groundwater levels. The river alluvium and glacial outwash deposits south of the dam form a high-permeability unconfined aquifer up to 40 to 50 feet thick. This aquifer is underlain by a confining unit of lacustrine and glacial till deposits.

Well logs were obtained from Ecology for an area within 2 miles of the west part of the conveyance pipeline to be excavated or tunneled in the shallow alluvial sand and gravel valley and where construction dewatering is likely to be required (Ecology, 2014h). The well locations were mapped to the nearest quarter section using the well log data (Figure 3-15). There are 38 wells located within 2 miles of the proposed pipeline shallow excavation and tunnel area. Approximately 20 of these wells are Reclamation dewatering wells south of the reservoir. Almost all of the remaining wells are either to the west of the Yakima River or along the east and west shore of the reservoir. Only two water supply wells (the Cle Elum Ranger District and Wenatchee Crystal Springs wells located southwest of the proposed pipeline alignment) are completed within the shallow alluvial deposits and are in hydraulic connection with the shallow alluvial aquifer.

Reclamation completed geologic investigations of the dam in 2000 and 2001, the results of which provide information about how groundwater flows through the study area. Groundwater flows from a high point created by the Keechelus Reservoir southeast down the Yakima River valley. Groundwater either flows southeast down the river valley or is discharged into the Yakima River. There is an impermeable cut off wall under the dam; however, it only partially penetrates the high-permeability sediments under the aquifer and only partially restricts seepage from the reservoir to the aquifer. In the area of the proposed KKC tunnel alignments, the depth to groundwater ranges from 12 to 28 feet bgs and the groundwater surface elevation ranges from approximately 2,435 to 2,450. Over 10 years, Reclamation collected data to establish seasonal groundwater elevations in piezometers located 500 feet south of the dam (Reclamation, 2014h). These data indicate that seasonal groundwater levels fluctuate 2 to 4 feet. Based on the geology in the tunnel alignment area, the seasonal fluctuation in the KKC alignment area is likely similar.

The hydraulic conductivity of an aquifer is a measure of its ability to transmit groundwater. Reclamation (2001) tested the hydraulic conductivity of the glacial outwash and river alluvium at up to 230 feet per day using rising head slug tests in monitoring wells. These hydraulic conductivity values indicate the glacial and alluvial sediments in the study area would likely yield significant quantities of water during dewatering or other groundwater control efforts for project construction.

3.5.4.2 Groundwater Quality

Groundwater quality in the study area was evaluated by examining water quality records maintained by the WSDOH (2014) and Ecology (2014b). No records indicating adverse groundwater quality within the study area were discovered. However, because the area is remote and there is little industrial or commercial land use, and because the aquifer receives a large amount of recharge from precipitation and from through-flow from the Yakima River, it is anticipated that groundwater quality is very good.

3.6 Fish

The historical lakes and tributaries of the upper Yakima basin formerly supported anadromous spring Chinook, summer steelhead, coho, and sockeye salmon as well as resident bull trout. However, the construction of dams and irrigation storage reservoirs has precluded anadromous fish access to over 70 miles of productive, historically available habitat within the basin. Kachess and Keechelus dams represent passage barriers for returning anadromous fish, and no anadromous fish species are present in either reservoir or in tributaries upstream of the dams (Haring, 2001).

Resident fish species currently occupy habitats in the reservoirs and tributaries upstream of Kachess and Keechelus dams. Downstream of the dams, the Yakima River watershed supports anadromous runs of salmon and steelhead as well as resident species. This section considers fish and their habitats upstream of Kachess and Keechelus dams as well as in the Kachess and Yakima rivers downstream of the dams. Bull trout and steelhead, federally listed species, are discussed in Section 3.9, Federal Threatened and Endangered Species.

The affected environment for fish encompasses the “primary study area”, which includes those areas that would be directly affected by the proposed project(s), and the “extended study area”, which include other areas within the Yakima basin that may be indirectly influenced by the project. Based on mechanisms for impacts, the primary study area for fish species includes the following areas:

- The Kachess Reservoir from the current maximum pool elevation of 2,262 to the proposed operational minimum pool elevation of 2,110;
- All tributaries currently accessible to resident fish species that discharge into the Kachess Reservoir (e.g., Kachess River, Box Canyon Creek, Mineral Creek, Thetis Creek, Lodge Creek, and Gale Creek);
- The Keechelus Reservoir and all tributaries currently accessible to resident fish species that discharge into the Keechelus Reservoir (e.g., Gold Creek, Cold Creek, Meadow Creek, Mill Creek, Coal Creek, and Townsend Creek); and
- The Kachess and Yakima Rivers within 300 feet of diversion and intake and discharge outlet work construction areas downstream of reservoirs.

The extended study area is the Yakima River basin, which encompasses all areas of potential downstream effects. This area extends from the existing Kachess and Keechelus outlet works downstream to the Wapato Irrigation Diversion just upstream of Sunnyside Dam in Parker, Washington, which is the lowermost point in the Yakima basin where water regime influences would be experienced (Figure 1-1).

3.6.1 Kachess Reservoir Area

The Kachess Reservoir and contributing tributaries upstream of Kachess Dam support both native and nonnative fish species. The fish assemblage in Kachess Reservoir and tributaries is expected to be representative of that observed in the upper Yakima basin. Eastern brook trout are the only expected nonnative fish species in Kachess Reservoir (Anderson, 2014).

The occurrence of species in the reservoirs (Table 3-13) is based on summary data (Mongillo and Faulconer, 1982; Pearsons et al., 1998; Wydoski and Whitney, 2003; Reclamation and Ecology, 2011b), refined by local observation (Anderson, 2014). Bull trout (discussed in Section 3.9, Federal Threatened and Endangered Species) is federally listed as a threatened species under the ESA, and pygmy whitefish is State listed as a sensitive species.

Table 3-13. Potential Habitat Use by Resident (Nonanadromous) Fish Species Inhabiting the Upper Yakima River Basin including Kachess and Keechelus Reservoirs

Resident Species	Shoreline Spawning	Tributary Spawning	Shallow Littoral Rearing	Open Limnetic Rearing	Deep Water or Benthic Rearing	Tributary Rearing
Kokanee	October to November	October to November	Prefers temperatures close to 50°F	Prefers temperatures close to 50°F	Diel vertical migrations between limnetic and deep water habitats	N/E
Mountain Whitefish	September to December	September to December	Yes	N/E	Yes	Typically in temperatures 48°F -52°F
Pygmy Whitefish	From late summer to early winter, when temp. is from 32°F to 39°F	From late summer to early winter, when temp. is from 32°F to 39°F	Typically in temperatures less than 50°F (Hallock and Mongillo, 1998)	N/E	Typically in temperatures less than 50°F (Hallock and Mongillo, 1998)	Typically in temperatures less than 50°F (Hallock and Mongillo, 1998)
Cutthroat Trout	N/E	March to July typically in water temperatures around 50°F	Prefers waters between 54°F and 59°F and less than 72°F (Hickman and Raleigh, 1982)	Prefers waters between 54°F and 59°F and less than 72°F (Hickman and Raleigh, 1982)	Prefers waters between 54°F and 59°F and less than 72°F (Hickman and Raleigh, 1982)	Prefers waters between 54°F and 59°F and less than 72°F (Hickman and Raleigh, 1982)
Rainbow Trout	N/E	February to June	Typically in waters where temperatures are less than 70°F	Typically in waters where temperatures are less than 70°F	Move into deep water when surface temperatures exceed 70°F	Typically in waters where temperatures are less than 70°F

Table 3-13. Potential Habitat Use by Resident (Nonanadromous) Fish Species Inhabiting the Upper Yakima River Basin including Kachess and Keechelus Reservoirs

Resident Species	Shoreline Spawning	Tributary Spawning	Shallow Littoral Rearing	Open Limnetic Rearing	Deep Water or Benthic Rearing	Tributary Rearing
Eastern Brook Trout (I)	August to December when water temperatures are between 40°F to 50°F at depths less than 5 feet deep	August to December when temperatures are between 40°F to 50°F and declining	Typically in water temperatures less than 68°F	Typically in water temperatures less than 68°F	Yes	Typically in water temperatures less than 68°F
Longnose Dace	May to late August at temperatures of 53-66°F (Edwards et al, 1983)	May - July	Typically found in shallow waters (Edwards et al., 1983)	Pelagic fry (Edwards et al., 1983)	N/E	Yes
Leopard Dace	N/E	May - July	Observed in temperatures of 59°F to 64°F	N/E	N/E	Observed in temperatures of 59°F to 64°F
Speckled Dace	N/E	June - August	Typically from 32°F to 68°F	N/E	N/E	Typically from 32°F to 68°F
Chiselmouth	N/E	Late May - early July	Typically from 48°F to 81°F	N/E	N/E	Typically 48°F to 81°F
Redside Shiner	April - July	April - July	Typically 55°-68°F	N/E	Typically 55-68°F but moves to deep water habitats when temperatures increase	Typically 55°-68°F

Table 3-13. Potential Habitat Use by Resident (Nonanadromous) Fish Species Inhabiting the Upper Yakima River Basin including Kachess and Keechelus Reservoirs

Resident Species	Shoreline Spawning	Tributary Spawning	Shallow Littoral Rearing	Open Limnetic Rearing	Deep Water or Benthic Rearing	Tributary Rearing
Peamouth	Late May to June when temperatures range from 50°F to 59°F. Hatch in 7-8 days at 54°F	Late May to June when temperatures range from 50°F to 59°F. Hatch in 7-8 days at 54°F	Yes	N/E	Yes	Yes
Northern Pikeminnow	Late May - Early August when temp. 57 - 65°F. Hatch in 7 days at 64°F	Late May - Early August when temp. 57 - 65°F. Hatch in 7 days at 64°F	Yes	Distributed throughout water column in summer	Typically benthic in winter	Yes
Largescale Sucker	N/E	Early April to July-observed spawning at depths of 8 inches to 9 feet	Primarily found in shallow waters	Pelagic larvae and fry	Uses deep water thermal refugia in summer	Congregates in areas where streams enter lakes
Mountain Sucker	N/E	June - July at temperatures of 48°F to 66°F	Typically 55°F - 70°F	N/E	N/E	Typically 55°F - 70°F
Bridgelip Sucker	N/E	Mid April - Mid June at temperatures 46°F to 59°F	N/E	N/E	N/E	Yes
Burbot	Late winter through early spring when temperatures are about 35°F	Late winter through early spring when temperatures are about 35°F	Moves to shallow water during winter (Bonar et al., 2000)	pelagic larvae	Summer distribution in deeper waters	N/E

Table 3-13. Potential Habitat Use by Resident (Nonanadromous) Fish Species Inhabiting the Upper Yakima River Basin including Kachess and Keechelus Reservoirs

Resident Species	Shoreline Spawning	Tributary Spawning	Shallow Littoral Rearing	Open Limnetic Rearing	Deep Water or Benthic Rearing	Tributary Rearing
Threespine Stickleback	May - August. Hatch in 7 days at 64°F	May - August. Hatch in 7 days at 64°F	Yes	Yes	Yes	Yes
Paiute Sculpin	May - June	May - June	Observed in warmer waters ranging from 59°F to 77°F	N/E	Observed in warmer waters ranging from 59°F to 77°F	Observed in warmer waters ranging from 59°F to 77°F
Torrent Sculpin	April - June	April - June	Yes	N/E	N/E	Observed in temperatures ranging from 59°F to 72°F
Mottled Sculpin	N/E	February – June in water ranging from 39°F to 59°F eggs hatch in 20 to 30 days at temperatures between 50°F and 60°F.	N/E	N/E	N/E	Yes

[1]Nonnative, introduced species are identified by a parenthetic “I” following species name.
[2]Not expected is denoted by “N/E”
[3]Data presented in table were obtained from Wydoski and Whitney (2003) except where other sources are noted parenthetically within the table.

3.6.1.1 Kachess Reservoir

Kachess Reservoir provides lake-type habitat for resident fish species within two connected subbasins: Kachess and Little Kachess. The overall productivity within the reservoir and individual subbasins is thought to be driven by nutrient availability and the efficiency with which nutrients are used by primary producers (e.g., phytoplankton; Mongillo and Faulconer, 1982). The potential productivity at all levels of a food web is determined by nutrient supply; however, actual productivity reflects complex interactions between different levels of the food web (Carpenter et al., 1985). Hiebert (1999) found nutrient levels to be low in Kachess Reservoir, and Mongillo and Faulconer (1982) determined that both reservoir subbasins are relatively unproductive (oligotrophic).

The flushing rate or hydraulic residence time of a reservoir also helps shape overall reservoir productivity (Reclamation, 2007). The hydraulic residence time is the average time required to completely renew the reservoir's water volume. If the residence time is too short, zooplankton communities may not develop sufficiently to provide food for resident fish. Obertegger et al. (2007) determined that residence time influenced the abundance and species composition of zooplankton communities. Brook and Woodward (1956) found that the residence time had to be greater than 18 days for significant development of zooplankton. Hayward and Van Den Avyle (1986) observed that residence times of at least 50 to 250 days were sufficient to allow the establishment of plankton populations that reflected the productive potential as well as effects of species' interactions in the reservoir. Kachess Reservoir has an average hydraulic residence time of 686 days based on data from 1925 to 2009 as discussed in Section 4.6.4.2.

Zooplankton is the major basis for fish production in all Yakima Project reservoirs, including both subbasins of Kachess Reservoir (Mongillo and Faulconer, 1982). The abundance of zooplankton prey can influence the growth of individual fish and the productivity of fish populations in a reservoir (Hyatt and Stockner, 1985). Historically, zooplankton abundance (measured as weight per volume, mg/m^3) in Kachess subbasin, was similar to that of the Cle Elum Reservoir, and higher than that of Little Kachess basin, but lower than that of Keechelus Reservoir (Table 3-14; Mongillo and Faulconer, 1982). In terms of numerical zooplankton abundance, Kachess and Little Kachess subbasins ranked highest among the Yakima Project reservoirs (Table 3-14). More recent sampling (Hiebert, 1999) indicates that zooplankton biomass may be highest in the Kachess subbasin followed in descending order by Cle Elum Reservoir, little Kachess subbasin and Keechelus Reservoir.

Table 3-14. Zooplankton Weight and Abundance in Yakima Basin Reservoirs

Reservoir	Zooplankton Weight per Volume of Water (mg/m^3)	Zooplankton Number per Volume of Water (no./m^3)
Cle Elum	19.98	2,522
Kachess Basin	19.28	5,872
Little Kachess Basin	12.47	3,319
Keechelus	28.70	1,052
Bumping Lake	1.75	1,499

Source: Mongillo and Faulconer, 1982

Goodwin and Westley (1967) concluded that the standing crop of zooplankton in the Kachess Reservoir is comparable to or greater than that of major sockeye-producing lakes in Alaska. The presence of self-sustaining runs of kokanee salmon in Kachess Reservoir indicates that zooplankton supply is adequate to provide food for resident species (Reclamation, 2005b).

Invertebrate prey items other than zooplankton are scarce in Kachess and Little Kachess subbasins; these items are dominated by juvenile insects from the midge family (Mongillo and Faulconer, 1982). Mongillo and Faulconer (1982) concluded that reservoir drawdowns of more than 7 meters (22.9 feet) reduced total number of individuals, number of species, and size of benthic invertebrates in Yakima basin reservoirs.

Based on gillnet surveys and estimates of angler catch during the 1970s and early 1980s, the overall abundance of resident fish in Kachess and little Kachess subbasins is lower than that of Keechelus Reservoir but higher than that of Cle Elum Reservoir. Pygmy whitefish, northern pikeminnow, kokanee, burbot, and mountain whitefish were captured most frequently (Mongillo and Faulconer, 1982). The current fish assemblages and relative abundance may differ from these historical data as recent entrainment studies had higher catch rates of resident fish at Kachess Reservoir versus Keechelus Reservoir (Thomas, 2014a).

3.6.1.2 Kachess Tributaries

The Kachess Reservoir is fed by tributaries that provide potential resident fish habitat; however, detailed accounts of use for most resident fish species are lacking. Low-gradient tributaries with perennial flow and no barriers to passage are assumed to represent the most significant habitat for existing resident fish and also those most suitable for future use by anadromous salmonids (Table 3-15; Reclamation, 2005b).

Table 3-15. Kachess Tributary Habitats Considered Suitable for Anadromous Salmonids

Tributary	Stream Habitat	
	Potentially accessible (miles)	Potentially available above manmade barriers
Kachess River	0.5	0
Box Canyon Creek	1.6	0
Mineral Creek	0.25	0
Gale Creek	1.5	0

Table adapted from Reclamation, 2005b.

Kachess River

The Kachess River is 5.5 miles long with a natural fish passage barrier 0.9 mile upstream from Kachess Reservoir. The Kachess River is dry near its confluence with Kachess Reservoir in late summer through mid-to late October, depending on fall precipitation. The USFS (1997) has identified five fish-passage-barrier culverts in miscellaneous tributaries to the Kachess River and one on Gale Creek (Reclamation, 2005b).

Box Canyon Creek

Box Canyon Creek is 7.7 miles long, with a barrier falls at RM 1.6 (Haring, 2001); USFS (1995) reported that a waterfall also occurs at about RM 4.5. Stream gradient near this area approaches 40 percent (Reclamation, 2005b). Historically, Box Canyon Creek supported sockeye salmon and cutthroat trout (Reclamation, 2005b), with sockeye salmon presumed to have occupied Box Canyon Creek up to the barrier at RM 1.6. With a substrate dominated by bedrock and small boulders, Box Canyon Creek has excellent bed and bank stability. The abundance of large woody debris (LWD) and pool frequency were below USFS Forest Plan standards (Reclamation, 2005b). Aerial surveys indicate that riparian conditions in Box Canyon Creek declined between 1942 and 1992. Summertime water temperatures have exceeded Northwest Forest Plan standards and ranged as high as 20°C (Reclamation, 2005b).

Mineral Creek

Mineral Creek is 19 miles long, with a natural blockage at RM 0.25. The USFS assigned a “good” rating to 2 miles of spawning habitat, 3 miles of summer rearing habitat, and 3 miles of winter rearing habitat in Mineral Creek (Haring, 2001).

Other Tributaries

In other potential tributary habitats around Kachess Reservoir, the combination of reservoir drawdown and extensive alluvial aggradation causes these streams to go subsurface and limits access by fish species. The small effective size of these habitats and lack of perennial access reduces the value of these tributaries to existing resident species and to anadromous species that may be introduced in the future.

Gale Creek. Gale Creek is 4 miles long with a barrier waterfall above RM 1.5. Fish access is potentially limited as flows may be subsurface in the first 165 feet when the reservoir is drawn down. Riparian conditions vary among reaches, with reach 1 having the lowest percent canopy closure (0 to 19 percent). Water quality conditions in Gale Creek are impaired, especially as related to water temperature (Haring, 2001; Reclamation, 2005b).

Thetis Creek. Thetis Creek is 2.7 miles long. In later summer, the creek commonly goes subsurface in the lake bed and upstream (Reclamation, 2005b).

Lodge Creek. Lodge Creek is a small stream providing a mix of habitat conditions in about 1.25 miles of accessible habitat. Habitat components include woody debris and wetlands. Brook trout are the most common species of fish observed (Reclamation, 2005b).

3.6.2 Keechelus Reservoir Area

The Keechelus Reservoir and contributing tributaries upstream of Keechelus Dam provide habitat for native and nonnative fish species. The species assemblage is expected to be the same as for Kachess Reservoir (Table 3-13). Similarly, Keechelus Reservoir and tributaries provide habitat for federally listed bull trout (endangered species; described in Section 3.9 Federal Threatened and Endangered Species), and State listed pygmy whitefish (sensitive species).

3.6.2.1 Keechelus Reservoir

Similar to the other Yakima Project reservoirs, Keechelus is considered to be relatively unproductive (Hiebert, 1999). However, it is considered to be more productive than Kachess, Bumping Lake and Cle Elum reservoirs (Mongillo and Faulconer, 1982).

For the operational portion of the reservoir (i.e., active pool), the average hydraulic residence time for Keechelus Reservoir is 128 days based on data from 1925 to 2009 as discussed in Section 4.6.4.2. This highly conservative estimate of the total reservoir hydraulic residence time is within the ranges identified for the establishment of zooplankton communities (Brook and Woodward, 1956; Hayward and Van Den Avyle, 1986). If data for the inactive portion of the reservoir were available, overall hydraulic residence time (active and inactive portions of the reservoir combined) would be expected to increase compared to the baseline estimate obtained for the active pool only.

Of the Yakima Project reservoirs, Keechelus ranks highest in the weight of zooplankton per volume of water (Table 3-14). Similar to Kachess Reservoir, zooplankton drives Keechelus Reservoir fish production (Mongillo and Faulconer, 1982).

Goodwin and Westley (1967) concluded that the standing crop of zooplankton in Keechelus Reservoir was comparable to or exceeded that of major sockeye-producing lakes in Alaska. The presence of self-sustaining runs of kokanee salmon in Keechelus Reservoir, indicate that zooplankton supply provides food for resident species (Reclamation, 2005b).

Invertebrates and prey items other than zooplankton are scarce in Keechelus Reservoir; when present these other prey species are mostly juvenile insects from the midge family (Mongillo and Faulconer, 1982). Reservoir drawdowns of more than 7 meters (22.9 feet) in each year reduced total number of individuals, number of species, and size of benthic invertebrates in Yakima Project reservoirs (Mongillo and Faulconer, 1982).

Keechelus Reservoir had higher abundance of fish than any other Yakima Project reservoir, based on gillnet surveys and estimates of angler catch during the 1960s through the early 1980s.

Kokanee, pygmy whitefish, and northern pikeminnow were captured most frequently (Mongillo and Faulconer, 1982).

3.6.2.2 Keechelus Tributaries

Keechelus Reservoir is fed by multiple tributaries, many of which are of steep gradient (greater than 30 percent), ephemeral, or restricted by barriers to passage (Ackerman et al., 2002). Detailed assessments of resident fish use for most species are lacking. Low-gradient tributaries with perennial flow and no barriers to passage are assumed to represent the most significant habitat for existing resident fish and also those most suitable for future use by anadromous salmonids (Table 3-16; Reclamation, 2005b; Ackerman et al., 2002).

Construction of Keechelus Dam inundated the lower reaches of Meadow and Gold Creeks, which flowed through the low-gradient valley bottom of the Keechelus basin. Before dam construction, Coal Creek flowed into Gold Creek about 2 miles above the northeast end of the reservoir, creating the largest channel flowing into Keechelus Reservoir. At post-dam reservoir levels, Gold and Coal creeks enter the reservoir at separate locations (Ackerman et al., 2002).

Table 3-16. Keechelus Tributary Habitats Considered Suitable for Anadromous Salmonids

Tributary Stream	Stream habitat	
	Potentially accessible (miles)	Potentially accessible if man-made barriers removed (miles)
Meadow Creek	3.9	3.9
Gold Creek	7.0	7.0
Cold Creek	0.0	1.9
Mill Creek	0.2	1
Coal Creek	2.5	2.5
Townsend Creek	0.2	0.5

Table adapted from Reclamation, 2005b.

Meadow Creek

The Yakima Watershed Assessment (Reclamation, 2005b) reports three culverts on road crossings of Meadow Creek steeper than gradient criteria for fish passage design. The reaches sampled in Meadow Creek did not meet the *Northwest Forest Plan* standards for LWD presence or pool frequency (Reclamation, 2005b). The standards are 100 pieces of large wood, 36 inches in diameter and 50 feet long; 100 pieces of small wood, 24 inches in diameter and 50 feet long; NMFS large-wood standard is 20 pieces of large wood.

Gold Creek

Gold Creek has a natural falls at RM 7.1 that is a barrier to upstream fish passage (Reclamation, 2000). Gold Creek routinely stays dewatered for a month or two, typically lasting into late September (Wissmar and Craig, 1997). The dewatering typically begins in reaches above Gold Creek Pond and can be intermittent for over 1.5 miles. Complete dewatering of portions of the

Gold Creek channel upstream from the maximum reservoir elevation has been noted in most recent years. At times, when the channel above the reservoir is dewatered, that portion of the channel traversing the reservoir bottom may also be impassable because of low Gold Creek flows, shallow water conditions, and poor stream habitat created by the reservoir's periodic inundation of the stream channel.

Cold Creek

The culvert at the old Milwaukee Railroad grade crossing of Cold Creek (about 100 yards upstream from the mouth) is perched and creates a total barrier to fish passage. Habitat conditions in Cold Creek upstream from the fish barrier are rated as good (Reclamation, 2005b) with good LWD presence, riparian shade, and cold water; however, none of the reaches sampled in Cold Creek upstream from the culvert met the Northwest Forest Plan standards for LWD presence or pool frequency (Reclamation, 2005b). This fish passage barrier still exists despite previous efforts to restore passage (Anderson, 2014). Cold Creek has essentially no flow in late August to early September, with maximum water temperature of about 17°C in late July to early August (Reclamation, 2005b).

Mill Creek

Mill Creek is about 2 miles long. A large culvert at about RM 0.2 blocks fish passage and as a result, the creek provides little spawning and rearing habitat for anadromous salmonids even if fish passage was provided at Keechelus Dam (Reclamation, 2005b).

Coal Creek

Coal Creek has at least two culvert fish passage barriers (one round corrugated metal pipe and one twin concrete box culvert) at crossings under I-90 upstream from the Hyak interchange (Reclamation, 2005b). Natural floodplain function in Coal Creek has been highly altered by I-90. The channel has been relocated, confined, and straightened as it runs adjacent to the highway. Much of the drainage basin is developed (highways, ski areas, and residential development) or clear cut, altering its water storage and runoff characteristics and habitat conditions are fair to poor. The daily range of summer water temperatures observed in Coal Creek was broad, due to extensive streamside development and degraded riparian conditions. Based on the relatively poor habitat conditions and passage barriers, Coal Creek would not provide suitable spawning and rearing habitat for anadromous salmonids. Stream flows are nearly zero in August and early September, while the 7-day average water temperature is greater than 15°C around the end of July and the maximum water temperature can reach 21°C during this time period (Reclamation, 2005b).

Anadromous salmonids may have historically used the smaller tributaries of Keechelus Reservoir (e.g., Mill, Resort, Roaring creeks), but data are lacking. Roaring, Resort and Rocky Run creeks are thought to be too small or steep for anadromous salmonids. The best habitat in the smaller creeks would have been in the downstream area now inundated by the reservoir (Reclamation, 2005b).

3.6.3 Yakima River and Kachess River Downstream of Keechelus and Kachess Dams

Flow regulation to support irrigation needs has substantially changed the available habitat for resident and anadromous species inhabiting the Yakima River basin, including areas below Kachess and Keechelus reservoirs in the extended study area. In some areas of the basin, flows are higher and in other areas flows are lower than would naturally occur, affecting anadromous and resident fish habitat conditions at different life stages. Natural flow regimes are important drivers of ecological functions that support fish and other aquatic life (Lytle and Poff, 2004; Naiman et al., 2008; Poff and Zimmerman, 2010; Reclamation and Ecology, 2012).

In general, spring flow and water quality conditions in the middle and lower Yakima River reaches are not optimal for survival of outmigrating smolts (see Table 3-1 for a description of the river reaches), nor are summer flow and water quality conditions in these reaches optimal for rearing juvenile salmonids. Flows steadily increase downstream of Sunnyside Dam (which is in the middle reach about RM 104) in the summer as a result of irrigation return flows from groundwater sources and surface drains; the increase becomes more pronounced between Zillah and Granger (RM 88 to RM 83). High flows also persist during the summer in the upper Yakima River reaches, which affects juvenile salmonid rearing habitat. The annual late summer "flip-flop" operation (Section 3.3.1.1 Flip-Flop and Mini Flip-Flop) disrupts salmonid habitat spatially; dewaters off-channel rearing habitat, which can result in stranding; and reduces aquatic insect populations. Winter flows in the upper Yakima and Cle Elum River are low, potentially impacting survival of overwintering juvenile salmonids (Reclamation and Ecology, 2012).

Aquatic invertebrate communities, which provide food and support ecological functions for resident fish and juvenile anadromous salmonids, appear to be resilient to flow regulation in the upper Yakima River. Reports suggest that high quality benthic invertebrate communities exist in this portion of the river (Cuffney et al., 1997; Nelson, 2004; Nelson and Bowen, 2003). Likewise, Stanford et al. (2002, cited in Reclamation, 2008a) report the presence of certain species of stoneflies in floodplain monitoring wells as an indication of the lack of human-caused impact in the Yakima River around the confluence with the Teanaway River and the Yakima River above the Yakima Canyon.

Habitat in the Kachess River is affected by Kachess Reservoir operations, which create flows that differ from the natural steamflow regime. During winter months (October to March) flow is reduced and less variable; in spring (April to June), flow is reduced; and in summer (July to September), flow is greatly increased (Reclamation and Ecology, 2012). The Kachess River is a relatively short (0.9 mile) reach that is a lesser priority for improving river flow because of other objectives in the Integrated Plan (Reclamation and Ecology, 2011h).

Habitat conditions in the Keechelus Reach (river mile 214.5 to 202.5) to Easton Reach (river mile 202.5 to 185.6) of the Yakima River are heavily influenced by seasonal flow fluctuations that reduce the quality and quantity of available habitat (Table 3-17) for salmon and resident species. Previous habitat analyses for spring Chinook salmon in the upper Yakima River indicated that, in descending order, parr, wintering parr, and fry were the most severely impacted life stages (NPCC, 2001). The most significant environmental impacts in descending order were habitat complexity, flow, and key habitat (NPCC, 2001).

Table 3-17. Current Seasonal Habitat Conditions in the Keechelus to Easton Reach

Season	Flow and Habitat Conditions
Spring	Flow pulses are reduced (except under certain operating conditions where pulse flow is requested) because runoff is captured by Keechelus Reservoir. Lower flows reduce available rearing and overwintering habitat into early spring in dry years.
Summer	Currently, flows are too high from July through early September when juvenile Chinook and steelhead (and potentially coho, if reestablished) are rearing in this reach. Juvenile salmon seek protection against high velocity flows to avoid being pushed downstream into less desirable habitat and to minimize energy expenditures, which can affect growth rates. The negative effects on rearing juvenile salmonids from high flow conditions in summer in this reach occur during all types of water years, but are most significant in wet years. Flows in summer during a wet year such as 2002 average about 1,000 cfs.
Fall	Lower flows reduce available rearing and overwintering habitat throughout the fall.
Winter	Flows are lower than unregulated conditions because runoff is captured by Keechelus Reservoir. Lower flows reduce available rearing and overwintering habitat throughout the winter.

Table Adapted from Reclamation and Ecology, 2012

Improving flow conditions in the Yakima River between Keechelus Dam and Easton was deemed a high priority in the Integrated Plan. Desired flow objectives for fish and modeled outcomes of Integrated Plan include the following (Reclamation and Ecology, 2011c):

- Reduce flows to 500 cfs during July
- Ramp flows down from 500 cfs on August 1 to 120 cfs the first week of September
- Increase base flow to 120 cfs year round
- Provide one pulse flow (500 cfs peak) in early April
- In drought years, provide an additional pulse of 500 cfs in early May

3.6.3.1 Yakima River Salmonids

The upper Yakima River basin supports anadromous stocks of spring Chinook salmon, coho salmon, and sockeye salmon (steelhead and bull trout are described in Section 3.9 Federal Threatened and Endangered Species). Migration timing is summarized in Table 3-18 for adults, and in Table 3-19 for juvenile migration.

Table 3-18. Adult Salmon Migration Patterns in the Yakima Basin

Upstream Run Migration or Passage Timing for Adult Migrants												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Spring Chinook salmon												
Coho												
Sockeye												
		= General Migration Period						= Peak Migration Period				

Adapted from Reclamation, 2005b

Table 3-19. Juvenile Salmon Migration Patterns in the Yakima Basin

Downstream Migration Timing for Juveniles												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Spring Chinook salmon												
Coho												
Sockeye												
		= General Migration Period						= Peak Migration Period				

Adapted from Reclamation, 2005b

3.6.3.2 Spring Chinook Salmon

Adult spring Chinook salmon return to the upper mainstem Yakima River beginning in May. Adults migrate close to the area where they would spawn and find a place to hold in cover (deep water with woody debris, undercut banks, or both) until they spawn in September and October. Depending on water temperature, the peak spawning activity for spring Chinook in the upper mainstem Yakima River is from September 15 to October 1 (Fast et al., 1991). Adults that spawn in the upper reaches of tributaries typically move into the tributaries by the end of June or early July, when flows are still high enough for them to traverse the lower reaches of the tributaries. Some migrating adult fish arrive early, traversing the parts of streams that go dry during summer. Variability in run timing is influenced by high and low flows. Run timing for spawning runs of all salmonids is delayed during years of high flow and accelerated in years of low flow (Reclamation, 2008a).

All Yakima River stocks of spring Chinook exhibit an extensive downstream migration of presmolts in the late fall and early winter (Pearsons, et al., 1996; Berg and Fast, 2001). Most juvenile spring Chinook salmon in the upper Yakima River basin migrate downriver during fall to winter and overwinter in the Yakima River between Roza and Prosser diversion dams (Berg and Fast, 2001).

The 10-year average (2004 through 2013) of spring Chinook adults passing Roza Dam and entering the upper Yakima River is 5,271 (Columbia River DART, 2014) and the average number of redds observed between Keechelus Dam and Easton Dam during the same period is 86 (Hubble, 2014a).

3.6.3.3 Coho Salmon

Coho endemic to the Yakima River basin were extirpated from the basin in the early 1980s (NPCC, 2001). Factors contributing to the extirpation include construction of dams on the Columbia River and overharvest of wild stocks (Johnson, 1991). Natural reproduction of hatchery-reared coho now occurs in both the Yakima and Naches rivers.

Currently, coho enter the Yakima River in the fall, with about 10 to 20 percent of the adults reaching the upper watershed between Cle Elum and Easton in November and December. Spawning occurs soon afterward; the eggs incubate over the winter and hatch in the spring. After the fry emerge from the gravel, the juveniles rear in the stream until the following spring, when they outmigrate as 1-year-old smolts (Reclamation, 2008a). Fish management agencies have reintroduced coho at Cle Elum Reservoir and may reintroduce coho throughout the Yakima River basin, pending evaluation of reintroduction at Cle Elum Reservoir (Reclamation, 2005a). The 10-year average (2004 through 2013) of coho adults passing Roza Dam and entering the upper Yakima River is 236 (Columbia River DART, 2014).

3.6.3.4 Sockeye Salmon

Historically, sockeye runs in the Yakima River basin were larger than any other fish runs in the Columbia River Basin (Reclamation, 2008a). Sockeye are dependent on lakes for juvenile rearing, and historical Kachess and Keechelus lakes were once an important habitat area for this species (Reclamation, 2007). The reintroduction of sockeye into Cle Elum Reservoir began in 2009 when the Yakama Nation released 1,000 pairs of adult sockeye. The Yakama Nation trapped the mixed Wenatchee and Lake Osoyoos stocks of sockeye at Priest Rapids Dam. Since 2009, the number of sockeye transported from Priest Rapids Dam to Cle Elum Reservoir has increased to 4,100 in 2010; 4,500 in 2011; 10,000 in 2012; 4,000 in 2013; and 10,000 in 2014, due in part to larger numbers of sockeye passing above Bonneville Dam (Yakama Nation Fisheries, 2014a). In addition, the Yakama Nation counted approximately 80,000 outmigrating sockeye smolts at Prosser Dam in 2011, the most recent year for which data are available.

In 2013, the first offspring of the adults originally transported to Cle Elum Reservoir returned to Roza Dam, where they were collected and transported to Cle Elum Reservoir (Yakama Nation Fisheries, 2014a). During the reintroduction period (2009-2014) an average of 395 sockeye passed Roza Dam (Columbia River DART, 2014).

3.6.3.5 Nonsalmonids

Thirty-seven resident nonsalmonid species are present in the Yakima River basin. The most abundant nonsalmonids are speckled dace, longnose dace, redside shiners, northern pikeminnow, largescale suckers, bridgelip suckers, and several sculpin species, including mottled, torrent, piute, and shorthead sculpins. Nonsalmonid species are an important component of the aquatic environment. Many serve as forage for other game and food fish. Although less abundant, mountain suckers, a State candidate species, and Pacific lamprey, a Federal species of concern, occur within the basin (Pearsons et al., 1998).

Pacific lamprey are rare in the Yakima River basin and little is known about their life history, historical distribution, or current limiting factors. The Yakama Nation is developing a long-term management and action plan specific to Pacific lamprey, and is considering reintroduction of the species in areas above Cle Elum Dam. The Yakama Nation is developing the plan in cooperation with local and regional government entities and other ongoing efforts conducted by the Nez Perce, Umatilla, and Warm Springs Tribes. The plan is consistent with the Columbia River Inter-Tribal Fisheries Commission Pacific Lamprey Tribal Recovery Plan, the Service Conservation Initiative, and the Lamprey Management Plans of Chelan County, Douglas County, and Grant County Public Utility Districts (Yakama Nation Fisheries, 2014b).

3.7 Vegetation and Wetlands

The primary study areas for vegetation and wetlands have been defined on the basis of actions that could impact vegetation and wetlands: construction activities, changes in reservoir pool elevations, and downstream changes, as described in Chapter 4. On this basis, the primary study areas for vegetation and wetlands are as follows (see Chapter 2 figures for additional detail):

- Kachess Reservoir
  - Locations of proposed KDRPP facilities and other construction-related sites along the Kachess shoreline
  - Kachess Reservoir banks between elevations 2,262 (maximum pool) and 2,110 (proposed operational minimum)
  - Downstream locations along the Kachess River that could be impacted by construction and project operations
  - The transmission line route
  - Proposed locations for the Kachess portal(s) (KKC)
- Keechelus Reservoir:
  - Locations of proposed KKC facilities areas
  - Keechelus Reservoir
  - Keechelus reach of the Yakima River
  - Gold Creek and Cold Creek
- KKC Alignment
  - Proposed location of the I-90 portal
  - Areas overlying the proposed alignments as described in Chapter 2

The Kachess Reservoir area is discussed in Section 3.7.1, the Keechelus Reservoir area is discussed in Section 3.7.2, and the KKC areas are discussed in Section 3.7.3.

The extended study area is the Yakima River basin (Figure 1-1). For vegetation and wetlands, potential downstream effects of the Proposed Action would most likely occur on the Kachess River and Keechelus Reach of the Yakima River (from Keechelus Dam to Lake Easton). The extended study area is located in the North Cascades Highland Forests ecoregion (EPA, 2010). This ecoregion encompasses the headwaters of the Yakima River to its confluence with the Kachess River at Lake Easton. It is characterized by glaciated valleys and narrow-crested ridges and high-relief peaks approaching elevation 8,000 (Kittitas County, 2013). The predominant vegetation is coniferous forest stands of Douglas-fir, true firs, and hemlocks in the cooler, wetter west portions of the region, and pines in the drier east portions of the region. Wetland complexes in the extended study area occur primarily as riparian forested and shrub wetlands within river floodplains and, in the upper Yakima River watershed, along smaller tributaries (Kittitas County, 2012).

The proposed east shore and south pumping plant sites and Kachess Lake Campground on Kachess Reservoir, the Kachess portals and discharge structure sites, and the KKC facility sites near Keechelus Dam were visited in August 2014 to document general characteristics of vegetation and wetland communities. Reclamation has not conducted formal wetland delineations or plant surveys for this DEIS.

3.7.1 Kachess Reservoir Area

3.7.1.1 KDRPP East Shore Pumping Plant Site

Vegetation

Vegetation at the proposed east shore pumping plant site on the east side of the Kachess Reservoir consists of two distinct communities. This segment of shoreline is gently sloped and supports a deciduous tree and shrub wetland community. Landward of the maximum pool elevation, vegetation consists of a dense stand of second-growth Douglas-fir trees, with an understory of vine maple, baldhip rose, western serviceberry, and Cascade Oregon grape. The proposed reservoir intake, fish screen, pipeline, and soil disposal area would be located along the unvegetated bed of the reservoir, waterward of the shoreline in an area that cannot support terrestrial vegetation communities.

Vegetation at the proposed Kachess River outlet works and associated facilities downstream from Kachess Dam is comprised of mature mixed coniferous and deciduous forest dominated by Douglas-fir, black cottonwood, red alder, and ponderosa pine, with an understory of vine maple, Cascade Oregon grape, and baldhip rose. A narrow swale located along the toe of slope southeast of the dam supports herbaceous wetland vegetation. Vegetation near the proposed causeway access road consists of dense second-growth Douglas-fir trees. The proposed transmission line would primarily follow existing roads and transmission corridors; vegetation in existing corridors consists of managed shrubs and grass and forb groundcover, transitioning to second-growth coniferous forest outside of managed rights-of-way.

Wetlands

The approximate extent of wetlands within the east shore pumping plant area was identified using the National Wetland Inventory (NWI) (Service, 2013) and observations from the August 2014 site visit (Figure 3-16). The NWI provides a landscape-scale inventory of wetlands and does not replace the accuracy of on-site wetland delineations. The mapping resolution of the NWI generally is too coarse to inventory smaller palustrine wetlands (less than an acre in size; Tiner, 1997) that may be in the study area. Additional site evaluations and on-site wetland delineations would be conducted as part of project-level evaluations.

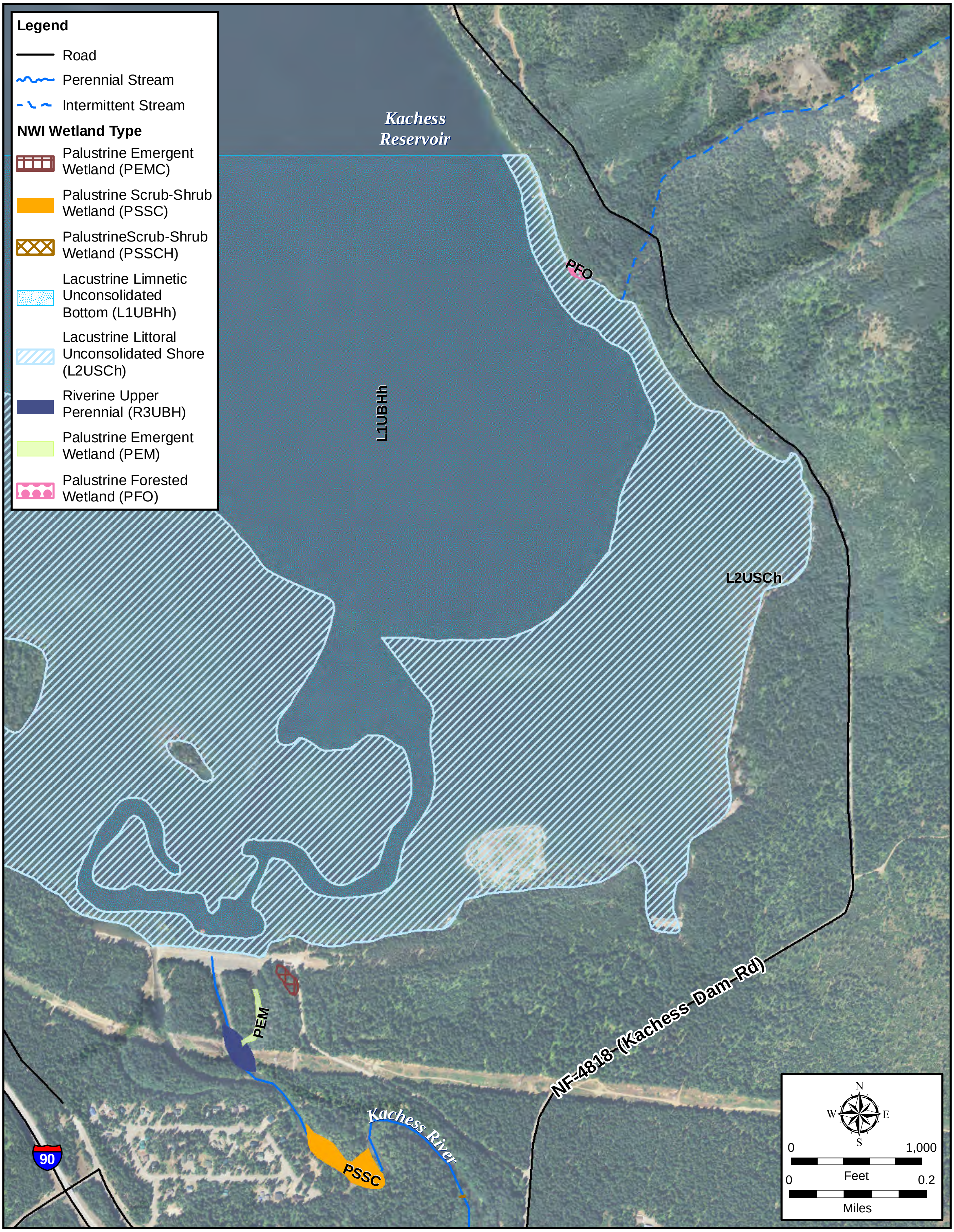

Figure 3-16. Wetlands in the Kachess Reservoir Study Area

The NWI classifies all of Kachess Reservoir as a lacustrine (freshwater lake) wetland—defined as deep water habitat that exceeds 20 acres in size and lacks trees, shrubs, or emergent vegetation (Cowardin et al., 1979). One palustrine emergent wetland (approximately 0.4 acres) is mapped on the NWI south of the (north) left abutment of the Kachess Dam near the proposed pipeline discharge spillway (Figure 3-16). A palustrine wetland is defined as a freshwater wetland dominated by vascular and nonvascular plants, although some palustrine wetlands may also lack vegetation (Cowardin et al., 1979).

Based on field observations at the east shore pumping plant and Kachess Lake Campground, scattered patches of palustrine wetland are found on more gently sloped shoreline segments along the reservoir, although fluctuating water elevations and steep shoreline topography generally preclude development of extensive vegetated wetland communities. A 0.3-acre palustrine forested, broad-leaved deciduous wetland is mapped along the shoreline of the proposed east shore pump plant facility (Figure 3-16). The wetland consists of black cottonwood trees, Pacific willow, and Scouler's willow. At the proposed pipeline outlet spillway south of Kachess Dam, a 0.5-acre narrow palustrine emergent wetland follows a swale from the drainage outfall under the left dam embankment and south to the left bank of the Kachess River discharge pool (Figure 3-16). However, no wetland was observed at the location corresponding to the approximately 0.4-acre feature shown on the NWI wetland maps (Service, 2013). No other wetlands are noted in the NWI inventoried and none were observed near the proposed causeway access road or transmission line alignment.

3.7.1.2 KDRPP South Pumping Plant Site

Vegetation

The proposed south pumping plant facility would be sited in a mature coniferous and deciduous forest stand located south of the Kachess Dam (Figure 3-16). The proposed intake and tunnel would be located along the unvegetated floor of the Kachess Reservoir. Vegetation along the proposed transmission line alignment consists of second-growth coniferous forest.

Wetlands

NWI mapped wetlands in the vicinity of the south pumping plant site include the approximately 0.4-acre palustrine emergent wetland identified for the east shore pumping plant spillway and the approximately 0.5-acre palustrine emergent wetland located south of Kachess Dam (Service, 2013) (Figure 3-16). The proposed tunnel, intake, and fish screen are located in Kachess Reservoir, which is mapped in the NWI as a lacustrine wetland feature. No wetland features are mapped along the proposed transmission line alignment.

3.7.1.3 Kachess Reservoir from Elevation 2,262 to the Minimum Pool Elevation 2,110

As discussed above, vegetation along the Kachess Reservoir shoreline near the maximum pool elevation 2,262 consists mainly of scattered palustrine wetlands, which generally occur in areas with gently sloping shorelines that allow for the establishment of rooted vegetation. The NWI maps approximately 28 acres of palustrine scrub-shrub and 23 acres of palustrine emergent wetlands, most of which are located along the west side of the reservoir and near the mouth of the Kachess River at the north end of the reservoir (Service, 2013). Many of these wetlands are dominated by deciduous tree and shrub species such as black cottonwood and willows. Although no palustrine wetlands are mapped along the east shore of Kachess Reservoir, narrow bands of shoreline mapped as lacustrine wetland are likely to be palustrine wetlands with scrub-shrub or forested vegetation communities, such as the forested wetland observed at the east shore pumping plant site.

3.7.1.4 Kachess River Downstream of Kachess Dam

Vegetation

The Kachess River between Kachess Dam and Lake Easton flows through forested areas with limited rural residential development (Kittitas County, 2013). Second-growth deciduous forest is predominant along most of the riverbanks, transitioning to coniferous forest landward of the river shoreline.

Wetlands

The NWI classifies the existing Kachess River discharge pool located downstream of the Kachess Dam as a riverine wetland (Service, 2013). A riverine wetland includes unvegetated wetlands and deepwater habitats contained within a naturally or artificially created channel (Cowardin et al., 1979). Downstream of the Kachess River, the NWI maps two freshwater scrub-shrub wetlands whose size ranges from 2.5 to 3.4 acres. Lake Easton is mapped as a 224-acre lacustrine feature.

3.7.1.5 Kachess Portals and Discharge Structures for KKC

Vegetation

Alternatives 3A and *3B* both include a portal and discharge structure on the west shore of Kachess Reservoir. Vegetation at the portal and discharge structure for *Alternative 3A* consists of second-growth to mature coniferous forest stands dominated by western hemlock, western red cedar, and Douglas-fir, with an understory of Oregon grape, red huckleberry, kinnikinnick, and Oregon boxleaf. Vegetation at the portal and discharge structure for *Alternative 3B* includes a second-growth to mature mixed stand of coniferous and deciduous trees including western red cedar, red alder, and Douglas-fir, with an understory dominated by vine maple and western serviceberry.

Wetlands

The portion of Kachess Reservoir shoreline at the proposed discharge locations for both *Alternative 3A* and *3B* is steep and subject to fluctuating reservoir levels, which likely precludes the development of vegetated wetlands. The NWI classifies this portion of Kachess Reservoir as a lacustrine feature (Figure 3-17) (Service, 2013).

3.7.2 Keechelus Reservoir Area

3.7.2.1 KKC Facility Sites

Vegetation

Vegetation near Keechelus Dam is a mix of upland forest and wetland habitats, as well as disturbed areas associated with an old borrow pit and existing operations at Keechelus Dam (Dubendorfer, 2002). The Yakima River diversion and intake would be located near existing dam facilities, and a concrete outlet from Keechelus Dam and drainage systems. These built-out areas are sparsely vegetated with small Douglas-fir saplings and fireweed. Second-growth conifer riparian forest starts downstream from the proposed Yakima River diversion and intake. The forested riparian corridor is dominated by second-growth stands of Douglas-fir and grand fir.

Both *Alternatives 3A* and *3B* include two conveyance options for the pipeline from the Yakima River intake to the Keechelus portal. Option B would tunnel under several wetlands and buffers that are part of a wetland mitigation site constructed in the early 2000s for the Keechelus Dam repair project (Dubendorfer, 2002). To the south, Option A would traverse second-growth conifer stands upslope of the wetland mitigation area. Dominant species along Option A include ponderosa pine, Douglas-fir, and western hemlock, with a well-developed understory of vine maple, Oregon grape, and other native groundcover.

Wetlands

NWI has mapped the Yakima River near the Keechelus Dam as riverine feature (Service, 2013).

There is a 9-acre wetland mitigation site downstream from Keechelus Dam; which consists of a series of excavated pools constructed in the early 2000s to compensate for wetland impacts due to repairs to Keechelus Dam (Dubendorfer, 2002) (Figure 3-17). The primary hydrologic input to the wetland mitigation site is springtime discharge originating from a drain system constructed within the dam embankment. This system collects seepage from the dam and discharges it into the northeast portion of the wetland mitigation site. Springtime precipitation and groundwater discharge are secondary sources of input to the wetland. The wetland mitigation site supports predominantly native emergent vegetation, including numerous rush and sedge species, as well as emergent species adapted to prolonged inundation such as field pennyroyal, common cattail, and burr-reed. Scrub-shrub wetland vegetation—mainly willows and red alders—are established upslope of the excavated pools (Figure 3-17).

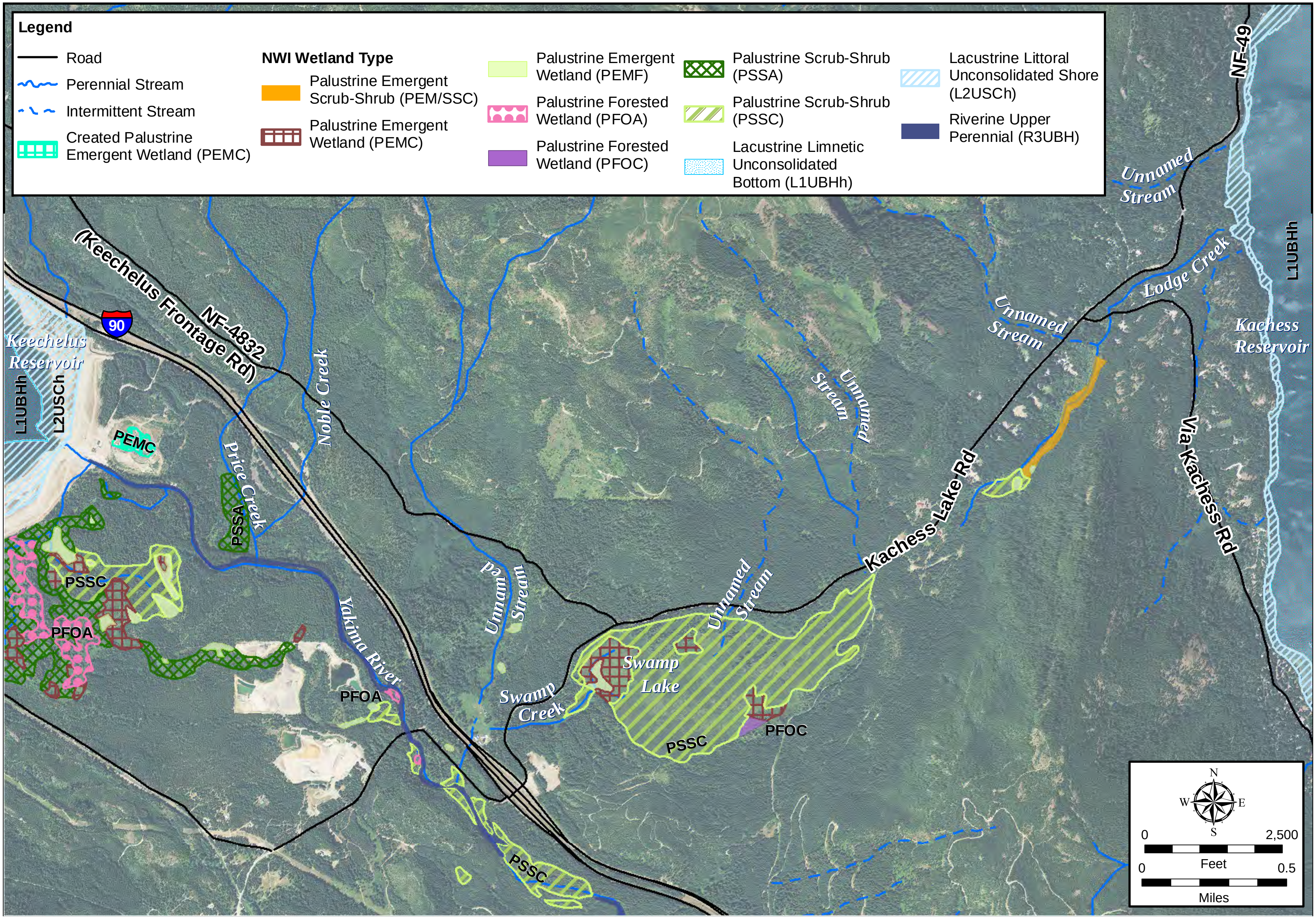

Figure 3-17. Wetlands in the KKC Study Area

3.7.2.2 Keechelus Reservoir

Vegetation

Vegetation along the Keechelus Reservoir shoreline is predominantly wetland vegetation (discussed below). Patches of second-growth coniferous forest occur landward of the reservoir, mainly on the west shoreline. I-90 parallels the east reservoir shoreline and upland vegetation is limited to scattered conifer trees.

Wetlands

Wetlands along the Keechelus Reservoir shoreline near maximum pool elevation 2,517 consists mainly of scattered palustrine wetlands, occurring generally in areas with gently sloping shorelines that allow for the establishment of rooted vegetation (Figure 3-17). The NWI maps approximately 78 acres of palustrine scrub-shrub and 77 acres of palustrine emergent wetlands, distributed primarily along the west shoreline of the reservoir (Service, 2013). Many of these wetlands are dominated by shrub species such as willows. The remainder of Keechelus Reservoir is mapped as a lacustrine wetland feature, although vegetation extends below the lacustrine wetland boundary and may be palustrine wetlands with scrub-shrub or forested vegetation communities.

3.7.2.3 Keechelus Reach of the Yakima River

Vegetation

The Keechelus Reach of the Yakima River is a braided, meandering channel with a relatively intact riparian corridor and minimal development (Kittitas County, 2013). Upland vegetation in the more steeply sloped areas of the Yakima River is comprised of dense second-growth Douglas-fir and grand fir forest.

Wetlands

The NWI maps over 322 acres of freshwater wetlands within the Keechelus Reach of the Yakima River (Figure 3-17) (Service, 2013). Of these, 303 acres are identified as forested/shrub wetland, 13 acres are emergent wetlands, and approximately 6 acres are freshwater pond. Black cottonwood galleries are common in the forested wetlands; other species include willows, a variety of deciduous shrub species, and scattered conifers such as ponderosa pine. Densely vegetated wetlands adjoining the river provide exceptional wetland functions as part of the overall riverine system, including stream shading, sediment and pollutant trapping, floodwater storage, and flood velocity attenuation, as well as a wide range forage opportunities, refugia opportunities, and intact movement corridors for terrestrial animals (Hruby, 2004).

3.7.2.4 Gold Creek and Cold Creek

Vegetation

Riparian vegetation in Gold Creek is primarily forestland with limited rural residential development. Nonwetland riparian vegetation in the riparian corridor consists of dense patches of deciduous shrubs. Cold Creek is located along the Iron Horse Trail, a historical railroad grade abutting the west shoreline of Keechelus Reservoir. Vegetation landward of the reservoir is comprised of second-growth coniferous forest; the riparian corridor waterward of the John Wayne Trail is sparsely vegetated by scattered willows.

Wetlands

The NWI identifies Gold Creek Pond as a 19-acre lacustrine wetland feature (Service, 2013). Although not named in the NWI, Heli's Pond is a 3.5-acre open-water feature located north of Gold Creek Pond (Figure 2-4). Both of these wetland features are former pit sites from late 19^{th} century gold mining (Deichl et al., 2011); both ponds are primarily open-water features. Scrub-shrub vegetation is apparent on segments of both shorelines. A 22-acre freshwater scrub-shrub wetland is mapped just north of I-90 along the Gold Creek floodplain (Service, 2013). At Cold Creek, Keechelus Reservoir is mapped as a lacustrine wetland feature.

3.7.3 KKC Alignments

3.7.3.1 KKC North Tunnel Alignment

The north tunnel alignment would be underground; therefore, it would avoid disturbance of vegetation. No wetlands are mapped along the north tunnel alignment (Figure 3-17).

3.7.3.2 KKC South Tunnel Alignment

Vegetation

The proposed I-90 Exit 62 portal site for the proposed south tunnel alignment is an active WSDOT staging area for ongoing I-90 construction activities. Little to no vegetation is present in this disturbed area. The south tunnel alignment would be underground and would not disturb vegetation.

Wetlands

The NWI identifies one headwater wetland complex—Swamp Lake—along the south tunnel alignment (Figure 3-17) (Service, 2013). Swamp Lake is a densely vegetated 180-acre wetland in the headwaters of the Swamp Creek tributary to the Yakima River. Vegetation along the perimeter of Swamp Lake is comprised mainly of scrub-shrub vegetation including spirea, viburnum, and western crabapple. The interior of the wetland, which appears subject to prolonged or permanent inundation, consists of emergent and aquatic vegetation communities and organic soils. Swamp Lake has high potential to provide hydrologic and water quality functions given its size, landscape position as a headwater wetland, and vegetative and soil composition. The diversity of vegetation strata, plant species composition, and hydrologic regimes also provides optimal habitat function opportunity for a wide range of terrestrial species.

3.7.4 USFS Survey and Manage Vascular Plant Species

As part of the *Northwest Forest Plan* (USFS, 2011c), the Okanogan-Wenatchee National Forest manages vascular plants, nonvascular plants, and fungi identified in the Survey and Manage standards and guidelines. The Survey and Manage standards and guidelines support conservation of rare and little-known flora and fauna species thought to be associated with late successional and old growth forests within the range of the spotted owl. These standards and guidelines are applicable to USFS and Bureau of Land Management (BLM) lands within the geographic boundaries of the Northwest Forest Plan area (western Oregon, Washington, and northern California). Survey and Manage species standards and guidelines require surveys for proposed disturbance within late successional or old growth habitat in the designated *Northwest Forest Plan* area. Some species require preproject surveys and prescribed management actions if found.

The USFS Survey and Manage standards and guidelines list of vascular plant species that have been documented within the Cle Elum Ranger District is provided in Appendix D (USFS, 2001; Lau, 2012; Gardy-Darda, 2014)

3.7.5 State Sensitive Species

Two State sensitive vascular plant species—western ladies tresses and water alwort—have been recorded in the vicinity of Kachess and Keechelus reservoirs in recent years (DNR, 2014a). Western ladies tresses grow along streams, but the mapped location for this species in the Kachess Reservoir basin is over 2 miles from proposed activities along the reservoir. Water alwort is a submerged aquatic plant that occurs near the margins of freshwater lakes and ponds and on streambanks and has been documented in the vicinity of Lake Easton south of Kachess Reservoir (DNR, 2014b). One sensitive nonvascular plant—luminous moss—is documented in the Swamp Lake wetland complex near Kachess Lake Road. This moss occurs on fine-textured mineral soil in shaded pockets of overturned tree roots that are typically adjacent to shallow pools of standing water at the base of the root wad (DNR, 2014b).

3.7.6 Invasive Species

Appendix D lists invasive plant species that are known to occur or may occur in or near the primary study area (Lau, 2012). The table highlights species that are considered to be priority weeds by USFS and that are regulated by Kittitas County.

3.8 Wildlife

The primary study areas have been defined on the basis of actions that could impact wildlife: construction activities, changes in reservoir pool elevations, and downstream changes, as described in Chapter 4. Based on these types of impacts, the primary study area for wildlife and wildlife habitat includes the following areas (see Chapter 2 figures for additional detail):

- The portion of Kachess Reservoir shoreline that would be exposed during drawdown (between elevations 2,262 and 2,110 feet) for KDRPP
- Wildlife habitats within 1 mile of proposed facility construction sites along the Kachess Reservoir shoreline for KDRPP
- Wildlife habitats within 1 mile of proposed facility construction sites for KKC, including the Keechelus portal, Keechelus diversion and intake structures, Kachess portal and discharge, and support facilities
- Wildlife habitat within one-quarter mile of proposed new transmission line
- Wildlife habitat within one-quarter mile of proposed KKC North and KKC South Tunnel alignments
- The Kachess and Yakima rivers within 300 feet of proposed diversion, intake, and discharge outlet structures
- Gold Creek and Cold Creek areas that would be affected by construction

The extended study area is the Yakima River basin, which encompasses Kachess and Keechelus watersheds and all areas of potential downstream effects (Figure 1-1). For wildlife and wildlife habitat, potential downstream effects would most likely occur in the upper portion of the Yakima River watershed.

3.8.1 Kachess and Keechelus Watersheds

The Proposed Action areas occur within the Kachess and Keechelus watersheds, which extend over 81.4 square miles (52,096 acres) and 55.4 square miles (35,456 acres), respectively (Haring, 2001). Wildlife habitats present in these watersheds of the Yakima River basin include coniferous forests, riparian forests (i.e., along rivers and tributary streams), freshwater wetland complexes, open water, and lake fringe. The rain shadow effect of the Cascade Range, along with the rapid change in elevation, creates a wide variety of habitats within a relatively small area, and this leads to high biodiversity of wildlife species (WSDOT, 2008). Forest habitats are used by elk and deer, small mammals, raptors, owls, grouse, and a wide range of songbirds. Riparian areas and wetland complexes are used by many species including bear, ungulates, small mammals, reptiles, amphibians, cavity-nesting birds, raptors, and songbirds. The reservoir and shoreline fringe vegetation are used by multiple waterfowl and shorebird species.

Habitat fragmentation near the reservoirs ranges from moderate to severe because of I-90, transmission lines, and timber harvest. Coniferous forests are the most prevalent habitat type and range from relatively recent clearcuts, to single-species even-aged stands, and mature or old growth forest. Fire suppression has created overly dense stands, while logging practices have removed the largest, oldest trees.

The Proposed Action is located in an important north-south migratory corridor for terrestrial wildlife and overall ecological connectivity in the Cascade Range. Landscape connectivity analyses conducted for various Federal land management plans, including the *Northwest Forest Plan*, have identified the area surrounding the Keechelus and Kachess reservoirs as a critical connectivity zone for wildlife moving between the North and South Cascades (Singleton and Lehmkuhl, 2000). I-90 in this location forms a barrier to wildlife movement, is a source of mortality for deer and elk, and reduces habitat quality in adjacent areas.

Within the extended study area, the I-90 Snoqualmie Pass East Project currently under construction includes 14 wildlife crossings along the portion of I-90 east of Keechelus Reservoir and south of the Kachess Reservoir. These crossings, referred to as connectivity emphasis areas (CEAs), would both connect stream, wetland, and forest habitats and allow safe north-south movement of wildlife (WSDOT, 2008). Preconstruction wildlife monitoring targeted at high-mobility mammals, pikas, amphibians, reptiles, and fish is under way to document the occurrence of a wide variety of species (Long et al., 2012). The CEAs would be constructed as various phases of the I-90 project are completed. A map of CEA locations to be constructed during each phase can be found at WSDOT's I-90 project webpage: http://www.wsdot.wa.gov/Projects/I90/SnoqualmiePassEast/library.htm

Selected sites within the primary study area were visited in August 2014 to document general characteristics of wildlife habitat. Sites visited included the proposed east shore and south pumping plant sites and Kachess Lake Campground on Kachess Reservoir, the Kachess portals and discharge structure sites, and the KKC facility sites near Keechelus Dam. Reclamation has not conducted formal wildlife surveys for this DEIS.

3.8.2 Kachess Reservoir Area

Kachess Reservoir is surrounded by a densely forested watershed with limited residential development. Although the forest has been logged, it provides wildlife habitat and is contiguous with large areas of unaltered habitat. Coniferous forests adjacent to the reservoir vary in age and are characterized by a multistoried canopy, marginally developed understory, downed logs, and a thick organic duff layer. These forests provide snags for roosting bats and cavity-nesting birds such as nuthatches, chickadees, and woodpeckers. Downed wood and multistory vegetation under closed canopies provide cover for breeding salamanders, such as the Larch Mountain salamander; songbirds; and small mammals, like the yellow-pine chipmunk and western red-backed vole (Kittitas County, 2013). Regenerating shrub and seedling areas supply important habitat for rodents and reptiles, such as the American pika and meadow vole (Sallabanks et al., 2000).

Most of the area immediately east of Kachess Reservoir is mapped as critical habitat for northern spotted owl (discussed in Section 3.9). This area is also mapped as elk and mountain goat wintering range. Priority cliff and bluffs are located at the northeast end of the reservoir, elk winter concentration area is mapped east of the reservoir, and mountain goat winter range is located at the south end of the reservoir. State priority species documented in the area are described below in Section 3.8.5.

Steep topography and fluctuating water levels in the reservoir limit emergent wetland or riparian habitats along the shoreline (Section 3.7.1.2). Waterfowl and shorebirds use the largely unvegetated shoreline for foraging and resting.

Wildlife habitat at the proposed pumping plant site on the east shore of Kachess Reservoir is limited by reservoir fluctuations and lack of vegetation, although some second-growth mixed coniferous and deciduous forest is present in part of the proposed pumping plant area. Habitat at the proposed south pumping plant site and at the Kachess River discharge is of higher quality because it contains mature coniferous trees that comprise a multistoried canopy with a well-developed understory (see Figure 3-18).

Figure 3-18. Conifer Habitat at KKDRP Kachess River Discharge

Migratory corridors adjacent to the reservoir are relatively intact. Logging roads disrupt connectivity throughout the watershed and the Kachess Dam Road separates shoreline habitats from upland conifer habitats near the proposed pumping plant on the east shore of Kachess Reservoir. Connectivity between habitats near the proposed south pumping plant is disrupted by Sparks Road and I-90 to the south, and a small area residential development.

The anticipated transmission line route for the KDRPP alternatives would follow existing distribution systems and roads. Because the existing distribution system corridors must be maintained for electrical clearance and access, no forested habitat is present in these areas. However, coniferous forests and shrub-dominated areas adjacent to the corridor provide wildlife habitat in the immediate vicinity of the proposed transmission line construction area.

At the Kachess portal for KKC, wildlife habitat includes coniferous forest connected to open water and fringe wetland habitats of the reservoir. This habitat is likely used by a high number of songbird species and small mammals.

3.8.3 Keechelus Reservoir Area

The Keechelus Reservoir area is similar to the Kachess Reservoir area in being surrounded by coniferous forests of various ages. However, the majority of the east shoreline of Keechelus Reservoir is traversed by I-90, which impacts habitat connectivity and wildlife movement. Some mature forest is present at the south end of the reservoir near I-90 (WSDOT, 2008). As noted in Section 3.8.1, WSDOT plans to construct CEAs at several locations along Keechelus Reservoir to restore migratory corridors. CEAs are planned along Keechelus Reservoir at stream crossings for Gold, Rocky Run, Wolf, Resort, Townsend, and Price and Noble creeks.

Wildlife habitat near Keechelus Dam includes disturbed, unvegetated areas associated with an old borrow pit and dam operations, limited areas of deciduous and coniferous forest, and the constructed wetland mitigation site. The wetland mitigation site is likely used by a variety of songbirds, amphibians, and small mammals and is well connected to adjacent coniferous forest habitats.

The reservoir shoreline supports some emergent and scrub-shrub wetlands, which provide habitat for migratory waterfowl and shorebirds; however, these areas are impacted by fluctuating water levels. Western toads, a State candidate species and Federal species of concern, may opportunistically use seasonal wetlands and pools in the large delta exposed during the summer low pool of Keechelus Reservoir (WSDOT, 2008).

The Gold Creek and Cold Creek tributaries to the Keechelus Reservoir, which would be enhanced as part of the BTE, provide freshwater and riparian wildlife habitat. Gold Creek supports riparian and wetland habitats adjacent to second-growth coniferous forest. Gold Creek Pond is a 19-acre freshwater wetland that supports habitat for waterfowl and wetland-dependent birds, amphibians, and small mammals. Both streams are well connected to adjacent coniferous forests, although Gold Creek's proximity to I-90 makes it potentially less suitable for some wildlife species.

3.8.4 KKC Alignments

Wildlife habitats for the KKC portal locations are described in Sections 3.8.2 and 3.8.3 with the exception of the I-90 portal proposed as part of the north tunnel alignment. The I-90 portal site is an active WSDOT staging area for ongoing I-90 construction activities. Currently little to no wildlife habitat is present, a condition to be expected given past clearing and current levels of human activity and noise (see Figure 3-19 below). Wildlife habitats including coniferous forest and portions of the Swamp Lake wetland complex are located adjacent to the portal area.

Figure 3-19. Active WSDOT Staging Area with Adjacent Wildlife Habitats at I-90 Portal Location

Wildlife habitats along the KKC tunnel routes include coniferous forest and wetlands. Coniferous forests along the tunnel alignment are important for migratory and resident wildlife such as bear, deer, and elk. Among the federally listed species using habitats in the vicinity are northern spotted owl, gray wolf, Canada lynx, grizzly bear, and cougar (see Section 3.9). The Swamp Lake wetland complex located along the north tunnel alignment provides substantial and diverse wetland habitats for deer, heron, waterfowl, small mammals, reptiles, amphibians, cavity-nesting birds, raptors, and songbirds (see Section 3.8).

3.8.5 State Species of Concern

WDFW (2014a) priority species with documented occurrences in the vicinity of Kachess and Keechelus reservoirs are listed in Appendix D. Other State priority species, such as white-headed woodpecker and common loon, are likely to occur in the suitable habitat that is present. The WDFW priority habitats in the primary study area include cliffs; bluffs; riparian areas; wetlands; and elk, white-tailed deer, and mountain goat habitat (WDFW, 2014a).

Section 3.9 discusses the gray wolf, grizzly bear, and northern spotted owl in greater detail. The Service lists these species as federally threatened or endangered under the ESA.

3.9 Federal Threatened and Endangered Species

The primary study areas have been defined on the basis of actions that could impact threatened and endangered species: construction activities, changes in reservoir pool elevations, and downstream changes, as described in Chapter 4.

Based on these types of impacts, the primary study area for threatened and endangered species includes the following areas (see Chapter 2 figures for additional detail):

1. Kachess Reservoir banks between elevations 2,262 (maximum pool) and 2,110 (proposed operational minimum)
2. Terrestrial habitat within 1 mile of proposed facility construction along the Kachess Reservoir shoreline
3. All tributaries currently accessible to listed fish species that discharge into Kachess Reservoir (Kachess and Mineral Creek and Box Canyon Creek)
4. Keechelus Reservoir and all tributaries currently accessible to listed fish species that discharge into Keechelus Reservoir (Cold and Gold creeks)
5. Terrestrial habitat within 1 mile of proposed facility construction for KKC including the Keechelus portal, Keechelus diversion and intake structures, Kachess portal and discharge, and support facilities
6. The Kachess and Yakima rivers within 300 feet of proposed diversion, intake, and discharge outlet structures
7. Terrestrial habitat within 1 mile of transmission line construction
8. Terrestrial habitat within one-quarter mile of KKC North and KKC South Tunnel alignments

The extended study area is the Yakima River basin, which encompasses all areas of potential downstream effects (Figure 1-1). For threatened and endangered species, the potential extent of downstream effects would occur primarily to listed fish species that occur in the mainstem Yakima River from the existing Kachess and Keechelus outlet works downstream to the Wapato Irrigation Diversion just upstream of Sunnyside Dam in Parker, Washington, which is the lowermost point in the Yakima basin where water regime influences would be experienced (Figure 1-1).

3.9.1 Regulatory Setting

The Endangered Species Act (ESA) is described in Section 1.9 Summary of Applicable Federal Regulations. As described in Section 5.5, Compliance with Federal and State Laws and Executive Orders, Reclamation is complying with the ESA and will initiate consultation with the Service and NMFS.

3.9.2 Listed Species and Critical Habitat

Federally listed species are included in Table 3-20; the table includes species with designated or proposed critical habitat in the extended study area. The Federal species lists were obtained from the Service and NMFS in May 2014.

Table 3-20. Species Federally Listed or Proposed for Listing that Potentially Occur in the Primary Study Areas and Extended Study Area

Species	Federal Status[1]	Anticipated Occurrence in Primary Study Area (1-8)[2]	Anticipated Occurrence in Extended Study Area[2]	Critical Habitat in Primary Study Area/Extended Study Area?
Bull trout—Columbia River DPS	T	1,3,4,6	Yes	1,3,4,6/Yes
Steelhead—Middle Columbia River DPS	T	6	Yes	6/Yes
Northern spotted owl	T	2,5,7, and 8	No	2,5,7,8/No
Gray wolf	E	No	No	None
Grizzly bear	T	No	No	None
Canada lynx	T	No	No	None
Marbled murrelet	T	No	No	None
Yellow-billed cuckoo	T	No	No	None

[1]E = Endangered; T = Threatened
[2]Primary study areas and extended study area as identified in Section 3.9.

All species listed in Table 3-20 could be affected by the KDRPP, KKC, and BTE whether positively or negatively. For example, bull trout populations that occur above the reservoirs have been trending downward as a result of low numbers and inability to interact with populations outside the reservoirs (that is, the populations are genetically isolated). Steelhead numbers in the

Yakima basin, particularly in the upper Yakima River, are also extremely low primarily because of habitat loss and migration barriers throughout the system. Northern spotted owl populations are low primarily as a result of timber harvest throughout their range, but also because of increased competition from the barred owl, whose range has expanded into that of the northern spotted owl over the last several decades. The barred owl preys on the northern spotted owl, adapts more readily to human disturbance, and enjoys greater reproductive success.

3.9.3 Bull Trout

In June 1998, the Service listed the Columbia River Basin distinct population segment (DPS) of bull trout as threatened under the ESA (63 Federal Register [FR] 31647). The Service at that time identified eight small subpopulations in the Yakima River basin, including the isolated populations in Keechelus and Kachess reservoirs. Bull trout require cold, clear water with stable channels and adequate cover (Thurow, 1987; Ziller, 1992).

In October 2004 the Service designated a wide area of bull trout critical habitat: 1,748 miles of stream habitat and 61,235 acres of lakes and marshes within the Klamath and Columbia River basins (69 FR 59995). For the Middle Columbia River Basin (Critical Habitat Unit 20), critical habitat designations were listed for 269 stream miles, all within the Yakima River basin. In September 2005, the Service issued a revised final designation for bull trout critical habitat and reduced the amount of critical habitat designated in the Middle Columbia River Basin to 188 stream miles (70 FR 56212). In response to a lawsuit, the Service voluntarily remanded the 2005 final rule, and on October 18, 2010, issued the final rule for the revised critical habitat designation for bull trout in the coterminous United States (75 FR 36897). The 2010 listing identifies the Yakima River as a critical habitat unit, with 557.3 stream miles and 15,530.9 acres of lakes and reservoirs designated as critical habitat. The mainstem Yakima, Kachess and Cle Elum rivers below their respective reservoirs as well as key tributaries to the upper Yakima basin reservoirs are included in the designation. Reservoir tributaries designated as critical habitat include Cold and Gold creeks (Keechelus); and Box Canyon and Mineral creeks and Kachess River (Kachess).

Bull trout occurred historically throughout most of the Yakima River basin. Today, however, they are fragmented into relatively isolated populations (Table 3-21). Although bull trout were probably never as abundant as other salmonids in the basin, due in part to their requirements for cold clear water, they were likely more abundant and more widely distributed than they are today (WDFW, 1998).

Table 3-21. Yakima Basin Bull Trout Stocks Recognized by WDFW
(Definitions for status classifications appear below table)

Stock	Life History Form	Status	Comments
Keechelus Lake	Adfluvial	Critical	Chronically low redd counts
Kachess Lake	Adfluvial	Critical	Chronically low redd counts
Cle Elum/Waptus Lakes	Adfluvial	Unknown	
Bumping Lake	Adfluvial	Depressed	Short-term severe population declines
Rimrock Lake	Adfluvial	Healthy	
N. Fork Teanaway River	Fluvial/Resident	Critical	Chronically low redd counts
Naches River	Fluvial/Resident	Critical	Chronically low redd counts
Yakima River[1]	Fluvial	Critical	Chronically low redd counts
Ahtanum Creek	Resident	Critical	Chronically low redd counts

[1]Stock not recognized by the Service as a subpopulation in final listing rule
Source: WDFW, 1998

The WDFW status ratings shown on Table 3-21 are:

- Critical – A stock of fish experiencing production levels that are so low that permanent damage to the stock is likely or has already occurred.
- Depressed – A stock of fish whose production is below expected levels based on available habitat and natural variations in survival rates, but above the level where permanent damage to the stock is likely.
- Healthy – A stock of fish experiencing production levels consistent with its available habitat and within the natural variations in survival for the stock.
- Unknown – There is insufficient information to rate stock status.

Stock

The fish spawning in a particular lake or stream(s) (or portion of it) at a particular season, which to a substantial degree, do not interbreed with any group spawning in a different place, or in the same place at a different season.

Additional data have been collected in the Yakima River basin since the *Draft Bull Trout Recovery Plan* (Service, 2002) and the *5-Year Status Review* (Service, 2005b) were compiled. The new data include population surveys (snorkel and electrofishing surveys), redd counts, dam counts, and radio-telemetry studies. A juvenile bull trout was captured by Yakama Nation fisheries personnel in a tributary to Cowiche Creek in 2002 (Reiss et al., 2012) and 13 bull trout were observed in the North Fork Tieton River during a comprehensive snorkel census in 2004. During redd surveys in the North Fork Tieton River in 2007 and 2008, field staff observed 39 bull trout redds in 2007 and 28 bull trout redds in 2008. Three adult bull trout were also observed, suggesting the presence of a local population in this area of the Yakima River basin.

Terms for population units are hierarchical, allowing recovery efforts to be focused at various spatial scales. The terms "local population" and "subpopulation" are used frequently in the following text; therefore, some explanation of the terms is warranted. Bull trout populations are analyzed by the Service on a subpopulation level because fragmentation and barriers have isolated bull trout throughout their range. A subpopulation is considered a reproductively isolated group of bull trout that spawns within a particular area of a stream. One to several local populations may comprise a subpopulation. Unless site specific surveys indicate spatial, temporal, or genetic isolation, a local population would be considered the smallest group of fish that is known to represent an interacting reproductive unit (Lohr et al., 2000).

Based on this newer bull trout population data, the Service and the WDFW have concluded that 16 local populations reside in the 2002 Draft Recovery Plan's Yakima Core Area (i.e., the Yakima River), which is included as the Middle Columbia River Recovery Unit for bull trout (Service, 2002). In addition, the Service has identified two areas as high priority for establishment of new local populations: the Taneum Creek drainage west of Ellensburg and the Little Naches River in the Naches basin. These local populations are listed below in Table 3-22.

Bull trout have been observed in each of the 16 tributaries listed in Table 3-22, and the Service Recovery Team believes that information exists to identify them all as local populations (Service, 2008). More detailed descriptions of tributaries and habitat used in these streams are available in the *Proposed and Final Bull Trout Critical Habitat Rules* (67 FR 71235; 69 FR 59995; 70 FR 56212) and the *Draft Bull Trout Recovery Plan* (Service, 2002). The potential local populations noted in Table 3-22 were identified as such, despite the absence of documented sightings, because habitat and temperature data indicate that high quality bull trout habitat is available and because the need for reestablishment is high (Service, 2008).

Three bull trout life history forms exist in the Yakima River basin (Table 3-22): adfluvial (migrate to lakes), fluvial (migrate to rivers), and resident. Young of the adfluvial and fluvial forms live in their birth streams for 1 to 4 years before migrating downstream into lakes or mainstem river systems. Adults then migrate back into tributary streams to spawn, after which they return to the lake or river. Individuals of the resident form live in a particular stream for their entire life cycle.

Table 3-22. Bull Trout Local Populations and Primary Life History Types within the Yakima Core Area

Local Population	Life History Type(s)
Mainstem Yakima (Including mainstem: Keechelus-Easton reach)	Migratory Fluvial
Ahtanum Creek (Including North Fork, Middle Fork, South Fork)	Resident/Fluvial
Rattlesnake Creek (Including Rattlesnake mainstem, Lower Wildcat, Shellneck Creek)	Migratory Fluvial
South Fork Tieton (Including South Fork, Bear Creek)	Migratory Adfluvial
North Fork Tieton (Including North Fork Tieton above Tieton Dam, and unnamed tributary)	Migratory Adfluvial
Indian Creek (Including mainstem Indian Creek)	Migratory Adfluvial
Bumping River (Including Bumping River mainstem above dam)	Migratory Adfluvial/Fluvial
Deep Creek (Including Deep Creek)	Migratory Adfluvial
American River(Including Union Creek and Kettle Creek)	Migratory Fluvial
Crow Creek (Including Crow Creek mainstem)	Migratory Fluvial
Teanaway River (Including North Fork and Deroux Creek)	Migratory Fluvial
Cle Elum River (Including Cle Elum mainstem and Cooper River)	Migratory Adfluvial/Fluvial
Waptus River (Including Waptus River mainstem)	Migratory Adfluvial
Kachess River (Including upper Kachess River and Mineral Creek)	Migratory Adfluvial
Box Canyon (Including Box Canyon Creek)	Migratory Adfluvial
Gold Creek (Including Gold Creek)	Migratory Adfluvial
Potential Local Populations	**Life History Type(s)**
Taneum Creek (Including upper Taneum and Forks)	Resident/Fluvial
Little Naches (Including Little Naches River)	Migratory Fluvial

Source: Service, 2008

Redd numbers have varied to a large degree since listing. Natural variability in fish population numbers can exceed 100 percent from year to year and other factors such as streamflow, weather patterns, and partial barriers (e.g., beaver dams) or complete barriers (e.g., dewatered reaches) may redistribute spawning bull trout. Bull trout are particularly susceptible to these factors because they spawn in the late fall when spawning streams are typically at or near seasonal low flow. Trends in bull trout populations were estimated on the basis of partial count data. Given the limited amount of scientific data available, this approach was determined to be the most accurate and reliable method. The Yakima Core Area Status Assessment Template (Service, 2005a) rated redd data quality and quantity in the Yakima basin as high despite several cautions in the literature about reliability, repeatability, and observer error in redd counts (Dunham et al., 2001; Maxell, 1999).

The upper Yakima River basin stocks consist of the Yakima River, Kachess Reservoir, Keechelus Reservoir, Teanaway River, and Cle Elum River subpopulations (Service, 2002). Figure 3-20 shows the current bull trout distribution and confirmed spawning areas in the upper

Yakima River basin. This map provides the most up-to-date information on bull trout usage of the upper Yakima River system.

Bull trout spawn in late summer and early fall and most spawning activity in the Yakima basin, occurs from early September through early October. However, spawning may occur as early as late August (Deep Creek in the Bumping system) or as late as early November (Kachess River-Mineral Creek in the Kachess system) (Reclamation, 2005c). For the migratory life history form, the spawning migration can begin as early as mid-July (Gold Creek in the Keechelus system) when adults move upstream to hold in deep pools, or it may occur just prior to spawning (Indian Creek in the Rimrock Lake system) (James, 2002).

The primary downstream migration period for juvenile bull trout from their natal tributaries into lakes or rivers occurs from June through November. The early summer migration appears to occur in response to increased flows and may correspond with a switch in prey from invertebrates to fish, whereas the fall migration appears to be primarily in response to decreasing water temperatures and the need for suitable overwintering habitat (Fraley and Shepard, 1989; Murdoch, 2002).

Relatively limited data exist on juvenile movement patterns downstream from lakes and reservoirs, or upstream into lakes or reservoirs from fluvial systems. Such movements are likely triggered by shifts in food resources, temperature regimes, overwintering habitat, or spawning activity or by entrainment through dams, in which case the fish may be lost to the system if upstream passage is not provided.

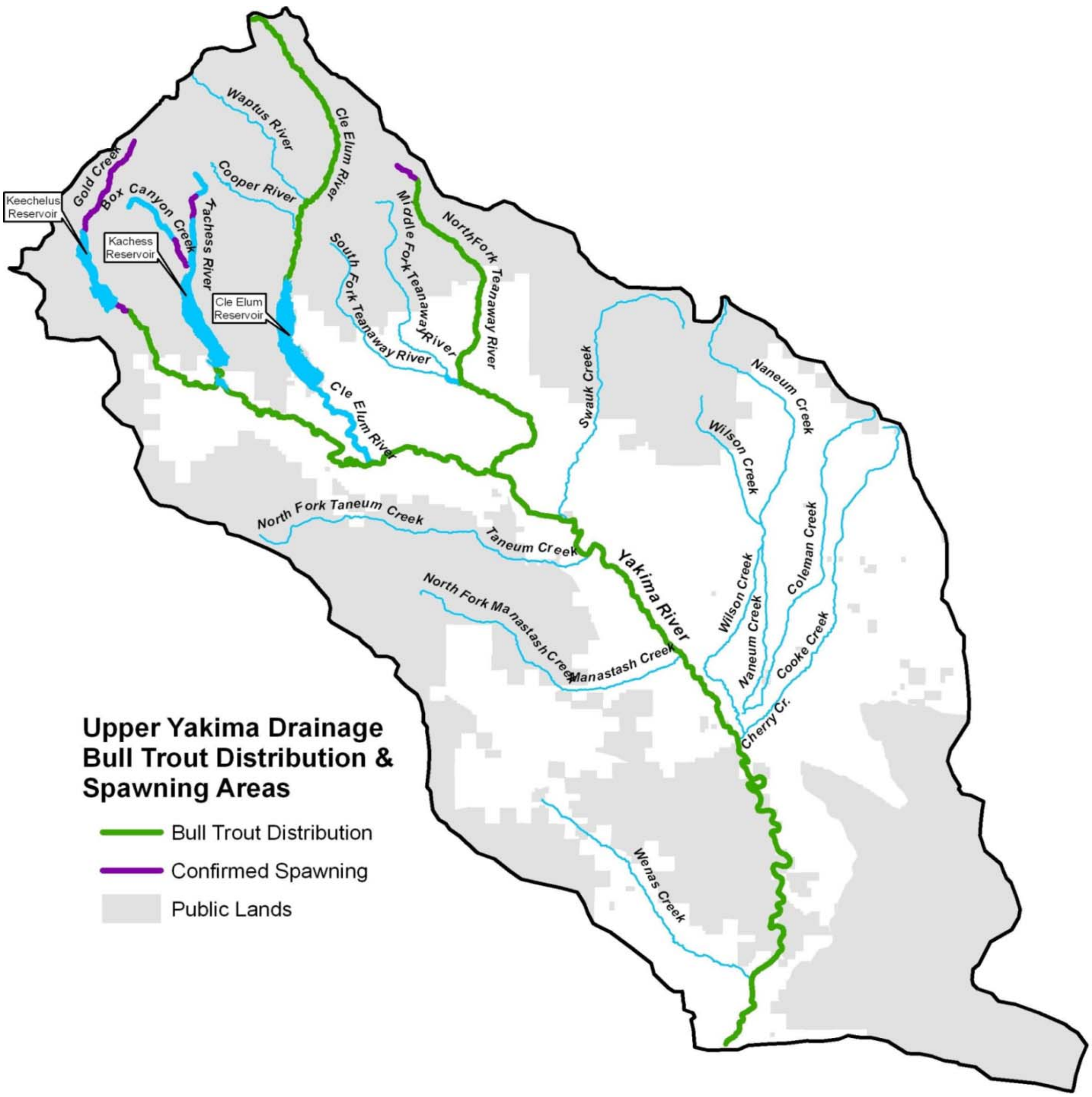

Figure 3-20. Upper Yakima River Drainage Bull Trout Distribution and Spawning Areas

3.9.3.1 Kachess Reservoir Subpopulation

Bull trout enter their spawning streams from July to early October and spawn from mid-September through mid-October in this subpopulation (WDFW, 1998; USFS, 2004). The timing of adult migration into this stream system is approximately 2 months later than average for the basin and the timing of spawning is a full month later than average dates (Meyer, 2002). WDFW (1998; Table 3-22) lists the Kachess Reservoir adfluvial population as critical. Only limited spawning habitat is available to adult bull trout in the two major tributaries (Kachess River and Mineral Creek and Box Canyon Creek) due to impassible barriers and predominance of large substrate material.

During surveys conducted between 1984 and 2012, an average of 10 redds was observed in Box Canyon Creek and in Kachess River. The maximum number of redds observed during this period was 31 in Box Canyon Creek and 33 in Kachess River, and the minimum was 0 in each tributary, which occurred in several different years (Reiss et al., 2012).

3.9.3.2 Keechelus Reservoir Subpopulation

An adfluvial bull trout population is found in Keechelus Reservoir (WDFW, 1998). This subpopulation consists of one local population that spawns and rears in Gold Creek. Currently, these bull trout have an adfluvial life history. Access has been cut off by Keechelus Dam. Some fish are likely entrained and lost below the dam and cannot make it back to Gold Creek or the upper Keechelus basin, and they may develop into fluvial fish. This population is close in distance to the Kachess and Box Canyon populations. WDFW (1998; Table 3-22) listed the Keechelus Reservoir bull trout population as critical because of low population size and chronically low redd counts. MacDonald et al. (1996) concluded that isolation and low numbers threaten the Keechelus Reservoir bull trout population.

In field surveys conducted between 1984 and 2012, 18 redds were observed in Gold Creek with a range of 2 to 51 (Reiss et al., 2012).

3.9.3.3 Yakima River Subpopulation

At the time of listing, the Service (1998) found no evidence that a subpopulation of bull trout remained in the mainstem Yakima River. The WDFW (1998), however, did recognize a mainstem Yakima stock. Until recently, the justification for such recognition was weak. Old catch records and anecdotal accounts indicated the species was present in the mainstem historically but bull trout had rarely been encountered in the recent past and no spawning activity had been observed. Through 1998, after 8 years of intensive electrofishing surveys, only four bull trout were captured in the mainstem upper Yakima River. Three of these fish were caught near Cle Elum and one near Ellensburg. (These surveys were conducted as part of the Yakima Species Interaction Study, a cooperative effort between WDFW and the Yakama Nation under the umbrella of the Yakima-Klickitat Fisheries Project.) Other bull trout sightings included an adult bull trout illegally caught in 1996 by an angler in Lake Easton about 11 miles below Keechelus Dam.

Based on more recent information gathered, the Service has indicated that stock (subpopulation) status may be justified. For example, during spring Chinook brood stock collection at Roza Diversion Dam (RM 127.9) in 1999, Yakama Nation fisheries personnel captured and released several bull trout that had ascended the fish ladder into the collection facility. Bull trout were also captured at the facility in subsequent years—two each in 2000 and 2001, five in 2002, and two in 2003 (Johnston, 2006). One to three bull trout continue to be caught annually in the Roza Dam adult trapping facility, although exact numbers have not been recorded at this site every year (Thomas, 2009). A large subadult bull trout was captured at Roza Dam and radio-tagged by WDFW in 2004. As of 2009, the Yakama Nation reported that the most recent bull trout sightings at the Roza facility occurred in January 2006 and in April 2008 (Bosch, 2009). All bull trout captured at the Roza facility, other than the fish captured in January 2006, were observed in the spring (April to June) and all were in the size range of 200 to 300 mm (8 to 12 inches).

Bull trout spawning activity was observed in the upper Yakima River during a redd survey of the reach between Keechelus Dam and the Easton Diversion Dam in mid-September 2000. The Service and WDFW biologists found two bull trout redds and four live adults; another redd was found the following year a dead adult (Anderson, 2006). Intensive monitoring efforts in fall 2002 and 2003 did not reveal any redds in this area. Incomplete surveys in 2004, 2005, and 2007 also failed to document any bull trout spawning activity in the mainstem upper Yakima River. In 2006, the Service observed several large adfluvial bull trout in the upper Yakima River in the areas above Cabin Creek. Bull trout redds continue to occasionally be located in the upper mainstem in the Keechelus to Easton reach between the Cabin Creek wetlands and the outlet of Keechelus Dam. A large gravid female was captured and radio-tagged at the base of Kachess Dam in 2005. Some of the fish that have been observed in the upper Yakima River may have been entrained over dams and unable to return to upstream spawning areas, and now spawn or attempt to spawn in the upper Yakima mainstem.

Although it is not clear what life history forms are present in the mainstem Yakima River, fish biologists assume that fluvial bull trout are present since they exist in the Naches subbasin and local movement between the Naches River and Yakima River is known to occur. During a telemetry study conducted by the WDFW, a few bull trout tagged in the Naches River were tracked into the mainstem Yakima River. These individuals used the mainstem Yakima between Ahtanum Creek and Wenas Creek for brief periods before migrating back to the Naches River. It is also reasonable to assume that the adfluvial life history form is present in Lake Easton, although no current data exist to assess this assumption.

3.9.4 Middle Columbia River Steelhead

The steelhead population in the Yakima River basin is a component of the Middle Columbia River (MCR) DPS steelhead that was listed as threatened in 1999 (64 FR 14517). Four genetically distinct spawning populations of wild steelhead have been identified in the Yakima River basin, one of which spawns in the upper Yakima River and its tributaries (Phelps et al., 2000). Critical habitat designated for the MCR steelhead includes the Yakima River downstream of Keechelus Dam as well as the Kachess River downstream of Kachess Dam (70 FR 52630-52858). The MCR steelhead population size is substantially lower than historical levels, and at least two extinctions are known to have occurred in the DPS. Early surveyors and visitors to the Yakima basin reported a robust and widespread steelhead population (Bryant and Parkhurst, 1950; Davidson, 1953; Fulton, 1970; NPCC, 1986; McIntosh et al., 1990).

Currently, no steelhead occur upstream of Kachess or Keechelus dams. However, if passage is provided in the future, both reservoirs offer habitat suitable for steelhead (see Section 3.6.1 for reservoir tributary information).

Generally, adult steelhead migration into the Yakima River basin begins in late summer and peaks in late October and again from late February or early March following a relatively inactive period during the coldest winter water temperatures. The run is dominated by wild fish, since hatchery releases ceased after 1993 (NPCC, 2001).

Typically, steelhead spawn earlier in the warmer water of lower-elevation areas than in the colder water of higher-elevation areas. Overall, most spawning occurs between March and May (Hockersmith et al., 1995), although WDFW personnel have observed steelhead spawning as late as July in the Teanaway River (RM 176.1), a tributary to the upper Yakima River. Most spawning occurs in complex multichannel reaches with a moderate gradient of about 1 to 4 percent (Berg and Fast, 2001).

Juvenile steelhead emerge from the gravel between June and August and rear in the areas near where they were spawned for 1 to 4 years before migrating to the sea. Juvenile steelhead utilize tributary and mainstem reaches throughout the Yakima River basin as rearing habitat, seeking faster and deeper water as they grow. Some downstream movement begins in November, but the peak of the smolt outmigration occurs between mid-April and May (Reclamation, 2008c).

Only a small percentage of steelhead that enter the Yakima basin each year migrate to habitat areas in the upper Yakima River upstream of Roza Dam (RM 127.9) (Hockersmith et al., 1995). Migration occurs during September through May and peaks in the months of March and April (YKFP, 2011; Figure 3-21). During the most recent 10-year period (2004 to 2013), an average of 233 wild steelhead passed over Roza Dam (Columbia River DART, 2014). More recent data on steelhead abundance and distribution within the Yakima basin indicate that only between 3.8 and 9.2 percent of all steelhead entering the Yakima basin migrated into the upper Yakima River above Roza Dam between 2001 and 2014 (Table 3-23).

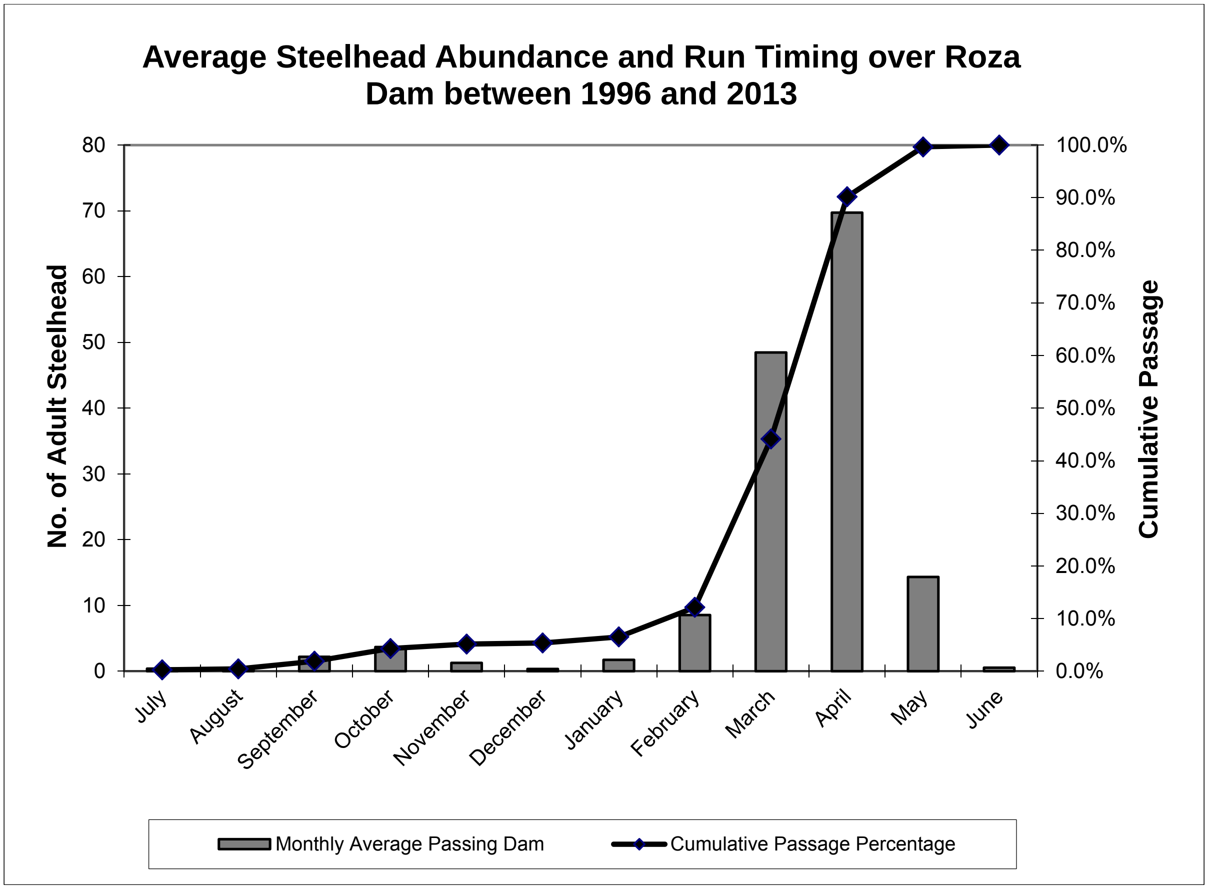

Figure 3-21. Average Steelhead Abundance by Month and Cumulative Passage Timing of Steelhead Passing Roza Dam between 1996 and 2013

Source: YKFP, 2011

Table 3-23. Passage of Steelhead at Prosser Dam (RM 47.1) and Roza Dam (RM 127.9) for brood years 2000-2014

Brood Year	Number of Steelhead Passing Prosser Dam	Number of Steelhead Passing Roza Dam	Percent of Total Run Above Roza Dam
2000-2001	3,089	139	4.5
2001-2002	4,525	236	5.2
2002-2003	2,235	133	5.9
2003-2004	2,755	209	7.5
2004-2005	3,425	227	6.6
2005-2006	2,005	123	6.1
2006-2007	1,540	59	3.8
2007-2008	3,310	169	5.1
2008-2009	3,450	204	5.9
2009-2010	6,793	326	8.6
2010-2011	6,196	346	5.6
2011-2012	6,362	361	6.5
2012-2013	4,788	305	6.4
2013-2014	4,106	376	9.2

Studies conducted by Reclamation and the Yakama Nation between 2002 and 2006 indicate that steelhead are migrating to and spawning in the Yakima River mainstem as well as in several major tributary systems of the upper Yakima River (Reclamation, 2009). Between 2002 and 2006, the Yakama Nation tagged 351 wild adult steelhead with radio tags. The steelhead were subsequently tracked to their presumed spawning location within the upper Yakima basin (Reclamation, 2009). Of these, most (98.3 percent) moved upstream following release, and 62 percent of those fish moved into tributaries to spawn. Upper Yakima River steelhead primarily migrated into the Teanaway River, Swauk Creek and Taneum Creek watersheds, and the mainstem Yakima River between Roza Pool and Easton Dam during the spawning season. The lower Cle Elum River, Umtanum Creek, Naches River, and Wilson-Cherry Creek watersheds were used less frequently by radio-tagged steelhead.

3.9.5 Northern Spotted Owl

The Service listed the northern spotted owl as a threatened species in 1990, primarily because of widespread habitat loss and inadequate protective mechanisms. The State lists it as endangered because of its sharp statewide decline in recent years. Spotted owls generally rely on older forested habitats because such forests contain the structures and characteristics required for nesting, roosting, and foraging. Features that support nesting and roosting typically include a moderate-to-high canopy closure (60 to 90 percent); a multilayered, multispecies canopy with large overstory trees (with diameter at breast height greater than 30 inches); a high incidence of large trees with various deformities (large cavities, broken tops, mistletoe infections, and other evidence of decay); large snags; large accumulations of fallen trees and other woody debris on the ground; and sufficient open space below the canopy for the birds to fly (Thomas et al., 1990). Forested stands with high canopy closure also provide thermal cover (Weathers et al., 2001) and protection from predators. Spotted owls forage on wood rats, mice, bats, and occasionally small birds, moths, crickets, and large beetles.

In 2011, the Service (2011) released the *Revised Recovery Plan for the Northern Spotted Owl*. The 2011 plan retains elements of the 2008 plan, including a strategy to assess and address threats from barred owls and support for forest restoration techniques. The previous recovery plan was remanded in 2008 because of a court challenge and investigation. The previous plan established a network of managed owl conservation areas (MOCAs) across the range of the northern spotted owl. However, based on scientific peer review comments on the recovery plan, the Service is not incorporating the previously recommended MOCA network or Conservation Support Areas and critical habitat designations into the revised recovery plan. The revised recovery plan states that in the interim, Federal land managers should continue to implement the standards and guidelines of the Northwest Forest Plan as well as to fully consider other recommendations in the *Revised Recovery Plan* (Service, 2011). Critical habitat designations were updated by the Service to address new threats and to incorporate emerging science regarding habitat management in fire-prone areas as part of a rulemaking process and was published on December 4, 2012 (Service, 2012). Critical habitat designation includes the majority of forested habitats on the west and north side of the Keechelus and Kachess reservoirs and portions of forested habitat along the east and south shorelines (Service, 2014).

Suitable habitat for northern spotted owls is likely to be present along the I-90 corridor but too fragmented to support nesting. The closest active nest site to Keechelus Reservoir is located on the northwest side of the reservoir approximately 5.25 miles from the KKC tunnel alignments (USFS, 2014). The closest nest site to proposed activities at Kachess Reservoir is approximately 500 feet east of the proposed KDRPP east shore pumping plant (USFS, 2014). Dispersal habitat (which allows northern spotted owls to move across the landscape to establish new territories) is present, particularly in the vicinity of Gold Creek, Swamp Lake, and Crystal Springs.

3.9.6 Other Listed Species

The following sections briefly describe other federally listed species that may occur in the terrestrial habitats of the primary study area, but are not likely to be affected by the action alternatives. Wolves, grizzly bear, and Canada lynx may occur in the primary study area on a transient basis; no breeding populations are known to occur in these areas. No suitable habitat for marbled murrelet exists in the primary study area.

3.9.6.1 Gray Wolf

The gray wolf is a Federal endangered and State endangered species. The Federal listing covers only certain counties in Washington, including Kittitas County. The gray wolf is a wide-ranging carnivore that uses a variety of habitats. Its primary prey includes deer and elk. Wolves were once common throughout most of Washington, but the breeding population was decimated in the 1930s with the expansion of ranching and farming and the species was extirpated from Washington. In the early 2000s, reliable reports of wolf sightings began increasing in Washington, due in part to the recent recovery of wolf populations in Idaho, Montana, and Wyoming. Five wolf packs have been identified and confirmed by WDFW in Washington since 2008. In July 2011, a gray wolf pack was confirmed in the Teanaway region of the Yakima basin (WDFW, 2011a). The other four packs occur in north-central and northeast Washington in Okanogan, Chelan, and Pend Oreille Counties.

In response to the return of wolves to Washington, WDFW (2011b) prepared the *Wolf Conservation and Management Plan for Washington*, which was adopted by the Washington Fish and Wildlife Commission on December 3, 2011. The plan focuses on recovering gray wolf populations sufficient to support downgrading and delisting wolves at the State level, and on management strategies to reduce and address conflicts with livestock and big game herds.

The primary study area could support this species because suitable habitat is present. However, in areas where construction is occurring, typically in areas containing roads and fragmented habitat, the potential for occurrence is minimal. Wolves tend to move away from areas with high road densities (Mech et al., 1988; Mech and Boitani, 2003). Habitat in the analysis area most likely to be used by gray wolves includes less fragmented habitat, particularly at the north end of the Kachess Reservoir.

3.9.6.2 Grizzly Bear

The grizzly bear is a Federal threatened and State endangered species. Grizzly bears are wide-ranging and feed on roots, berries, ants, grubs, carrion, small mammals, ungulates, and salmon. Suitable habitat existed in the upper Yakima River basin historically, but fairly high road densities, development, and increased human use have decreased the quality of the habitat in the area. Grizzly bear observations have been recorded in the vicinity of the Kachess Reservoir and it is likely that a limited number of grizzly bear use the area north of I-90 in the North Cascades (WDFW, 2014a; WSDOT, 2008). The primary study area is not likely to support this species because of a relatively high level of human activity, a high degree of fragmentation, and a limited area of suitable habitat; however, this wide-ranging species may travel through the area.

3.9.6.3 Canada Lynx

In March 2000, the Service listed the Canada lynx as threatened under the ESA. Canada lynx are known to occur in several western and northern tier states including Washington. In Washington, resident lynx populations were historically found in the northeast and north-central regions and along the east slope of the Cascade Range in association with subalpine coniferous forest. Lynx are most likely to persist in areas that receive deep snow, for which the lynx is highly adapted. Most of the lynx occurrences are in the 4,920- to 6,560-foot elevation class and this type of habitat is present between Keechelus and Kachess reservoirs. However, Canada lynx have not been documented in the primary or extended study area (WDFW, 2014a). If present in these areas, lynx are likely uncommon or rare.

3.9.6.4 Marbled Murrelet

The Service listed the marbled murrelet as a threatened species under the ESA in 1992, based on a decline in abundance and habitat degradation in the southern portion of their range. Marbled murrelet are marine birds that forage in nearshore environments from northern California through Alaska. They nest in mature coniferous forests west of the Cascade crest at low to moderate elevations (Smith et al., 1997). Marbled murrelet are resident year-round on coastal water, but exact numbers are unknown. Historical data are limited, but marbled murrelet are currently rare and uncommon in areas where they had been common or abundant in the early 1900s, especially along the southern coast of Washington (Sealy and Carter, 1984; Marshall, 1988; Carter and Erickson, 1992; Nelson et al., 1992; Ralph, 1994).

Marbled murrelet population decline has been attributed primarily to the loss and fragmentation of old-growth nesting habitat caused by logging and development (Ralph and Miller, 1995). It is believed that forest fragmentation causes nests near forest edges to become vulnerable to predation by other birds, such as jays, crows, ravens, and great-horned owls. In addition, this species is vulnerable to fishing nets and oil spills (Marshall, 1988).

The Keechelus and Kachess reservoirs and their tributary streams are located near the eastern extent of the breeding range for marbled murrelet. Fewer than 6 percent of marbled murrelet sightings occur more than 40 miles from the marine environment and the most inland nest that has been documented in Washington is approximately 55 miles from the ocean (WDFW, 2013). Keechelus Reservoir is the most westerly of the reservoirs and is located approximately 43 miles due east of Puget Sound. While it is possible that marbled murrelet occur in the primary study area, the distance from foraging habitat likely precludes the area from supporting suitable nesting habitat.

The closest designated critical habitat for the marbled murrelet is located on the west side of Keechelus Reservoir approximately 5.75 miles northwest of any proposed activities (Service, 2014). Surveys conducted for the I-90 Snoqualmie Pass East Project indicated marbled murrelet presence in the upper Gold Creek Valley, which is located at the north end of Keechelus Reservoir (WSDOT, 2008).

3.9.6.5 Yellow-billed Cuckoo

The Service listed the western DPS yellow-billed cuckoo as a threatened species on October 3, 2014 (79 Federal Register 192). Critical habitat for the cuckoo was proposed on August 15, 2014; however, habitat in Washington State was excluded from the proposed designation (79 Federal Register 158). Specific threats to the western yellow-billed cuckoo include degradation of riparian habitat which contributes to habitat fragmentation and conversion to habitats dominated by nonnative plant species. In addition, the rarity of habitats suitable for western yellow-billed cuckoo and the isolation of populations put the species at an elevated risk of further population decline (78 Federal Register 192).

Yellow-billed cuckoo habitat is characterized by large blocks (greater than 25 acres) of dense cottonwood and willow bottomlands with thick understory growth. The northern limit of the breeding range for western yellow-billed cuckoos is now believed to be in California and potentially southern Oregon.

Historically in the Pacific Northwest, including Washington State, the yellow-billed cuckoo was locally and fairly common in cottonwood and willow bottoms of the Willamette and Columbia rivers and in the Puget Sound lowlands (Jewett et al., 1953; Gabrielson and Jewett, 1970; Roberson, 1980; Marshall, 1996; Marshall, 2003). In Washington State, the last confirmed breeding records were from the 1930s and it is likely to have been extirpated as a breeder. Of the 24 breeding records documented in Washington State between 1836 and 1940, 23 were west of the Cascade Range and one was east. Between 1956 and 2012, researchers have documented 17 western yellow-billed cuckoo in the State, 13 of which occurred east of the Cascades. WDFW ranks the species as having historical occurrences only, but they still expect the western yellow-billed cuckoo to occur in the State (78 Federal Register 192). It is possible that a few vestigial breeding populations remain in the State (Wahl et al., 2005); however, the lack of extensive river floodplain habitats, similar to those in the Puget Sound region where most historical sightings were made (King County, 2007), has reduced the breeding success of the species within the State. Most recently, exploratory surveys have been conducted in several counties where previous sightings were documented (e.g., Okanogan County) and in areas where suitable habitat exists (Wahkiakum, Yakima, and Cowlitz Counties). Yellow-billed cuckoo sightings were documented (Salzer, 2010; Flotlin, 2011). If breeding is occurring in Washington State, it is likely limited to breeding pairs in the single digits.

The action alternatives are generally located in or adjacent to large tracts of mixed age stands of coniferous forest and the Kachess and Keechelus reservoir shorelines and adjacent wetland complexes contain scattered willows and cottonwoods. Based on the current breeding range of the species, and limited breeding habitat, the presence of yellow-billed cuckoo in the primary study area is unlikely.

3.10 Visual Quality

The primary study areas for visual quality have been defined on the basis of actions that could impact visual quality: construction activities, changes in reservoir pool elevations, new or modified facilities, and downstream changes, as described in Chapter 4. Based on these types of impacts, the primary study area generally includes areas where visual changes caused by the alternatives would be seen by the general public or nearby residents.

The primary study area for visual quality encompasses three distinct landscapes:

- Kachess Reservoir and its surroundings
- Keechelus Reservoir and its surroundings, including Gold and Cold creeks
- Areas along the KKC alignments between Kachess and Keechelus reservoirs

The Kachess Reservoir portion of the primary study area includes residential and recreation areas along the shoreline, and other areas where the Proposed Action facilities along the Kachess shoreline would be constructed and viewed, including the route of the KDRPP transmission line. These areas are described in Section 3.10.1, Kachess Reservoir, and shown in Figures 2-1 and 2-5.

The Keechelus Reservoir portion of the primary study area includes recreation areas along the shoreline, and other areas where KKC facilities would be constructed and viewed; the Keechelus Reach of the Yakima River; and areas where the enhancement actions at Gold and Cold creeks would be constructed and viewed. These areas are described in Section 3.10.2, Keechelus Reservoir, and shown in Figures 2-4, 2-8, and 2-10.

Areas along the KKC alignment between Kachess and Keechelus reservoirs include the I-90 Exit 62 portal area and areas overlying the KKC tunnel alignments as described below in Section 3.10.3, KKC Alignments. These areas are shown in Figures 2-8 and 2-10.

The dominant features of the primary study area are the Keechelus and Kachess reservoirs. Before the Keechelus and Kachess dams were constructed, the Keechelus and Kachess reservoirs were natural glacial lakes. Views from the lakes were of undisturbed forested areas. The Keechelus and Kachess reservoirs share the characteristic of being drawn down during the summer. The reservoirs are generally full in late spring and early summer, but are drawn down for irrigation starting in June. The reservoirs do not refill until the following spring and may not completely refill in drought years.

The extended study area is the Yakima River basin, which encompasses Kachess and Keechelus watersheds and all areas of potential downstream effects (Figure 1-1). There are no designated Wild and Scenic Rivers in the primary or extended study area.

3.10.1 Kachess Reservoir Area

The visual setting for Kachess Reservoir provides a perceived “natural” landscape with limited development along the shores. Prior to dam construction in 1910-1912, the natural lake was smaller with a consistent year-round water level, and there was little evidence of human influence along the lake shoreline. Today, the reservoir is a managed system with a seasonally fluctuating water level. The highest elevations occur in the spring when snowmelt runoff fills the reservoir; the lowest in the summer when it is drawn down. During drawdown, much of the exposed shoreline is devoid of vegetation. The relatively gradual slope to the reservoir bottom results in a relatively large area of exposed reservoir bed with lower water levels. In dry years, the reservoir may not completely fill and the upper portion of the reservoir is exposed year-round.

Kachess Reservoir is located between the north-south trending Keechelus Ridge to the west and Kachess Ridge to the east (Figure 3-22). Background views are forested, with views of valley walls, ridges, and mountains beyond. Douglas-fir forests dominate the vegetation. Development is generally limited to USFS roads on the east and west shores, boat launches, other recreational facilities, and increasing residential development on the south and west shores. Kachess Dam, located on the southern end of the reservoir, is the dominant built element on the landscape. The earth fill dam is approximately 115 feet tall and 1,400 feet long with a gated spillway. Kachess Dam is viewable from shorelines along the southeast portion of the reservoir.

Figure 3-22. Kachess Dam – East End (at Dam) Facing West

Kachess Reservoir is the dominant landscape element in this portion of the primary study area. Although the reservoir was created for water supply, the resulting reservoir setting affords visitors with dramatic panoramas of the reservoir and the surrounding natural landscape, which remains largely forested. Together, the reservoir shoreline and hilly topography provide significant variety in viewpoint orientation. These resources include a combination of panoramic views in which the reservoir forms the dominant foreground element and the surrounding forested landscape forms the background, with Kachess Dam as the most prominent built feature. Viewers of the reservoir are primarily recreationists and seasonal residents. The reservoir is viewable from recreational areas, residential areas, and surrounding USFS roads, but not from I-90.

The transmission line for the KDRPP would extend from the existing Easton Substation east of the reservoir to the new pumping plant. The route would likely cross and run adjacent to moderate- to high-use recreational areas, including the John Wayne Pioneer Trail in Iron Horse State Park and Lake Easton State Park. Information on these recreation facilities is included in Section 3.14, Recreation.

3.10.2 Keechelus Reservoir Area

The visual setting for Keechelus Reservoir provides a perceived “natural” though “slightly altered” to “moderately altered” landscape, contrasting with a developed east shore—the I-90 corridor. Because of its proximity to I-90, Keechelus Reservoir is viewed by more people than any other Yakima River basin reservoir. The John Wayne Pioneer Trail, described below, is the principal development on the west shore of the reservoir.

Similar to Kachess Reservoir, prior to dam construction in 1911 to 1917, the natural lake was smaller with a consistent year-round water level, with little evidence of human influence along the shoreline. Today, the reservoir is a managed system with a seasonally fluctuating water level. The highest elevations occur in the spring when snowmelt runoff fills the reservoir. For most of the year, the view of the reservoir is of the exposed shoreline because the reservoir is drawn down in the summer and does not refill until spring. Stumps from trees that were logged before the dam was constructed are exposed. In dry years, the reservoir may not completely fill and the upper portion of the reservoir may be exposed year-round. Shrubby vegetation has grown in the exposed shorelines; that vegetation is green during the summer.

Keechelus Reservoir is the dominant landscape element in this portion of the primary study area (Figure 3-23). The dominant landscape character is openness with dramatic contrasts of rock rising sharply to the east and water immediately adjacent to I-90 to the west, which curves around the east shore of the reservoir. Background views to the west are generally forested, with views of distant hills and mountains beyond. Douglas-fir trees dominate the vegetation.

Figure 3-23. Keechelus Reservoir – South End (at Dam) Facing Northwest

Foreground views to the west at the south end of Keechelus Reservoir are dominated by I-90 and its concrete Jersey barrier. The middle ground view is of grasses between the road and the reservoir. The earth fill Keechelus Dam can be seen in the background, as well as the mountains in the far distance. The dam's low profile relative to the surrounding landscape allows it to blend with the landscape, but it is noticeable from I-90. Below the dam, the Keechelus Reach of the Yakima River flows to the south.

The BTE areas (Gold Creek and Cold Creek) are within perceived "natural" and "slightly altered" visual settings. At the north end of Keechelus Reservoir, westbound views from I-90 afford open middle-ground views toward Gold Creek, with the ski slopes at Snoqualmie Summit in the background view. The highway and cleared areas of the ski slopes interrupt the visual character, but overall the view presents an intact landscape character.

The John Wayne Pioneer Trail, a long-distance trail for nonmotorized recreation along the former railbed of the Chicago, Milwaukee, St. Paul & Pacific Railroad, follows the western shoreline of Keechelus Reservoir. The view from the trail on the north end and middle section of the reservoir is natural, with Cold Creek and native vegetation in foreground views, and stumps in middle ground views. To the south, views from the trail are dramatic and sweeping. The foreground is occupied by vegetation along and below the trail. Additional background views are of distant peaks. Evidence of development is limited to the narrow band of the highway, which is mostly obscured by trees. Figure 3-24 shows a view of the John Wayne Pioneer Trail as it passes over the existing culvert at Cold Creek.

Figure 3-24. View of John Wayne Pioneer Trail and Cold Creek Culvert

The I-90 corridor, including the portion of I-90 running adjacent to Keechelus Reservoir, is part of the Mountains to Sound Greenway, which is a National Scenic Byway. National Scenic Byways are designated by the U.S. Secretary of Transportation and managed by the Federal Highway Administration to help recognize, preserve, and enhance selected roads throughout the country. This designation is based on the route's outstanding scenic character and environmental experiences. The Mountains to Sound Greenway runs from Ellensburg to Seattle. The Greenway is managed by the Mountains to Sound Greenway Trust in accordance with the *Mountains to Sound Greenway Implementation Plan*, developed by WSDOT in 1998. The harvested slopes within the Mountains to Sound Greenway have been planted, and would mature and provide enhanced views within the next 20 years.

3.10.3 KKC Alignments

Areas along the KKC north tunnel and south tunnel alignments are within the Okanogan-Wenatchee National Forest. The forested landscape offers limited viewpoints. Scenic viewpoint opportunities are present at recreational areas, which include sno-parks for winter recreation activities and hiking trails.

The proposed I-90 Exit 62 portal is located immediately adjacent to I-90. The site has been used for construction staging and has been heavily modified. The site is at a higher elevation than the I-90 road grade; therefore, views into the site from I-90 are restricted.

3.10.4 Forest Service Criteria

USFS manages a high proportion of Federal land in the primary study area around Kachess and Keechelus reservoirs, including areas above the current full pool elevation. This Federal land is part of the Okanogan-Wenatchee National Forest, and is managed for multiple objectives, including resource production, habitat, ecological connectivity, and recreation. According to its 1990 *Wenatchee National Forest Plan* (USFS, 1990), the USFS manages the land principally as a scenic viewshed. The USFS management direction for scenic viewsheds containing dams and reservoirs is described in terms of visual quality objectives (VQOs). The VQOs describe the degree of acceptable alteration of the undisturbed landscape (USFS, 1974). The USFS applies zoning designations to its land as part of its forest planning process, termed land allocation. The USFS's land allocation for the Keechelus and Kachess reservoirs is Developed Recreation (RE-1) Retention VQO, and Scenic Travel 1 Retention VQO and Partial Retention VQO, depending on the middleground and foreground view context of management activities (Reclamation, 2008a). The USFS (1990) considers visual quality to be one of the most important resources to be protected under this land allocation.

In 1995, the USFS developed the Scenery Management System for integrating scenic values and landscape aesthetics in forest plans (USDA, 1995). The scenic integrity or intactness of National Forest land is the means by which proposed alterations to the land are evaluated. The Scenery Management System established scenic integrity levels (SILs) for each management area ranging from very high, meaning the landscape is unaltered, to low, meaning moderate alterations are apparent on the landscape. The SIL for land around Keechelus and Kachess reservoirs includes both high, meaning the landscape appears intact, and moderate, meaning the landscape appears slightly altered (Reclamation, 2008b). Bonneville Power Administration (BPA) transmission lines are located south of both reservoirs and north of I-90. The USFS considers the landscape appearance around BPA transmission lines as very low, meaning it appears heavily altered. The visual quality analysis in this DEIS references both the VQO and the SIL of the study area. Table 3-24 describes the relationship between VQOs and SIL as contained in the Scenery Management System (USDA, 1995).

Table 3-24. Relationship between Visual Quality Objectives and Scenic Integrity Levels

SIL/VQO	Condition	Perception, Degree of Deviation
Very High/Preservation	Unaltered	The valued landscape character is intact with only minute if any deviations.
High/Retention	Appears Unaltered	Not evident. Deviations may be present but must repeat form, line, color, and texture of characteristic landscape in scale.
Moderate/Partial Retention	Slightly Altered	Appears slightly altered. Noticeable deviations must remain visually subordinate to the landscape character being viewed.
Low/Modification	Moderately Altered	Appears moderately altered. Deviations begin to dominate the valued landscape character being viewed but they borrow valued attributes such as size, shape, edge effect, and pattern of natural openings.
Very Low/Maximum Modification	Heavily Altered	Appears heavily altered. Deviations may strongly dominate the valued landscape character. They may not borrow from valued attributes such as size, shape, edge effect, and pattern of natural openings.
Unacceptably Low (Not a management objective, used for inventory only)	Unacceptable Modification	Deviations are extremely dominant and borrow little if any form, line, color, texture, pattern, or scale from the landscape character.

Source: USDA, 1995, 2-4

3.11 Air Quality

Air quality impacts result largely from construction-related fugitive dust and emissions as described in Chapter 4. Based on these mechanisms, the primary study area for air quality includes the areas around Keechelus and Kachess reservoirs where construction is proposed, as well as the area surrounding the proposed I- 90 Exit 62 portal. Land throughout the primary study area is primarily forested, with areas of low-density rural residential and recreational uses near the west shorelines of the reservoirs. The primary study area also includes the Alpine Lakes Wilderness Area, a federally designated Class I area located approximately 8 miles to the north (at the closest point) of the Proposed Action. The affected environment for air quality impacts does not include the extended study area (the downstream Yakima basin), as the project would not result in any impacts to air quality outside of the primary study area. The environmental setting is described in terms of air pollutant sources and existing concentrations within the primary and extended study areas.

3.11.1 Regulatory Setting

The EPA has developed standards for air pollutant concentrations, called national ambient air quality standards (NAAQS). Washington State adopts current Federal NAAQS in State regulations (WAC 173-476). The Federal Clean Air Act requires EPA to review NAAQS every 5 years to make sure the standards protect human health and the environment. State regulations are updated when EPA revises or establishes a new standard. Washington State must also address visibility within federally designated Class I areas, where good air quality is deemed to be of national importance, as defined in Section 162 of the Clean Air Act. The Alpine Lakes Wilderness Area, a designated Class I area, is located to the north of the Proposed Action, and the prevailing wind direction in the area is from the northwest.

Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly.

Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

Under provisions of the Clean Air Act, government entities must maintain concentrations of pollutants of concern below the NAAQS. Areas that meet the primary or secondary NAAQS for pollutants are designated as attainment areas. Nonattainment areas are defined as areas that do not meet the primary or secondary NAAQS for a pollutant, or that contribute to ambient air quality in a nearby nonattainment area.

In Washington State, air quality is tracked by county. The Ecology Central Regional Office is responsible for regulating air quality in the primary study area. Kittitas County is currently in attainment for all criteria pollutants. Kittitas County is not currently designated as a nonattainment area for any pollutant of concern listed in the Clean Air Act; therefore, no regional air quality authority exists for Kittitas County (Ecology, 2014c).

No air quality monitoring stations are located in the primary study area. The closest Ecology monitoring stations are located in North Bend, Leavenworth, and Ellensburg, developed locations that are not representative of the project area. Even in these more developed areas, air quality is generally “Good” according to Ecology’s Washington Air Quality Advisory rating system. The sparse population and rural nature of most of Kittitas County, including all areas surrounding the Proposed Action, result in minimal existing sources of air pollution. Prevailing southwesterly and westerly winds averaging approximately 8 mph through the Snoqualmie Pass vicinity further limit any potential for localized areas of poor air quality. Although variable, winds in the primary study area can increase fugitive dust generated by earth-disturbing activities, like construction-related clearing, excavation, and transport of soils.

Applicable State and Federal ambient air quality standards are displayed in Table 3-25. Carbon monoxide is a pollutant generated by transportation sources and other fuel-burning activities such as residential space heating. Ozone is a highly reactive form of oxygen created by chemical transformations of ozone precursors (such as nitrogen oxides and volatile organic compounds) in the atmosphere. Lead is a toxic heavy metal formerly used in house paint and fuel. Nitrogen dioxide is a gas emitted by motor vehicles. Particulate matter PM_{10}, consisting of airborne particles less than or equal to about 10 micrometers in diameter, can be inhaled deeply into the human lung and is considered important in terms of potential human health impacts. Fine particulate matter ($PM_{2.5}$), consisting of particles whose diameter is less than or equal to 2.5 micrometers, can also be inhaled deeply and has been found to represent the most dangerous size of particulates in terms of human health.

Projects that require earthwork or otherwise have the potential to create fugitive dust are required to use BMPs to control dust at the work site. According to WAC 173-400-300, fugitive air emissions are those that "do not and which could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening". These emissions include dust from unpaved roads, construction sites, and tilled land.

Table 3-25. Ambient Air Quality Standards

Pollutant[1]	National		Washington State
	Primary	Secondary	
Carbon Monoxide			
8-Hour Average	9 ppm	NS	9 ppm
1-Hour Average	35 ppm	NS	35 ppm
Ozone			
1-hour Average[2]	0.12 ppm	0.12 ppm	0.12 ppm
8-Hour Average [3]	0.08 ppm	0.08 ppm	0.08 ppm
Lead			
Maximum Arithmetic Mean (averaged over calendar quarter)	1.5μg/m^3	1.5μg/m^3	NS
Nitrogen Dioxide			
Annual Average	0.05 ppm	0.05 ppm	0.05 ppm
Particulate Matter (PM_{10})			
Annual Arithmetic Average	50 μg/m^3	50 μg/m^3	50 μg/m^3
24-Hour Average[4]	150 μg/m^3	150 μg/m^3	150 μg/m^3
Particulate Matter ($PM_{2.5}$)			
Annual Arithmetic Average	15 μg/m^3	15 μg/m^3	15 μg/m^3
24-Hour Average	65 μg/m^3	65 μg/m^3	65 μg/m^3
Particulate Matter (TSP)			
Annual Geometric Average	NS	NS	60 μg/m^3
24-Hour Average	NS	NS	150 μg/m^3
Sulfur dioxide (SO_X)			
24-hour	0.14 ppm	NS	0.10 ppm
3-hour	NS	0.5 ppm	NS

NS = No standard established
μg/m^3 = micrograms per cubic meter
ppm = parts per million
[1]Annual standards never to be exceeded, short-term standards not be exceeded more than once a year unless noted.
[2]Standard attained when expected number of days with a 24-hour concentration above 150 μg/m^3 is one or less.
[3]Standard attained when expected number of days with an hourly average above 0.12 ppm is equal to one or less.
[4]This would replace the 1-hour ozone standard when EPA approves a state or local agency's ozone State Implementation Plan.

3.11.2 Current Air Quality Environment

Air quality changes over time as economic development occurs and regulatory programs affect the emissions from sources. Sources of existing air pollutants in the project area are generally limited to vehicle emissions, primarily from I-90. A daily average of 28,000 vehicles travel over Snoqualmie Pass on I-90, including the corridor closest to the Proposed Action. Traffic volumes on I-90 are expected to increase 2.1 percent every year, reaching an average of over 41,000 vehicles per day by 2030 (WSDOT, 2012). Other roads within the project vicinity receive relatively low levels of traffic.

Forest fires on the dry east side of the Cascade Range are another source of occasional air pollution. Wood smoke contains carbon monoxide, formaldehyde, nitrogen oxides, and particulates. Relatively low levels of pollution can also occur during winter months from use of wood-burning stoves at rural residences and seasonal cabins. Fugitive dust and combustion emissions are generated in the area by vehicles traveling on gravel or dirt roads, construction, and other activities that disturb the soils and utilize combustion engines. Air pollution from urban centers west of the Cascades can also enter the project area during certain weather conditions.

3.12 Climate Change

The affected environment for climate change is described according to potential trends and patterns that could affect the Proposed Action. Global climate change has the potential to impact water resources in the Kachess and Keechelus watersheds and the Yakima River basin; therefore, the Proposed Action alternatives could be affected by these changes. Scientists predict that increasing atmospheric carbon dioxide (CO_2) concentrations would produce significant changes in atmospheric circulation, resulting in higher global air temperature and changes in average precipitation amounts.

Potential climate change-related impacts could result from changes in future temperatures and precipitation patterns, with resulting implications for stream runoff volume and timing, water temperatures, and reservoir operations. To understand how climate change could affect water resources and the approaches to deal with these changes, it is important to understand the range of potential effects that could occur. Given the uncertainty associated with predicting any type of event in the future, Reclamation and Ecology considered the possible range of effects.

Reclamation and Ecology evaluated the potential effects associated with climate change at a programmatic level in the Integrated Plan PEIS (Reclamation and Ecology, 2012). Building on those studies, project-level hydrologic modeling studies of potential changes associated with climate change were conducted for this DEIS. The results of these studies are presented in the *2014 Hydrologic Modeling Report* (Reclamation and Ecology, 2014o) and discussed below.

The Yakima River basin is both the primary and extended study area for climate change for this DEIS. The primary study area and the extended study area (collectively called the study area in this section) are the same because the potential impacts from climate change are analyzed at the regional, rather than local level. The components of water resources, and of the projects most likely to be affected by climate change within the study area, are related to streamflows, water supplies, and reservoir levels. The modeling conducted to estimate the potential range of effects is described below.

3.12.1 Climate Change Effects in the Yakima River Basin

Streamflow in the Yakima River basin is primarily influenced by a mix of direct runoff from fall, winter and spring rains, and spring snowmelt. Wetter and colder winters tend to generate greater snowpack in the highest-elevation portions of the watersheds above the five existing Yakima basin storage reservoirs. In colder springs more of this accumulated snowpack is retained longer, producing snowmelt runoff during the irrigation season. In contrast, warmer and drier winters and springs tend to accumulate less snowpack, with snowmelt runoff before the start of irrigation season. When snowmelt runoff occurs during the irrigation season, a larger portion of the irrigation demand can be met with unstored runoff, rather than having to be supplied out of water stored in the reservoirs. This situation leaves the reservoirs fuller after runoff ceases, and better able to supply late-season demand.

Climate change hydrologic simulations conducted by Mantua et al. (2010) predict that a mid-level elevation watershed like the Yakima basin would be most affected by climate change. The results of the simulation indicate that because the watershed areas above the Yakima basin reservoirs are not extremely high in altitude, a relatively small increase in winter and spring temperature can cause winter precipitation to fall as rain, rather than snow, or can initiate earlier melting of the snowpack.

To develop an understanding of the potential effects of climate change on the water resources in the study area, for this DEIS, Reclamation and Ecology used climate change data from the University of Washington to model climate change effects. Two climate change scenarios are described briefly below: historically based hydrology (the Baseline scenario) and climate-influenced hydrology (the Adverse scenario) (RMJOC, 2010).

The Baseline scenario uses hydrologic conditions developed from historical stream gage data collected in the study area. The Adverse scenario, uses University of Washington data that approximates the median predicted climate variations associated with the 30-year period from 2030 to 2059. The Adverse scenario incorporates a 1.7^{o} C average increase in temperature, and a 3.7 percent average increase in precipitation. These changes are smaller than the changes predicted under certain sets of emission assumptions and global climate models, but are larger than others. Thus the assumptions that are used for the Proposed Action are near the middle of (or central to) the range of climate changes predicted using global climate models considered and their assumptions. Table 3-26 summarizes the Baseline and Adverse climate change scenarios used in analyses for this DEIS. As presented in the table, average annual inflow to the five reservoirs would decrease under the Adverse scenario. This decrease occurs despite an increase in precipitation because watershed runoff decreases as evapotranspiration loss increases with the higher temperatures.

Table 3-26. Summary of Climate Change Scenarios

Scenario	Climate Model Used	Descriptive Label	Average Temperature Change	Average Precipitation Change	Average Annual Inflow to Five Reservoirs (kaf[1])
Baseline	None	Baseline	0	0	1,660
Adverse	HadCM (B1 emissions pathway)	2040s Central Change	1.7 ºC increase	3.7% increase	1,480

Source: Reclamation and Ecology, 2011f (page 42)
[1]kaf = thousand acre-feet

The following sections present potential changes to the Yakima River basin water supply as predicted by the Adverse climate change scenario when compared to the Baseline scenario.

3.12.1.1 Changes in Snowpack

Snowpack is considered the "sixth reservoir" in the Yakima River basin because most demands in the spring and early summer are met from runoff that comes from melting snowpack. Only about 30 percent of the average annual total natural runoff above the Parker stream gage can be stored in the current Yakima River basin reservoirs (Reclamation and Ecology, 2011i). Because of this, the water supply of the Yakima River basin is susceptible to changes in snowpack caused by climate change.

When compared to the Baseline scenario, increased air temperatures under the Adverse climate change scenario would cause more precipitation to fall as rain rather than snow in the Cascade Range. This condition would reduce snowpack in the headwaters above Keechelus and Kachess reservoirs. Also, higher air temperatures would cause snowpack to melt (Reclamation and Ecology, 2011a).

Previous studies have shown that the snowmelt volume in the Yakima River basin is likely to decrease by 12 percent given a 1°C rise in air temperature, and a 27 percent volume given a 2°C rise (Vano et al., 2010). The results prepared for this DEIS and summarized below are comparable as they show a 20 to 21 percent decrease in inflow to Kachess and Keechelus.

3.12.1.2 Changes in Quantity and Timing of Runoff

Total modeled inflow into Keechelus and Kachess reservoirs under the Baseline and Adverse climate change scenarios is shown in Figure 3-25 tabulated in Table 3-27.

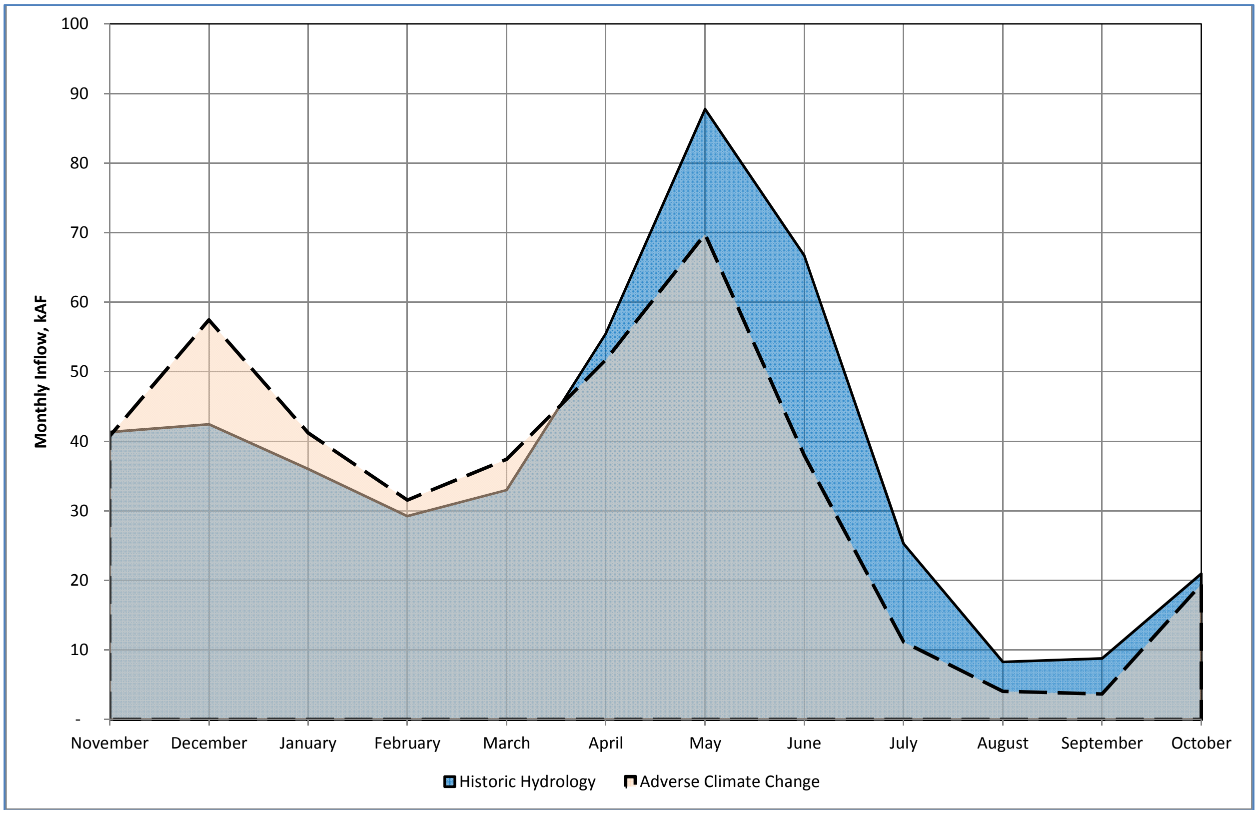

Figure 3-25. Comparison of Average Monthly Combined Reservoir Inflow to Keechelus and Kachess Reservoirs between Baseline and Adverse Scenarios

Source: Reclamation and Ecology, 2014o

[1]kaf = thousand acre-feet

Table 3-27. Comparison of Average Seasonal Inflows into Keechelus and Kachess Reservoirs for the Baseline and Adverse Climate Change Scenarios

Scenario	Fall (Oct – Dec)	Winter (Jan – March)	Spring (April – June)	Summer (July – Sept)	Total
Keechelus Reservoir Inflow					
Baseline (kaf[1])	58.5	50.9	109.3	24.5	243.0
Adverse (HadCM B1) (kaf)	66.0	56.7	82.6	12.0	195.5
Difference (%)	13	11	-24	-51	-20
Kachess Reservoir Inflow					
Baseline	46.2	47.3	100.6	17.8	211.9
Adverse (HdCM B1) (kaf)	51.5	53.5	76.9	6.9	166.6
Difference (%)	11	13	-24	-61	-21

Source: Reclamation and Ecology, 2014o

[1]kaf = thousand acre-feet

The model results indicate significant changes in runoff into Keechelus and Kachess reservoirs due to climate change. For the Adverse scenario modeled as part of this DEIS, the annual reservoir inflow decrease an average of 20 or 21 percent compared to the Baseline scenario (Reclamation and Ecology, 2014o). Spring runoff is expected to decrease by an average of 24 percent, and summer runoff is expected to decrease by 51 or 61 percent. Fall and winter runoff is expected to increase by an 11 to 13 percent.

The shifts in runoff quantity and timing shown in the model results would cause risks to water supply. Reclamation and Ecology (2011g) expect future agricultural demand to be higher than under historical conditions in the low inflow period of the summer. Fall and winter inflow would increase, but the reservoirs may not be able to refill completely before spring. Additionally, a decrease in spring and summer flow would cause water stored in the Keechelus and Kachess reservoirs to be depleted at a faster rate to meet demand.

A comparison between simulated existing reservoir water surface elevation under the Baseline and Adverse climate scenarios is shown in Figure 3-26 for Keechelus Reservoir and Figure 3-27 for Kachess Reservoir. On average, Keechelus Reservoir is predicted to be 12 feet lower, with a monthly average difference ranging from 1 to 22 feet lower under the Adverse climate change scenario. The model predicts the existing Kachess Reservoir to be 13 feet lower, on average, with a monthly average difference ranging from 8 to 18 feet lower under the Adverse climate change scenario. Under these conditions, full pool would occur less often.

The Adverse climate change scenario simulation indicates lower water surface elevations, which would result in the existing reservoirs filling less frequently.

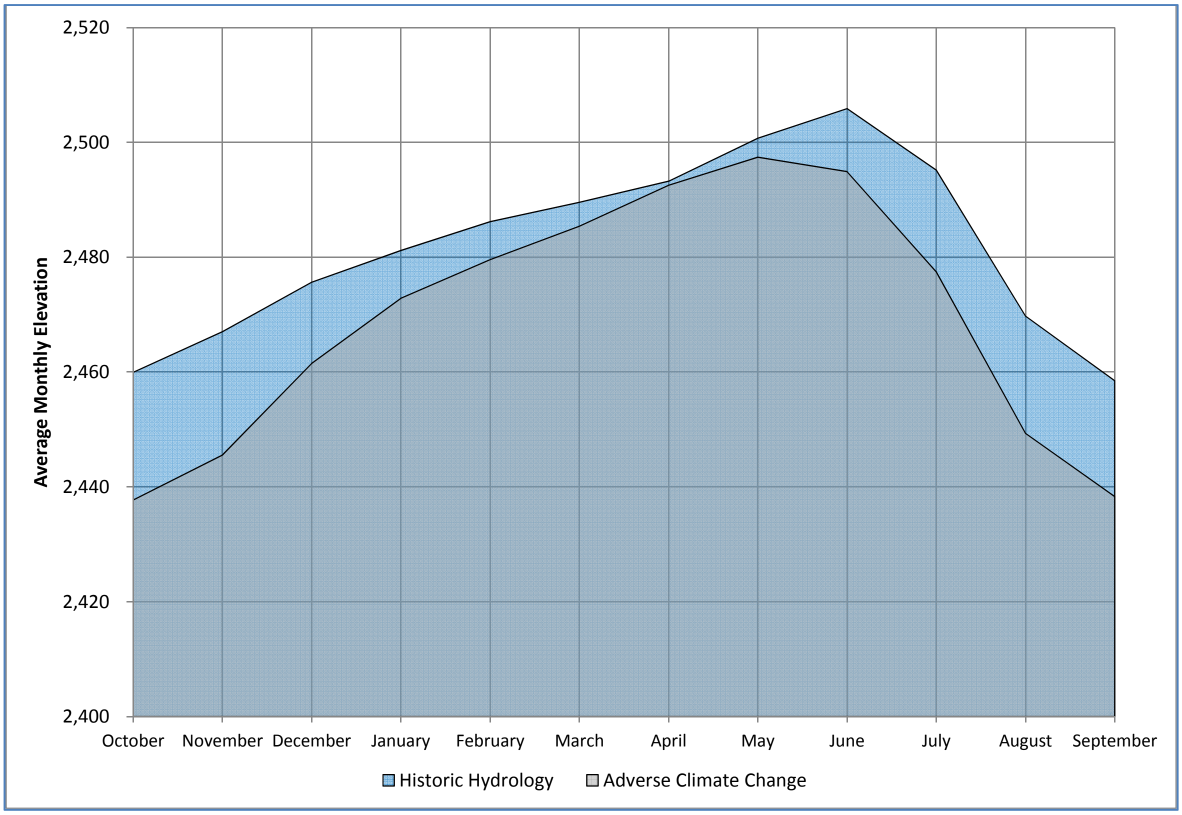

Figure 3-26. Comparison of Average Monthly Keechelus Reservoir Water Surface Elevation between Baseline and Adverse Scenarios

Source: Reclamation and Ecology, 2014o

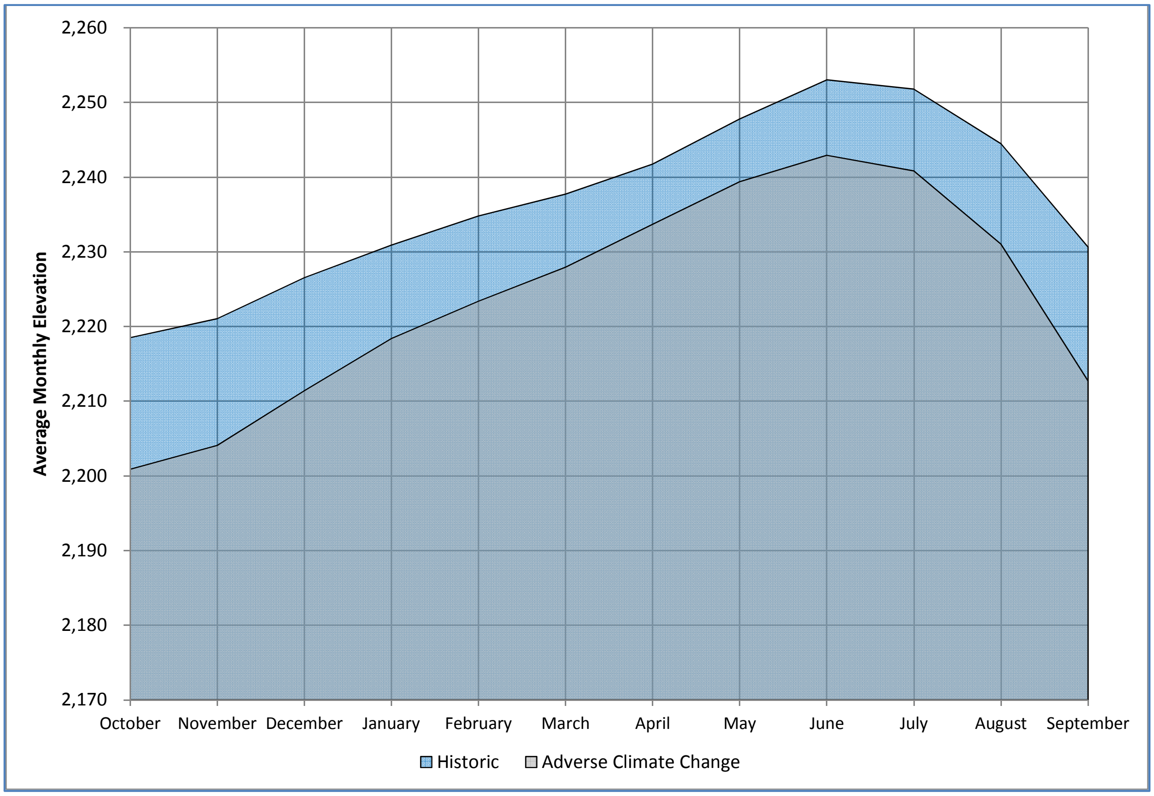

Figure 3-27. Comparison of Average Monthly Kachess Reservoir Water Surface Elevation between Baseline and Adverse Scenario
Source: Reclamation and Ecology, 2014o

3.12.1.3 Changes in Water Supply

Under the Adverse scenario, a large reduction in summer runoff would put a much larger demand upon the water stored in the reservoirs in the Yakima system. Natural runoff and streamflow in the system would decrease by 50 percent or more in some months when compared to the Baseline scenario; therefore, irrigation demands and instream flow targets would have to be met by releasing larger amounts of water from the existing reservoirs. Currently, there are many years when the reservoirs are not capable of meeting these demands. Under climate change, the number of years with water supply shortages would greatly increase. The effects of climate change on Yakima basin water supply are most clearly quantified by examining the prorationing level, the TWSA, and the April through September irrigation deliveries. Under the Baseline scenario, average September 30 prorationing is reduced by 21.1 percent, and minimum year prorationing is reduced by 19.5 percent. This decrease in available irrigation water supply under the Adverse scenario, would result in more frequent prorationing and lower prorationing levels (Table 3-28). Average July 1 TWSA is reduced by 332,000 acre-feet, and average delivery to the major irrigation districts is reduced by 118,000 acre-feet.

Table 3-28. Comparison between Simulated Water Supply Conditions under Baseline and Adverse Climate Change Scenarios

Range		Sept 30 Prorationing (Percent)	Jul 1 TWSA (kaf)[1]	Apr – Sep Deliveries (kaf)
Baseline scenario	Min	19	842	923
	Average	88	1,520	1,577
	Max	100	2,210	1,675
Adverse scenario	Min	0	692	649
	Average	66	1,188	1,459
	Max	100	1,819	1,820
Change due to Adverse scenario	Min	-19	-150	-274
	Average	-21	-332	-118
	Max	0	-391	145

Source: Reclamation and Ecology, 2014o
[1]kaf = thousand acre feet

3.12.1.4 Changes in Instream Flow

The Adverse climate change scenario effects on instream flow are also substantial. For the purposes of this DEIS, the most important Yakima River reaches are Keechelus, Easton, and Wapato. Under the Adverse scenario, target flows in the Keechelus Reach would be met between 20 and 40 percent less frequently compared to the Baseline scenario, except during July and August, when the ramp-down to 500 cfs would be easier because of lower volumes of water available in, and delivered out of, the Keechelus Reservoir (Reclamation and Ecology, 2014o) (Figure 3-28).

The effects of the Adverse scenario on instream flow in the Easton Reach are shown in Figure 3-29. Under the Adverse scenario, the winter and spring target flows are met 10 to 20 percent less frequently and the fall flows are met 41 percent less frequently when compared to the Baseline scenario. The frequency at which summer flow targets are met is essentially unchanged.

The effects of the Adverse scenario on instream flow in the Wapato Reach are shown in Figure 3-30. The average target flow is reduced from 530 cfs to 454 cfs when compared to the Baseline scenario, due to the effect of climate change on TWSA. Even though the target is lower, the target flows are met or exceeded on about 5 percent fewer days under the Adverse scenario. The average flow in the Wapato Reach is reduced from 2,301 cfs to 2,147 cfs, a change of slightly more than 150 cfs.

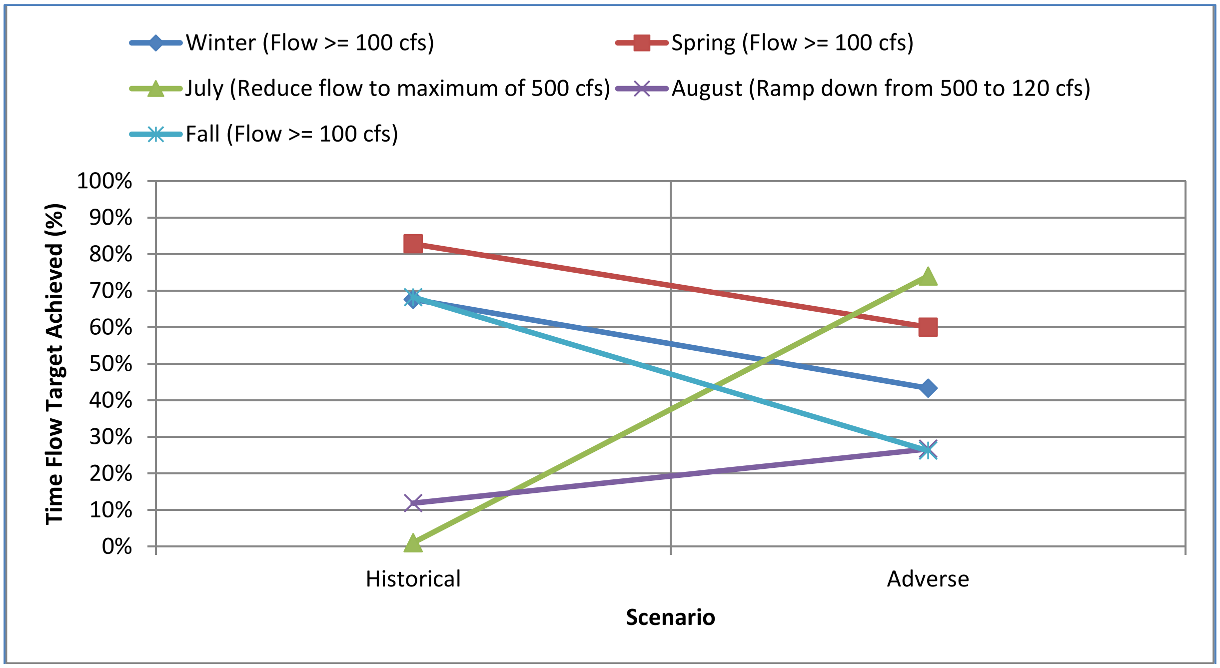

Figure 3-28. Effect of Adverse Climate Change on the Percent of Time Keechelus Reach Target Flows are Achieved

Source: Reclamation and Ecology, 2014o

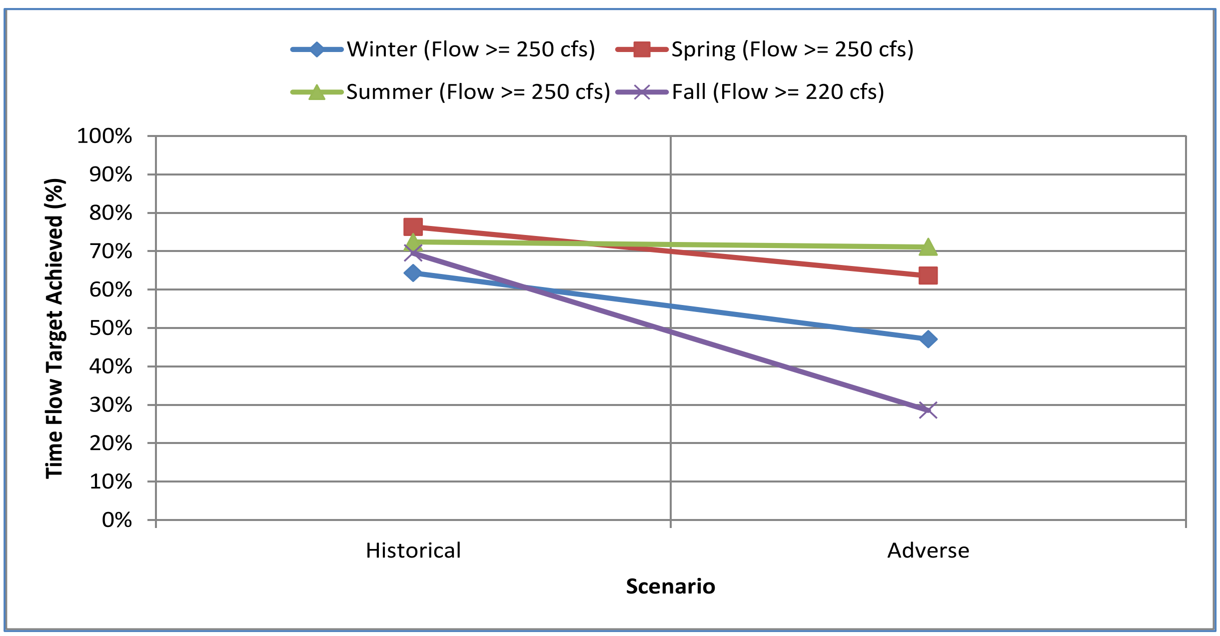

Figure 3-29. Effect of Adverse Climate Change on the Percent of Time Easton Reach Target Flows are Achieved

Source: Reclamation and Ecology, 2014o

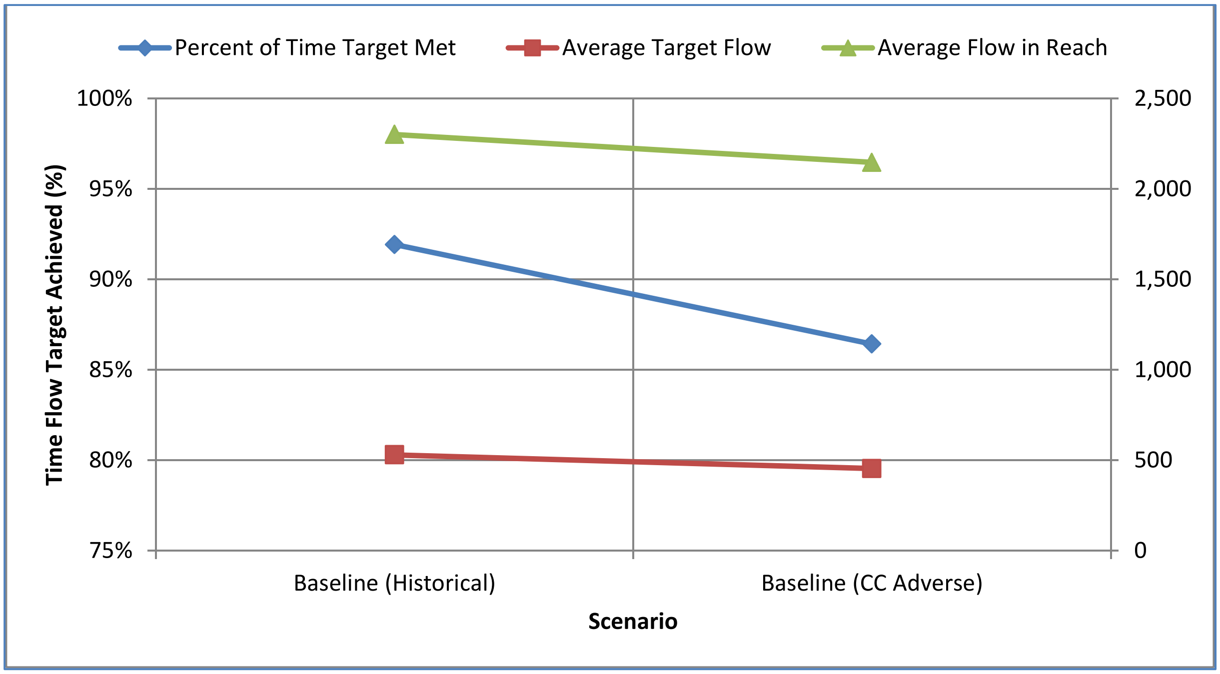

Figure 3-30. Effect of Adverse Climate Change on the Flow and Percent of Time Wapato Reach Target Flow is Achieved
Source: Reclamation and Ecology, 2014o

The changes in runoff timing and volume seen under the Adverse scenario are similar to those described in the Integrated Plan PEIS (Reclamation and Ecology, 2012). These changes are likely to affect how the KDRPP and KKC operate and how effective they are at meeting their water supply and instream flow objectives. These changes are also likely to increase the need for the action alternatives, as water supplies are reduced and instream flow targets are met less frequently when compared to the Baseline scenario. These issues are discussed further in Section 4.12.

3.12.2 Changes in Related Resources

Climate change may affect water-related resources in the Yakima River basin as a whole, including flood control, hydropower, fish and wildlife, and surface water quality.

The availability of water-related recreation in the Yakima River basin could be affected by a number of climate change-related factors, including changes in snowpack and changes in the timing and quantity of streamflow. Climate change is expected to result in a decline in the quantity and quality of freshwater habitat for salmonid populations across Washington State (Mantua et al., 2010). Studies have predicted increasing water temperatures and thermal stress for salmonids in eastern Washington that are minimal for the 2020s but increase considerably later in the century (Mantua et al., 2010).

Based on projections for the 2040s, climate change may significantly alter temperature, the amount and timing of runoff, and fish habitat in the Yakima River basin. Average annual air temperature is expected to increase, with accompanying increased water temperatures, according to the University of Washington, and more precipitation is expected to fall as rain rather than snow (RMJOC, 2010). These temperature changes could affect fish in the Yakima River basin, including the federally listed threatened MCR steelhead and bull trout.

Climate change would have a direct impact on water temperature and, indirectly, on DO. In general, an increase in air temperature caused by climate change would cause water temperatures to increase. In the upper Yakima River, climate change models predict that the number of weeks when average water temperatures exceed 21°C may rise from less than 5 weeks in historical conditions to over 10 weeks in the 2040s (Mantua et al., 2009). Warmer water can hold less dissolved oxygen than cooler water, so dissolved oxygen would decrease as air and water temperatures increase due to climate change (Karl et al., 2009).

3.13 Noise

Construction and by operation of the completed Proposed Action facilities would cause impacts on noise-sensitive receptors. These impacts are described in Section 4.13. Accordingly, the primary study area for noise and vibration includes the following locations:

- Areas that would be impacted by construction and operation of proposed facilities along the Kachess shoreline
- Areas that would be impacted by construction and operation of proposed facilities along the Keechelus shoreline
- Areas at the I-90 Exit 62 portal that would be impacted by construction of the proposed KKC south tunnel

Construction activities and facilities within each of portion of the primary study area are described in Chapter 2. The affected environment for noise and vibration impacts does not include the extended study area (the downstream Yakima basin) because the project would not result in any impacts from noise or vibration outside of the primary study area.

3.13.1 Regulatory Setting

Several ways to measure noise exist, depending on the source of the noise, the receiver, and the reason for the noise measurement. The amplitude of sound is described in decibel (dB). In relation to sound, amplitude is the measure of the degree of change in atmospheric pressure caused by sound waves; sounds with greater amplitude would produce greater changes in atmospheric pressure. Noise levels are stated in terms of decibels on the A-weighted scale (dBA). This scale reflects the response of the human ear by filtering out some of the noise in the low- and high-frequency ranges that the ear does not detect well. The A-weighted scale is used in most noise ordinances and standards.

Noise effects in humans can be physical or behavioral. The mechanism for chronic exposure to elevated sound levels leading to hearing damage is well established. Elevated sound levels cause trauma to the cochlear structure in the inner ear, which gives rise to irreversible hearing loss. Hearing loss can begin with prolonged exposure at 85 dB. For context, normal conversation is approximately 60 dB and noise from heavy city traffic can reach 85 dB. Motorcycles, firecrackers, and small firearms emit sounds in the range of 120 to 150 dB (NIDCD, 2008). Noise pollution also constitutes a significant factor of annoyance and distraction.

Construction activities have the potential to produce vibration levels that may be annoying or disturbing to humans and cause damage to nearby structures. Measurements of vibration are expressed in terms of the peak particle velocity (PPV), the maximum velocity experienced by any point in a structure during a vibration event. An indication of the magnitude of energy transmitted through vibration, PPV is often used in determining potential damage to buildings due to blasting and other construction activities.

State, county, and local noise regulations specify standards that restrict both the level and duration of noise measured at any given location. The maximum permissible environmental noise levels depend on the land use of the property generating the noise (i.e., industrial, resource-based, commercial, or residential) and the land use of the property receiving the noise.

The Keechelus and Kachess reservoirs are located in Kittitas County, which has no noise regulations; therefore, the Washington State regulations apply to the project. WAC 173-60 establishes limits on the levels and duration of noise that may cross property boundaries. The maximum permissible environmental noise levels established by WAC 173-60-040 are based on the Environmental Designation for Noise Abatement (EDNA), which is defined as an area or zone (environment) within which maximum permissible noise levels are established. There are three EDNA designations (WAC 173-60-030), which generally correspond to residential commercial and recreational, and industrial, agricultural, and silviculture uses:

- Class A – Lands where people reside and sleep (such as residential and certain recreation uses)
- Class B – Lands requiring protection against noise interference with speech (such as commercial and certain recreational uses where human habitation would not occur)
- Class C – Lands where economic activities are of such a nature that higher noise levels are anticipated (such as industrial, agricultural, and silviculture)

Noise-sensitive areas in the project vicinity include Class A and Class C EDNA. Table 3-29 summarizes the maximum permissible levels applicable to noise received at the three EDNAs.

Table 3-29. Maximum Allowable Noise Levels

Environmental Designation for Noise Abatement of Noise Source	Environmental Designation for Noise Abatement of Receiving Property		
	Class A (dBA)	Class B (dBA)	Class C (dBA)
Class A (residential and recreational)	55	57	60
Class B (commercial)	57	60	65
Class C (industrial, agricultural, and silvicultural)	60	65	70

Source: WAC 173-60

WAC 173-60-050, exempts certain noise sources and activities:

- Sounds created by traffic on public roads
- Sounds created by warning devices (e.g., backup alarms)
- Sounds from blasting and from construction equipment during the day (7:00 a.m. to 10:00 p.m. weekdays, 9:00 a.m. to 10:00 p.m. on weekends) in rural and residential districts

3.13.2 Kachess Reservoir Area

Kachess Reservoir is located in a relatively remote and sparsely populated forested area. Sensitive noise receptors at Kachess Reservoir include several houses or cabins located primarily on the west side of the reservoir. These rural residential receptors are primarily located along Kachess Lake Road and Via Kachess Road to the west of Kachess Reservoir. Areas of higher density rural residential or cabin use are located approximately 2,600 feet or more to the south of the proposed Kachess Lake Road portal. Recreational boaters, fishers, campers, hunters, and skiers may also use the Kachess Reservoir primary study area.

Typical daytime background noise levels in coniferous recreational settings range from 35 to 45 dBA in the summer and 30 to 35 dBA in the winter (USFS, 2007). Current sound levels at Kachess Reservoir are not uncharacteristic for the type of land uses found there, as vegetation and winter snowpack absorb human-caused noise. At the shore or on the reservoir surface, however, noise tends to amplify and travel farther in the absence of features that serve as sound barriers or absorbents. Major noise sources include traffic on Kachess Lake Road and Kachess Dam Road, recreational uses of the reservoir (e.g., motor boats and jet skis), and Easton State Airport. Managed by WSDOT and located less than 1 mile from the dam, the airport is used by an average of 30 aircraft per month. Use during summer is higher, when the airport supports firefighting efforts. Noise levels are lower in the winter as recreational uses and traffic levels on Kachess Lake Road decline.

3.13.3 Keechelus Reservoir Area

Like the Kachess Reservoir, the Keechelus Reservoir is located in a sparsely populated forested area. Sensitive noise receptors at Keechelus Reservoir are limited to several parcels of private land and recreational uses on the southwest side of the reservoir. These areas are primarily located along National Forest Road 5480 (NF-5480) more than 1.5 miles (7,920 feet) west of the proposed Keechelus portal site.

The primary noise source at Keechelus Reservoir is I-90, which runs along the north shore of the reservoir for approximately 5.5 miles. With I-90 along the shore and only slight noise attenuation over the open water, existing noise levels at Keechelus Reservoir are higher than those at Kachess Reservoir. However, there are fewer sensitive receptors than at Kachess Reservoir.

3.13.4 KCC Alignments

The proposed KCC alignments run generally east-west between the Kachess and Keechelus reservoirs. The conveyance areas are sparsely populated, with existing residential structures focused along Kachess Lake Road and Via Kachess Lake Road – areas within approximately 1.5 miles of the west shoreline of Kachess Reservoir. The only area of anticipated noise-generating construction activity within the KCC alignment is at the I-90 Exit 62 portal site, proposed for *Alternative 3B*. In all other areas, conveyance construction would occur below ground with a TBM. Only two rural residential receptors are located within the vicinity of the I-90 Exit 62 portal site (approximately 1,000 feet to the west). These properties directly abut the I-90 corridor, with loud existing daytime environmental noise levels from I-90. Other noise-sensitive receptors are located a minimum of 1.5 miles (7,850 feet) from the I-90 Exit 62 portal site.

3.14 Recreation

Potential impacts on recreation can occur through construction activities and disruption of boating access, fishing opportunities, and quality of recreation due to reservoir drawdown. These impacts are described in Chapter 4. The primary study area thus generally includes areas of water-oriented recreation that could be affected by the action alternatives. Water-oriented recreation is defined as both water-dependent activities such as boating, water skiing, fishing, and swimming, and activities that do not require but are enhanced by proximity to water access, such as camping, picnicking, and hiking. The primary study area includes the following locations:

- Kachess Reservoir Area (Section 3.14.1)
  - Kachess Reservoir and recreation areas adjacent to its shoreline
  - Areas where KDRPP facilities would be constructed
  - The KKC Kachess portal location

    - The route of the KDRPP transmission line
- Keechelus Reservoir Area (Section 3.14.2)
    - Keechelus Reservoir and recreation areas adjacent to its shoreline
    - Areas where KKC facilities would be constructed
    - Keechelus Reach of the Yakima River
    - Gold Creek and Cold Creek
- KKC Alignments (Section 3.14.3)
    - I-90 portal area
    - Areas overlying the KKC tunnel alignments

The extended study area is the Yakima River basin as a whole.

Recreationists visit the Keechelus and Kachess reservoir areas for its scenic setting, water recreation, and other recreation opportunities. Primary recreation activities include camping, fishing, swimming, boating, jet-skiing, paddle boarding, picnicking, hiking, horseback riding, biking, berry picking, and use of cabins. In the winter, recreational activities include cross-country skiing, snowshoeing, sledding, ice climbing, and snowmobiling. The majority of visitors to the reservoirs are from greater Seattle or from local areas, and population growth is increasing the demand for recreational opportunities. Visitors to the reservoirs are an important part of the economy of upper Kittitas County. Kachess has a higher number of recreational visitors than Keechelus Reservoir or the nearby Cle Elum Reservoir (Reclamation and Ecology, 2012). Recreational opportunities at Keechelus Reservoir are more limited, and it has the lowest annual visitation of all Yakima Project reservoirs.

Primary recreation activities in the Yakima River basin as a whole include fishing the reservoirs and rivers for cold-water species; whitewater boating and kayaking; motorized boating; and other related activities such as camping, hiking, picnicking, and wildlife viewing. Public demand for access to rivers, streams, and reservoirs continues to increase yearly. The Yakima River has a national reputation for its high-quality fly fishing, one of the fastest growing activities on the river. The Yakima River is also considered a “blue ribbon” trout stream. Although fishing occurs on the river throughout the year, the prime periods are February through May, September, and October. Campsites along the Yakima River mainstem are available near the Keechelus, Kachess, and Cle Elum reservoirs; and downstream in the Yakima River canyon between Ellensburg and Roza Dam. All of these sections of the Yakima River are also popular for swimming during summer months; rafting is popular in the Yakima River canyon. Figure 3-31 shows the location of formal recreation opportunities in the primary study area.

Figure 3-31. Recreation Facilities in the Primary Study Area

3.14.1 Kachess Reservoir Area

Two USFS campgrounds are located at Kachess Reservoir. The larger, Kachess Campground, is located on the west shore; a group site is located on the east shore. Kachess Campground includes two boat launches. Many additional recreation facilities, such as docks and informal boat launches, are associated with private development on the reservoir. According to USFS, an informal boat launch and beach area are present on the east shore of the lake. Developed recreation facilities in the Kachess Reservoir area are listed in Table 3-30.

Table 3-30. Recreation Facilities Affected by KDRPP

Facility	Facilities	Operator	Estimated Average Annual Use (visitors per year)
Recreation Facilities on Kachess Reservoir			
Kachess Campground	• 92 acres • Over 100 campsites and one group campsite • Two boat launches (one paved and one maintained gravel) • Picnic area	USFS	Campground–23,000 Boat launch–11,000
East Kachess Group Site	• One group campsite with a capacity of 100 people and 25 vehicles • Open by reservation only from Memorial Day to mid-September • Vault toilet	USFS	700 to 1,000
Recreation Facilities along the Proposed KDRPP Transmission Line Route			
Lake Easton State Park	• Boat launch • Camping, picnic, and RV areas	Washington State Parks	212,400
John Wayne Pioneer Trail in Iron Horse State Park	• Long-distance trail for nonmotorized recreation including walking, bicycling, horseback riding, cross-country skiing, dog sledding, and fishing	Washington State Parks	90,000

Campgrounds are primarily seasonal, generally open from Memorial Day to mid-September. The most popular campgrounds tend to stay open until the third week in September while smaller campgrounds tend to close the week after Labor Day. The Cle Elum Ranger District is the busiest in the area and its campgrounds tend to be completely booked on summer weekends with prereserved sites booked early in the season. The Kachess Campground is the most popular in the district and is normally completely booked most weekends during the summer season. Summer camping extends from the weekend prior to Memorial Day to late September (weather and snow permitting).

Reservoir drawdown causes the boat launches at Kachess Campground to be unavailable in late summer in some years (WDFW, 2014b). Figure 3-32 shows the maintained gravel boat launch and Figure 3-33 shows the paved boat launch at Kachess Campground.

Fishing is a major recreational use at Kachess Reservoir, with a year-round open season for kokanee, burbot, rainbow trout, and cutthroat. Daily catch limits for kokanee are 16 fish, while trout catches are limited to two fish of 12-inch minimum size. Fishing for bull trout is not allowed because it is an ESA-listed species. WDFW stocks the reservoir with kokanee and cutthroat fry (WDFW, 2014b).

Figure 3-32. Maintained Gravel Boat Launch at Kachess Campground

Figure 3-33. Paved Boat Launch at Kachess Campground

In addition to facilities listed in Table 3-30, the reservoir area also supports dispersed recreation (i.e., activity such as camping or motorized recreation occurring outside of developed recreation facilities). Dispersed recreation is common in the reservoir area, particularly during the summer when developed campsites are full and lower water levels afford increased access to shorelines. According to USFS, an informal boat launch and beach area are located on the east side of the reservoir. Visitors use dispersed recreation sites for camping and day use.

The transmission line for the KDRPP would extend from the existing Easton Substation to the proposed pumping plant. The route would likely cross the John Wayne Pioneer Trail in Iron Horse State Park and run adjacent to or through Lake Easton State Park. Information on these recreation facilities is included in Table 3-30. The transmission line would likely be built along existing routes following roads such as Kachess Dam Road and NF-4818, both of which provide access to recreational areas along the east side of Kachess Reservoir.

3.14.2 Keechelus Reservoir Area

Public recreational facilities in the vicinity of Keechelus Reservoir are listed in Table 3-31. Private facilities are also available; the community of Hyak and various recreation enterprises associated with Snoqualmie Pass Ski Area are located near the northwest corner of Keechelus Reservoir.

Table 3-31. Recreation Facilities Affected by KKC

Facility	Facilities	Operator	Estimated Average Annual Use (visitors per year)
Public Recreation Facilities on Keechelus Reservoir			
Keechelus Lake Boating Site and Picnic Area	• Boat ramp • Picnic area • Access to Iron Horse Trail and Lake Keechelus Trail	USFS	5,000
John Wayne Pioneer Trail in Iron Horse State Park	See Table 3-30		
Cold Creek Campground	Small campground associated with John Wayne Pioneer Trail	Washington State Parks	Included in average annual use for John Way Pioneer Trail
Roaring Creek Campground	Small campground associated with John Wayne Pioneer Trail	Washington State Parks	Included in average annual use for John Way Pioneer Trail
Recreation Facilities in the Bull Trout Enhancement Area			
Gold Creek Pond Picnic Area	• 20 picnic tables • ADA-accessible hiking trail • Portable toilets • Interpretive site	USFS	7,000
John Wayne Pioneer Trail in Iron Horse State Park	See Table 3-30		
Cold Creek Campground	See above		

Keechelus Reservoir supports recreational fishing, with a year-round open season for kokanee, burbot, rainbow trout, and westslope cutthroat. Daily catch limits for kokanee are 16 fish, while trout catches are limited to two fish of 12-inch minimum size. Fishing for bull trout is not allowed. WDFW stocks the reservoir with kokanee fry. According to WDFW, fishing pressure at Keechelus is light. The boat launch is not usable in late summer because of reservoir drawdown (WDFW, 2014c).

Cold Creek Campground is located at the mouth of Cold Creek. The Gold Creek Pond Picnic Area is located adjacent to Gold Creek north of I-90 and contains an approximately 27-acre pond formed by gravel mining for construction of I-90. Recreational facilities at the Gold Creek Pond Picnic Area are described in Table 3-31. Figure 3-34 shows a view of Gold Creek Pond from the ADA-accessible hiking trail.

Figure 3-34. Gold Creek Pond

3.14.3 KKC Alignments

Areas along the KKC alignments lie within the Okanogan-Wenatchee National Forest. Recreational uses include winter activities such as cross-country skiing, snowshoeing, sledding, and snowmobiling. The area is accessible for winter recreation through a series of sno-parks located on Federal land and operated by Washington State Parks as part of the State Winter Recreation Program. Information on sno-parks in this area is included in Table 3-32.

Table 3-32. Recreation Facilities between Keechelus and Kachess Reservoirs

Facility	Facilities	Operator	Estimated Average Annual Use (visitors per year)
Kachess Sno-Park, Gold Creek Sno-Park, and Price Creek Sno-Park	• Access to 23 miles of groomed snowmobile trails between Kachess and Keechelus reservoirs	USFS and Washington State Parks	Not available
Crystal Springs Sno-Park	• Currently used by WSDOT as a stockpile location for I-90 construction • Access to 51 miles of trails	USFS and Washington State Parks	Not available
Cabin Creek Sno-Park	• Access to 10 miles of groomed cross-country ski trails	USFS and Washington State Parks	Not available

The USFS closed the Crystal Springs Campground and thus it no longer provides recreational opportunities. The Crystal Spring Sno-Park remains open; it is located near the proposed I-90 Exit 62 portal.

3.15 Land and Shoreline Use

The basic mechanisms for impacts on land and shoreline use are changes in current land use; acquisition of private property or easements; compliance with applicable local, State, and Federal plans and regulations; and changes in irrigation water supply. Based on these mechanisms, the primary study area for land use includes the following:

- Kachess and Keechelus reservoirs, their shorelines, and their surrounding lands including areas along Gold and Cold creeks
- Areas that would be impacted by construction and operation of the proposed KDRPP transmission line

The extended area for land and shoreline use is the Yakima River basin.

The small residential community of Easton is located approximately 2 miles south of the Kachess Reservoir along I-90. The community of Hyak is located at Snoqualmie Pass directly northwest of Keechelus Reservoir and is predominantly a winter recreation destination. Several private parcels with houses or cabins are located on the west side of Kachess Reservoir along Kachess Lake Road and Via Kachess Road and in higher densities approximately 0.5 mile south of the proposed KKC Kachess Reservoir portal. Approximately 5 miles east of Kachess Reservoir is Cle Elum Reservoir, and south of the reservoir, the communities of Ronald, Roslyn, and Cle Elum. I-90 runs along the east side of Keechelus Reservoir and continues southeast past Kachess Reservoir, though the latter is not visible from I-90.

While private parcels are scattered throughout the area, the land surrounding the reservoirs is primarily in public ownership, managed by the USFS (Figure 3-35). Reclamation manages the reservoirs and land around the dams as part of the Yakima Project. Federal activities on the land are not subject to the local or State regulations, but Federal policies generally direct that activities of the Federal Government be consistent with local regulations to the extent feasible within the mission of each agency. The John Wayne Pioneer Trail runs west along Keechelus Reservoir, and is owned and managed by the Washington State Parks Department. Private land in the project area is regulated by Kittitas County zoning and comprehensive planning regulations.

Private and recreational development in the Proposed Action area (Section 3.14, Recreation) is located on the west side of Kachess Reservoir and to the northwest and southwest of Keechelus Reservoir. Private land exists mostly as large blocks surrounded by National Forest land. This "checkerboard" land pattern is part of the railroad legacy. In the late 1800s, the U.S. government deeded large blocks of land to railroad companies to support construction of the transcontinental railroad. Most of this land was eventually transferred to private timber companies, some of which was sold to other private parties for residential development.

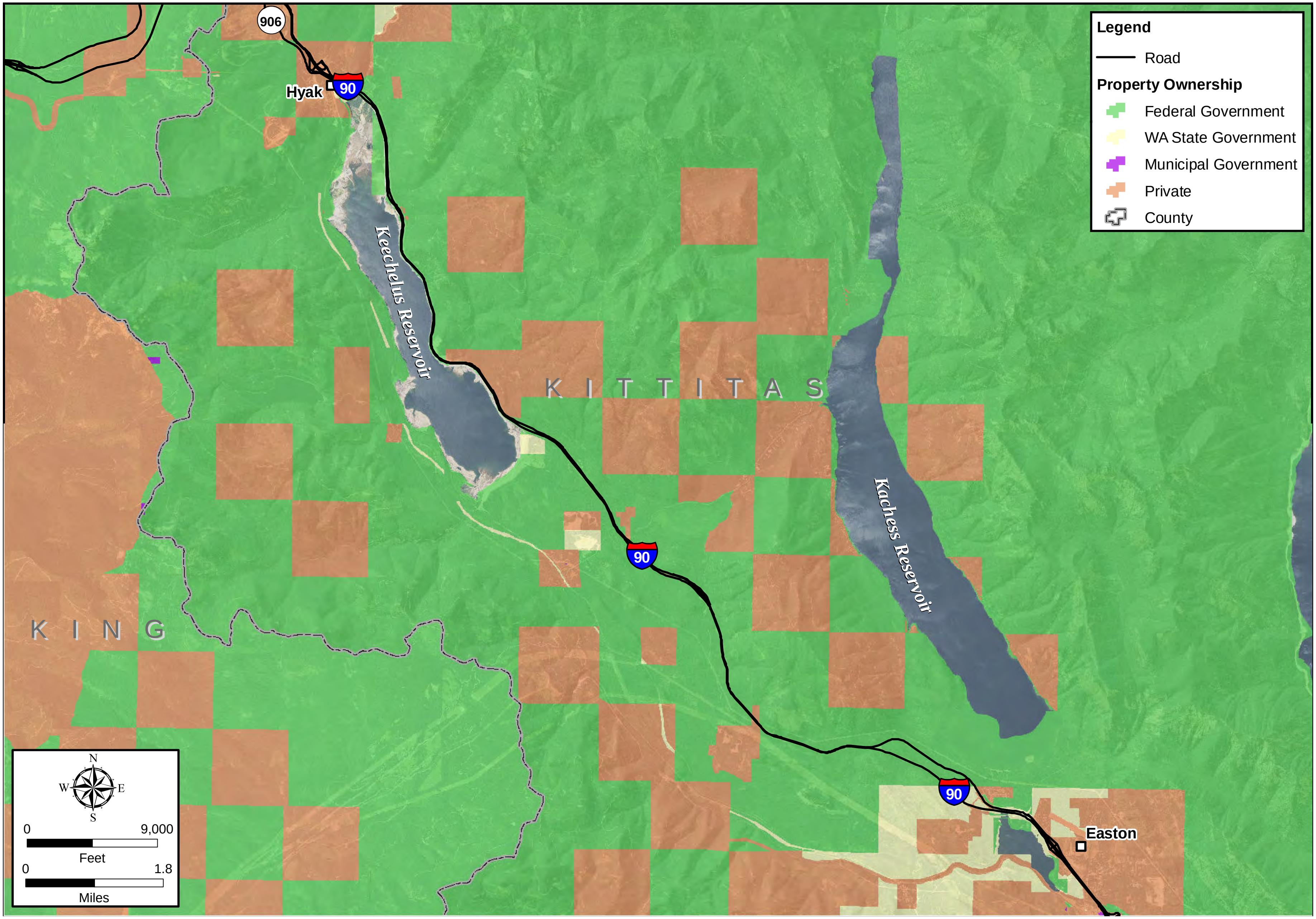

Figure 3-35. Land Ownership in the Primary Study Area

3.15.1 Federal Plans and Policies

An interagency agreement and a number of management plans and policies apply to the Federal land around Kachess and Keechelus reservoirs. This section discusses the interagency agreement and the most relevant plans and policies. Kachess and Keechelus reservoirs are located within the Okanagan-Wenatchee National Forest; therefore, plans and policies that guide USFS management of adjacent lands are discussed; however, USFS management policies are not implemented by Reclamation. There are currently no designated or proposed Wild and Scenic Rivers near Kachess or Keechelus reservoirs, so Wild and Scenic Rivers are not described in this section.

3.15.1.1 1987 Master Interagency Agreement with the Forest Service

Reclamation and the USFS cooperatively manage land in the Yakima Project under the 1987 Master Interagency Agreement (Master Agreement) between the two agencies, which provides guidance at a national level. The Master Agreement covers all Federal land nationwide that is within the National Forest System Lands and Reclamation Project Lands in the West. The Master Agreement establishes procedures for planning, developing, operating, and maintaining Reclamation water projects within or affecting land within the National Forest System, including facilitating coordination and cooperation with the USFS regarding areas of mutual interest or responsibility, or both. In addition, a Project Supplemental Agreement for Cle Elum Reservoir guides local interaction between the agencies.

The two agencies executed project supplemental agreements for the Yakima Project reservoirs. These local agreements identify what Federal land will be under the primary administration of Reclamation, referred to as the "Reclamation Zone." Reclamation retains control for construction, operation, maintenance, and protection of the project as identified in the Master Agreement and the project supplemental agreement. Pursuant to the YRBWEP legislation (Public Law 96-162) and the Reclamation Act of June 17, 1902, Reclamation has authority to perform feasibility study activities within the Yakima Project.

3.15.1.2 Northwest Forest Plan

The USFS and BLM adopted the Northwest Forest Plan in 1994, in response to the ESA listing of the northern spotted owl. The *Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl* (USFS and BLM, 1994a) and *Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl* (USFS and BLM, 1994b) include the policies of the Northwest Forest Plan. The plan designates a number of conservation measures and allocates land (including the Riparian Reserves discussed below) designed to comprise a comprehensive ecosystem management strategy for forest areas throughout the Northwest.

3.15.1.3 Okanogan-Wenatchee National Forest Plan

The USFS adopted the *Wenatchee National Forest Plan* in 1990 (USFS, 1990). The plan set management goals, objectives, and standards and guidelines for management of the forest. Currently, the USFS is developing an updated *Okanogan-Wenatchee National Forest Plan* and released the *Proposed Action for Forest Plan Revision, Okanogan-Wenatchee National Forest,* in June 2011 (USFS, 2011c).[3] The USFS will prepare an EIS on the proposed Forest Plan revision.

3.15.1.4 Riparian Reserves

The USFS maintains Riparian Reserves along the shoreline of reservoirs, streams, and wetlands. The Riparian Reserves along the Keechelus and Kachess reservoirs have 150-foot buffers from the maximum pool elevation of the reservoirs. The Riparian Reserves along the Yakima and Kachess rivers have 300-foot buffers (150 feet from each side of the river). The aquatic conservation strategy objectives defined in the Northwest Forest Plan must be met within the Riparian Reserves. Within Riparian Reserves where physical and biological processes are determined to be fully functional, the requirement is to maintain those functions. Within reserves where those processes have been degraded, they must be restored (USFS and BLM, 1994b).

3.15.1.5 Snoqualmie Pass Adaptive Management Area

The Kachess and Keechelus reservoirs lie within the Snoqualmie Pass Adaptive Management Area (SPAMA), which was established under the Northwest Forest Plan. The SPAMA includes 212,700 acres of National Forest land. Management goals for the SPAMA were established in 1997 in the *Snoqualmie Pass Adaptive Management Area Plan Final Environmental Impact Statement* (WSDOT, 2008). Within the SPAMA, the USFS focuses on ecosystem management, primarily restoration of late-successional forests and connecting wildlife habitat. The USFS is actively decommissioning roads within the SPAMA and timber harvest is allowed only where it benefits restoration.

3.15.1.6 Wilderness Areas

The Wilderness Act (16 USC §§1131-1136) established the National Wilderness Preservation System. Wilderness areas are intended to preserve “areas where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain…” Each agency administering any wilderness area is responsible for preserving the area's wilderness character. The Alpine Lakes Wilderness Area is located north of the reservoirs.

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[3] The USFS administratively combined the Okanogan and Wenatchee National Forests in 2000. The USFS changed the administrative name to Okanogan-Wenatchee National Forest in 2007.

3.15.2 Local Land Use Planning

Except in areas managed by Reclamation and USFS, land use planning in the primary study area is under the jurisdiction of Kittitas County. The majority of land in and around the Keechelus and Kachess reservoirs is zoned Commercial Forest (Kittitas County Code Title 17 Zoning) (Figure 3-36), a zone is intended to

> *provide for areas of Kittitas County wherein natural resource management is the highest priority and where the subdivision and development of lands for uses and activities incompatible with resource management are discouraged consistent with the commercial forest classification policies of the comprehensive plan.*

The land use classification of Forest and Range also exists within the primary study area. The intent of this land use is to “provide for areas of Kittitas County wherein natural resource management is the highest priority and where the subdivision and development of lands for uses and activities incompatible with resource management are discouraged.”

According to Kittitas County Municipal Code Section 17.15.060.1, both the Commercial Forest and Forest and Range land uses allow for utilities, which are defined in Section 17.61 as the

> *supply, treatment and distribution, as appropriate, of gas, gas meter stations, municipal domestic and irrigation water, sewage, storm water, electricity, telephone, fiber-optic and cable television. Such utilities consist of both the service activity along with the physical facilities necessary for the utilities to be supplied…*

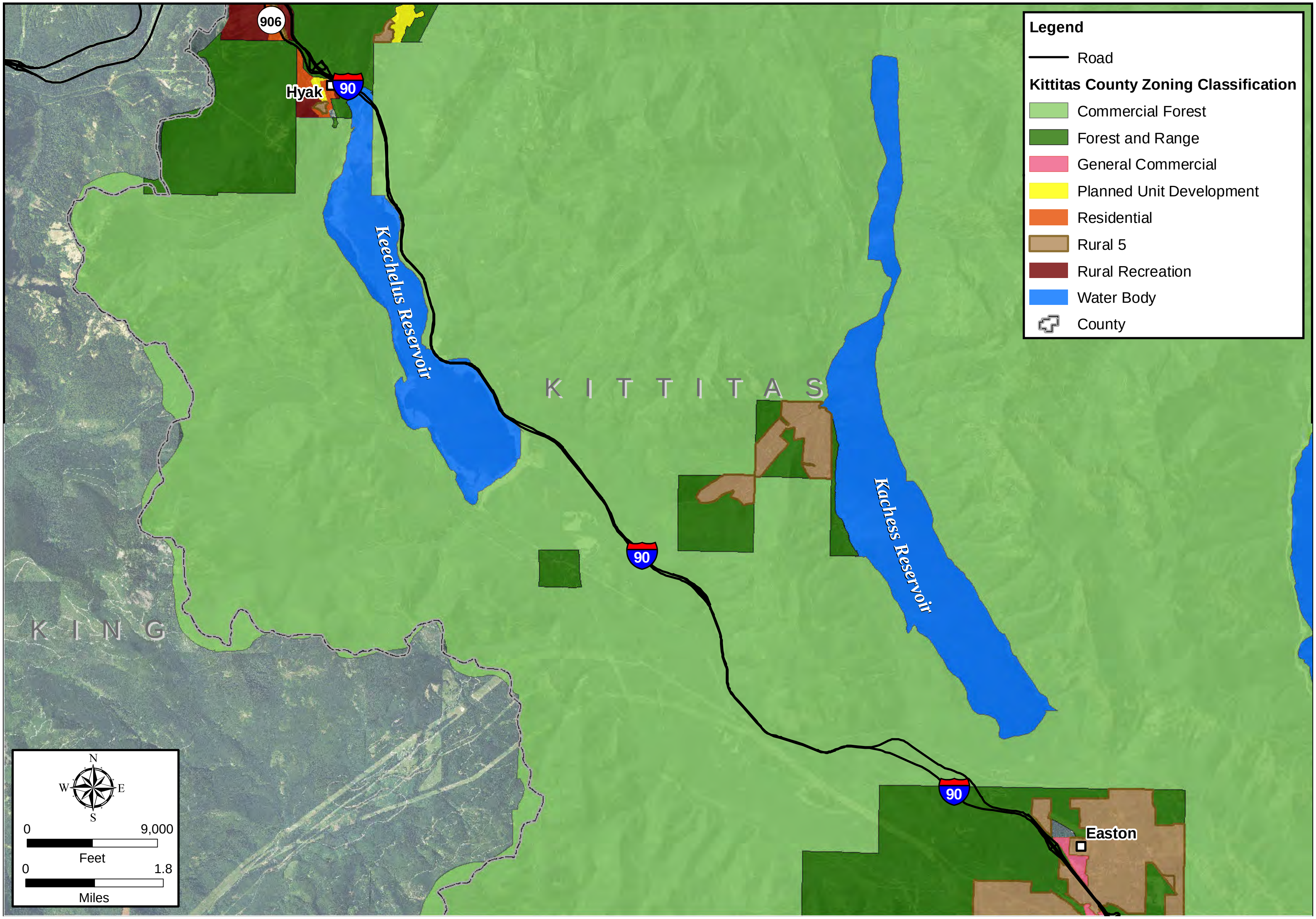

Figure 3-36. Zoning in the Primary Study Area

3.15.2.1 Shoreline Management Act

Keechelus and Kachess reservoirs are designated as lakes of statewide significance under the State Shoreline Management Act. Lakes with this status are those over 1,000 acres in area. Under the Kittitas County Shoreline Master Program (SMP), adopted in 1975, the shoreline of both reservoirs is designated a conservancy shoreline environment. The intent of this designation is to sustain natural resource development while maintaining the natural character of the shoreline area. Under the SMP, shoreline protection measures (called "shoreline works") are permitted in a conservancy designation only where they “do not substantially change the character of that environment.” Projects are not permitted “if the possibility [exists] that downstream properties and natural river systems will be adversely affected by any such development” (Kittitas County, 1975).

Kittitas County released a revised final draft of its updated SMP in July 2014. Under this draft SMP, the majority of both reservoirs would be designated as rural conservancy. Portions of both the west and east sides of Kachess Reservoir would be designated as shoreline residential (Kittitas County, 2014).

The Kittitas County SMP does not apply to Federal land, including the portions of the reservoir shorelines owned and managed by Reclamation and USFS. However, the SMP applies to privately owned land.

3.15.2.2 Critical Areas

Land under the jurisdiction of Kittitas County is subject to the Kittitas County Critical Areas Ordinance (CAO) adopted in 1994 (Kittitas County Code Title 17A). The county expects to adopt an updated CAO in 2015. The CAO establishes buffers around wetlands and riparian habitat. It also regulates development in frequently flooded areas, geologically hazardous areas, big game winter range areas, and aquifer recharge areas.

3.16 Utilities

Public utilities include electricity, drinking water, wastewater, and telecommunications. The potential impacts on utilities are increased demand on utilities such as electricity and interruption of services; see Section 4.16 for details. The primary study area for utilities includes the areas that could be directly affected by construction and operation of the Proposed Action, areas within approximately 1 mile, road corridors that may be used for construction, and campgrounds adjacent to the shorelines of both reservoirs. The extended study area is the entire Yakima basin; refer to Section 3.17 of the Integrated Plan for details regarding utilities in the extended study area (Reclamation and Ecology, 2012). Groundwater wells are described in Section 3.5, Groundwater.

3.16.1 Electrical Service and Infrastructure

Electric power within Kittitas County is provided by Kittitas County Public Utility District (PUD) #1 and Puget Sound Energy (PSE). PSE provides electrical service to Kachess and Keechelus reservoirs and vicinity but coverage is localized to developed areas. Transmission lines are typically routed overhead on utility poles or towers. PSE delivers power to both Kachess and Keechelus Dams with a 12.5-kilovolt (kV) line which is transformed to 3-phase power at the dams. The existing dams are gravity operated, and thus power requirements would be for functions such as lighting and ventilation.

Transmission lines to residential and recreational areas around Kachess Reservoir are located parallel to Kachess Lake Road. No transmission lines are located along the reservoir shoreline. Overhead transmission lines run approximately 0.5 mile from the shoreline along the west side of Keechelus Reservoir. A Bonneville Power Administration high-voltage transmission line (345 kilovolts) is located south of both reservoirs and north of I-90. It then crosses I-90 and continues west on the west side of Keechelus Reservoir.

3.16.2 Water Supply

Water supplies for Kachess Reservoir and vicinity are provided by community water systems or individual private wells. Water supplies for Keechelus Reservoir and vicinity are provided by the Snoqualmie Utility District on the north end of the reservoir. See Section 3.5, Groundwater, for information about wells in the Proposed Action area.

3.16.3 Wastewater and Solid Waste

No large wastewater collection or treatment systems are located near Kachess or Keechelus reservoirs. Most residential and recreational developments located in the Kachess Reservoir and vicinity use on-site sewer (OSS) systems for wastewater treatment. Typically, individual homes and cabins are connected to an individual OSS. In some areas, septic from several buildings may be routed to a single OSS. The Kachess Lake Campground uses an OSS. East Kachess Group Campground uses vault toilets, which are pumped. Most wastewater systems are located along the west side of the reservoir. The highest concentrations of OSS are located in the Kachess Ridge residential area on the west side of the reservoir.

At Keechelus Reservoir, the Snoqualmie Pass Utility District provides sanitary sewer management on the north end of the reservoir. No other areas around the reservoir have residential or commercial development. Roaring Creek and Cold Creek campgrounds have vault toilets. Gold Creek Pond and Picnic Area has portable toilets.

Solid waste services are provided by Kittitas County. In unincorporated Kittitas County, garbage collection is voluntary. The many residents and businesses that choose to self-haul transport their waste to either the Cle Elum or Ellensburg Transfer Station (Kittitas County, 2010).

3.16.4 Telecommunications

FairPoint Communications and CentryLink provide telecommunication services in the primary study area. The majority of the landline facilities are located in county-owned rights-of-way and on private easements. Telecommunications lines, which are made of either copper wire or fiber optic cable, are routed overhead on utility poles and underground. When routed over rivers, telephone lines may be attached to bridges. There are no transcontinental fiber optic lines in the vicinity of Kachess or Keechelus reservoirs. Communications (cellular) towers are present along major travel corridors in the project vicinity. A fiber optic line is buried in the John Wayne Pioneer Trail alignment at Cold Creek.

3.17 Transportation

This section addresses the roads, highways, and airports serving the areas where the Proposed Action would be located. In addition, this section addresses emergency response, school bus routes, and other means of transportation (e.g., bicycles and snowmobiles). Impacts on transportation systems can occur in association with construction vehicles and disruption, and long-term impacts can be associated with increased traffic volumes. Accordingly, the primary study area for the Proposed Action covers the following locations:

- Areas where construction vehicle traffic and operation trips would occur following construction (Figure 3-37), including land on the east side of Keechelus Reservoir (for KKC)
- The east, west, and south sides of Kachess Reservoir (for KKC and KDRPP)
- Between the Keechelus and Kachess reservoirs (for KKC)
- Additional areas north and west of Keechelus Reservoir where activities for the BTE would occur

The extended study area includes I-90and the transportation systems in the Yakima River basin. No navigable waterway transportation system or facilities exist in the primary or extended study areas.

The major highway in the primary study area is I-90. I-90 runs directly adjacent to the northwest shore of Keechelus Reservoir for approximately 5.5 miles through the western portion of the primary study area. I-90 also passes a quarter to half a mile from the south shore of Kachess Reservoir. WSDOT plans to construct safety and reliability improvements in this portion of I-90 starting in spring 2015. The primary planned activities are pavement replacement and addition of a new lane in each direction as described for the No Action Alternative (see Section 2.4).

Other highways in the Yakima River basin include I-82, Federal highways 97 and 12, and State and local highways 10, 821, 410, 24, 240, and 241. The Burlington Northern Santa Fe (BNSF) Railroad runs generally parallel to I-90 in the upper basin, west of the Yakima River.

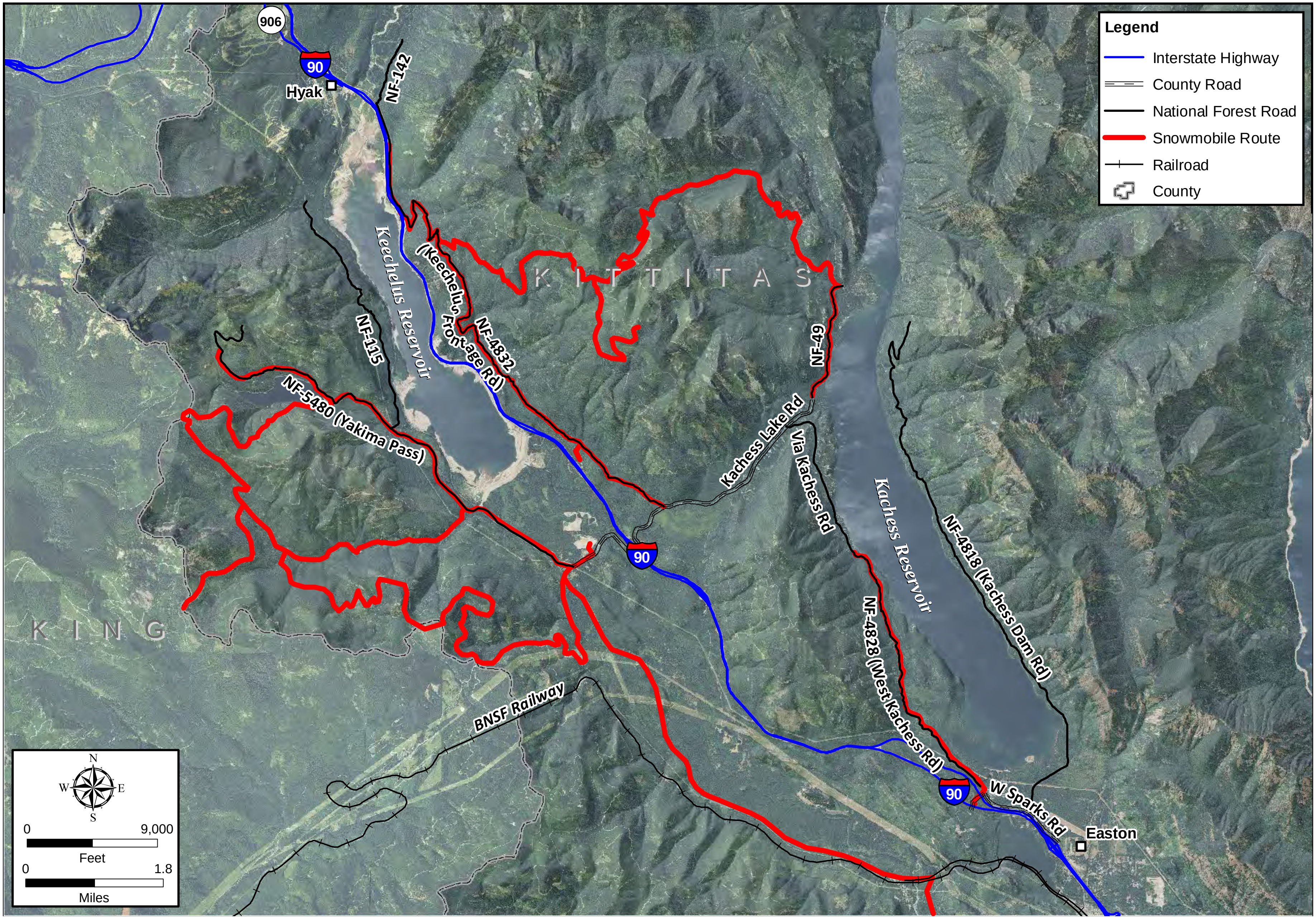

Figure 3-37. Local Transportation Facilities in the Primary Study Area

3.17.1 Kachess Reservoir Area

Local access to the Kachess Reservoir area from I-90 is via West Sparks Road, Kachess Dam Road, and Kachess Lake Road. West Sparks Road is a two-lane roadway that turns into Via Kachess Road (NF-4828/West Kachess Dam Road). NF-4828 parallels the south half of the west side of the reservoir. Kachess Dam Road is a two-lane roadway that turns into NF-4818. NF-4818 parallels the east side of the reservoir. Access to the northern half of the reservoir is generally limited.

3.17.2 Keechelus Reservoir Area

Local access to the Keechelus Reservoir area is provided by Kachess Lake Road and NF-4832. Kachess Lake Road runs from the Kachess Reservoir west to an interchange at I-90 southeast of Keechelus Reservoir. NF-4832 runs parallel to Keechelus Reservoir and I-90 to the southeast until intersecting Kachess Lake Road in the center of the primary study area. Much of the rest of the primary study area is inaccessible by vehicle. Easton State Airport is approximately 3,500 feet to the southeast of the Kachess Reservoir. Access to Cold Creek on the west side of the reservoir is via NF-115; however, NF-115 is currently gated and under a USFS closure order. Access to Gold Creek on the north side of the reservoir is via NF-114.

3.17.3 KKC Alignments

Kachess Lake Road is the primary two-lane roadway that runs east to west between the two reservoirs. Near the west side of the Kachess Reservoir, it turns into NF-49 and turns to the north to parallel the reservoir. Kachess Lake Road intersects I-90 southeast of the Keechelus Reservoir.

3.17.4 Primary Study Area Road Conditions and Standards

The local roads in the primary study area are used primarily by recreationists and local residents. Kachess Lake Road and West Sparks Road are two-way, painted, paved, residential Kittitas County roads. Via Kachess Road and Kachess Dam Road are two-way, unpainted, paved, rural Kittitas County roads. All four roads are maintained by Kittitas County and plowed in the winter. The USFS maintains NF-4828, NF-4818, NF-49, NF-114, NF-115, NF-4930, and NF-4832. NF 114, NF-115, NF-4930, NF-4828, and NF-4832 are unpaved, single-lane roads; NF-4818 and NF-49 are two-way, unpainted, paved roads. The USFS does not plow the roads under their jurisdiction. All USFS maintained roads are assumed to be primitive.

The Kittitas County Road Standards (KCRS) provide standards for roadway design that must also meet WSDOT and American Association of State Highway and Transportation Officials (AASHTO) standards. Table 3-33 describes the major components of KCRS county road design standards and width requirements.

Table 3-33. Roadway Design Standards

Average Daily Traffic[1]	Functional Classification	Lane Width (feet)	Shoulder Width (feet)	Total Pavement Width (feet)
0-399	Local	11	1	24
400-749	Local or Collector	11	2	26
750+	Local or Collector	11	3	28

[1]Vehicles per day

3.17.5 Primary Study Area Traffic and Transportation Safety Information

Average daily traffic volumes, based on actual traffic counts, for I-90 are included in WSDOT's *2013 Annual Traffic Report*. The average daily traffic for I-90 in the area of the Keechelus and Kachess reservoirs is approximately 28,500 trips (approximately 14,250 vehicles heading in each direction on the highway) (WSDOT, 2013). The peak travel period on I-90 in the project area is generally in the afternoon between 4 and 6 pm and typically has about 1,500 vehicles going in each direction per hour (WSDOT, 2011). Traffic counts for the local roads in the primary study area were unavailable; however, for purposes of analysis, it is assumed that the peak period on local roads would occur between 7 and 9 am and 4 and 6 pm.

The *Kittitas County Long Range Transportation Plan* (2008) lists none of the primary study area roads or intersections as high accident locations (high accident locations are defined as corridors and intersections that had three or more accidents during the 2004 to 2006 analysis period).

3.17.6 Emergency Response

Emergency response in the primary study area is provided by Kittitas County Fire District 8, which operates three fire stations (81, 82, and 83) and Kittitas County Fire District 3, which operates one fire station (31). Fire Station 31 in Easton provides emergency response to the Easton area, including the southern portion of Kachess Reservoir. Fire Station 83, located southwest of the Stampede Pass Interchange at I-90, provides emergency response to Keechelus Reservoir. Fire Stations 81 and 82, located on the west side of Kachess Reservoir, provides emergency response to the west side of Kachess Reservoir and the area between I-90 and the reservoir.

3.17.7 Other Means of Transportation

As described in Section 3.14, snowmobiling is a common winter activity in the primary study area. Designated snowmobile routes are found in the primary study area along NF-4832, NF-5480, and NF-49. In addition, snowmobiling is permitted along Kachess Lake Road when it has been plowed. There would also be snowmobiling anticipated along undesignated routes throughout the area, but as they are undesignated, the exact locations are unknown. Sno-parks, described in more detail in Table 3-22, provide parking and access to winter recreation activities. Kachess Sno-park has 100 parking spaces; Price Creek Sno-park has 25 parking spaces; Gold Creek Sno-park has 200 parking spaces; Crystal Springs Sno-park has 150 parking spaces; and

Cabin Creek Sno-park has 200 parking spaces (Washington State Parks, 2014). Bicycling is permitted along all roads in the primary study area except along I-90.

3.17.8 School Bus Routes

One school, Easton K-12 School, is located to the southeast of the primary study area in Easton, Washington. School bus service is provided to students living within school district boundaries; however, the exact routes change based upon where students are living. In addition, the majority of students would be anticipated to live to the southeast of the primary study area in Easton and Cle Elum, Washington (Easton School District, 2014).

3.18 Cultural Resources

Cultural resources are the aspects of the environment, physical and intangible, natural and built, that have cultural value of some kind to a group of people (King, 2013). These resources encompass a broad range and can include specific places associated with traditional ceremonies or practices, artifacts, structures, archeological sites, objects, buildings, and landscapes associated with a period of time, a person, or historical movements. They also include Native American human remains and funerary offerings. Federal agencies are required to identify and evaluate the significance of cultural resources located within the area of potential effects (APE) with a Federal undertaking that has the potential to cause effect. For the purposes of cultural resources, the primary and extended study areas coincide with the APE.

The information on cultural resources included in this DEIS are based on the *Draft Investigation of the Yakima Basin Integrated Plan: Keechelus Lake, Kachess Lake, Cle Elum Lake* prepared by the Yakama Nation Cultural Resources Program (YCIP) (YCIP, 2014). The YCIP surveys do not include all of the Proposed Action areas; however, the survey provides adequate data for comparing and evaluating alternatives. Reclamation will conduct additional surveys prior to construction.

3.18.1 Regulatory Setting

A number of Federal laws and regulations require Federal agencies to consider and protect cultural resources. In particular, the National Historic Preservation Act (NHPA) of 1966, as amended, and its implementing regulations for Section 106, set out the requirements and process to identify and evaluate historical resources, determine effects on these resources, and resolve adverse effects on significant National Register-eligible properties that occur as a result of the agency's permitted undertaking. Under Section 110 of the NHPA, the responsibility of the Federal agency that owns or formally manages land includes identifying and managing the historical resources on that land, even when there is no new undertaking. The Native American Graves Protection and Repatriation Act (NAGPRA); the American Indian Religious Freedom Act; EO 13007, Protection of Native American Sacred Sites; and other Federal, State, or Tribal laws and policies, where applicable, also protect cultural resources.

For cultural resources, an effect occurs when the proposed project would disrupt or impact a prehistoric or historical archeological site or a property of historical interest or cultural significance to a community or ethnic or social group. These effects are adverse if they would occur to cultural resource sites that are listed, or eligible for listing, on the NRHP. Other adverse effects would include disturbance to graves and cultural items protected under NAGPRA and destruction of, or preventing access to, Indian sacred sites protected under EO 13007. Examples of the types of impacts that could potentially result from the Proposed Action include destruction, disturbance, disassociation, or alteration of a protected resource due to installation of the KDRPP and KKC facilities, utilities, and pipeline; road construction; temporary construction facilities; habitat improvement activities; and changes in reservoir levels.

The State of Washington also regulates cultural resources through SEPA, which requires identification of cultural resources within a proposed project area. The State requires that agencies propose measures to reduce or control impacts on these resources. Under SEPA, the Washington Department of Archaeology and Historic Preservation (DAHP) provides formal opinions on the significance of sites and the impact of proposed projects on sites. Other State laws governing historical resources protect Native American graves (RCW 27.44), abandoned historical cemeteries (RCW 68.60), and archaeological sites (RCW 27.53). These laws contain clauses regarding the inadvertent discovery of cultural resources during activities such as construction. Washington State Governor's EO 05-05 requires State agencies to review capital projects with DAHP and the affected Tribes; conduct appropriate surveys; and take reasonable actions to avoid, minimize, or mitigate adverse effects to historical properties. Because the Proposed Action is subject to Section 106 of the NHPA, EO 05-05 does not apply.

3.18.2 Archaeological and Historical Overview

A historical overview of the Proposed Action area is included in the *Draft Investigation of the Yakima Basin Integrated Plan: Keechelus Lake, Kachess Lake, Cle Elum Lake* report and is summarized below (YCIP, 2014). The preliminary cultural resource survey includes background research on the reservoirs and field investigations and initial evaluations of the structural elements of the Proposed Action.

Archaeological evidence of occupation of indigenous groups in the area of the Kachess and Keechelus reservoirs has been dated to at least 12,000 years before present based on the discovery of a Paleo-Indian Clovis point found at the south end of nearby Cle Elum Reservoir. From 11,000 years before present and extending to 4,500 years before present, indigenous groups in the area had a predominantly mobile lifestyle. From 4,500 to 250 years before present, indigenous groups shifted towards a less mobile lifestyle. An increase in semi-subterranean dwellings and food storage occurred during this period.

The Proposed Action area is within the territory of the Kittitas or upper Yakama Tribes. The Kittitas occupied the lowland Kittitas and Yakima valleys and the headwaters of the Yakima River. The Kittitas used Keechelus and Kachess lakes for summer homes annually. According to information provided by the Colville Confederated Tribes, the Proposed Action is also within the traditional territory of the Wenatchi, one of the Confederated Tribes of the Colville Reservation (Colville Confederated Tribes). Historical records also indicate Indian trails extended between historical Kachess and Cle Elum lakes, from Keechelus Lake to Snoqualmie Falls, and from Keechelus Lake to Roaring Creek and the Yakima Pass. Leaf-shaped projectile points have been collected along the margins of the historical Kachess and Keechelus lakes.

The first documented Euro-Americans in the area were fur traders of the Northwest Company in 1814. In 1853 and 1854, Territorial Governor Isaac Stevens sent George McLellan to find a route for a wagon road over what is now Snoqualmie Pass.

In 1855, the Tribes and Bands that are officially known today as the Confederated Tribes and Bands of the Yakama Nation (which includes the Kittitas) signed the Treaty of 1855, ceding over 6 million acres to the U.S. Government. The Treaty allocated the Yakama Nation a reservation located in Yakima County and the north boundary of Klickitat County set aside for the sole use and benefit of the Yakama people. The Yakama Nation retained the exclusive rights to hunt, fish, and gather on the ceded land, which includes the area around Kachess and Keechelus reservoirs.

Passage of the Homestead Act in 1862 and construction of a wagon road over Snoqualmie Pass in 1865 brought about an increase in Euro-American activity throughout the project area. Early interest focused on mineral resources, including coal, gold, and iron. In 1867, the Northern Pacific Railroad sent surveyors to the Snoqualmie Pass area to establish access routes across the Cascade Range. Commercial interests in the project area increased, including coal mining and timber harvesting, in the late 1800s and throughout the 1900s. In 1886, coal was discovered in the east Cascades. The coal mines, including those in the Roslyn and Ronald area, fueled the trains of the Northern Pacific Railroad.

Congress authorized Reclamation’s Yakima Project in 1905, which led to construction of an extensive water storage and irrigation system, including Kachess and Keechelus reservoirs. A crib dam was constructed on Kachess Lake in 1903 to provide water for a canal in Kittitas County. Reclamation began construction on the current Kachess Dam in 1910 and finished in 1912. Reclamation constructed Keechelus Dam between 1911 and 1917.

3.18.3 Known and Reported Resources in the Kachess Reservoir Area

The YCIP conducted a preliminary cultural resources survey in late 2013 in the area of the proposed locations for the facilities associated with KDRPP east shore pumping plant. The survey was conducted as part of the *Draft Investigation of the Yakima Basin Integrated Plan* (YCIP, 2014). The report included research in the DAHP database, which lists 18 previously recorded archaeological sites at Kachess Reservoir, eight of which are located within 1 mile of the proposed KDRPP project area. The other 10 sites are located around the immediate shoreline or drawdown area of the reservoir. Of the total 18 sites, 14 are precontact, one is historical (a

Civilian Conservation Corps camp), and three are multicomponent, with both historical and precontact elements.

According to the *Draft Investigation of the Yakima Basin Integrated Plan*, the natural Kachess Lake has spiritual and ceremonial associations to the Yakama Nation. The YCIP suggests that the lake and associated precontact archaeological resources may qualify as Traditional Cultural Properties (TCPs).

The area investigated for KDRPP consists of a corridor 200 feet in width and nearly 3 miles in length, on the south and east shores of the reservoir. The survey focused on the general location of proposed KDRPP facilities and no survey was conducted of the entire lake shoreline, although the database search included the entire shoreline. Once precisely defined, a supplemental survey of the KDRPP facilities would have to be performed. The survey did not document any new sites, but determined that one existing site (45KT1014) is located within the survey corridor. The site is at the south end of the reservoir near Kachess Dam. The site was originally located in 1993 and identified as a fishing camp and dam construction camp. Previously identified artifacts include fire-cracked rock, flake fragments related to stone tool manufacture, large primary flakes of course-grained material, cores, projectile points and knives, scrapers, and celts (axe-like tools) likely associated with the Indian campsite and fish dam located at the outlet of the lake. Several historical features and artifacts associated with construction of Kachess Dam were also documented. During the 2013 survey, numerous artifacts and features were observed at the documented site and southeast of the original site boundary. Artifacts and features observed included 11 linear earthen features; metal, glass, wood, and concrete artifacts; cans; cables; whiteware; and bricks.

3.18.4 Known and Reported Resources in the Keechelus Reservoir and KKC Conveyance Areas

The preliminary cultural resources survey conducted in late 2013 included the areas of the proposed facilities at the Keechelus Dam and Kachess portal areas (YCIP, 2014; Central Washington University, 2014). The reports included research in the DAHP database, which lists 63 previously recorded archaeological sites at Keechelus Reservoir. Twenty-three of the sites are within 1 mile of the project APE, with the remaining 39 located around the immediate shoreline or drawdown area of the reservoir. Of the total 63 sites, 21 are precontact; nine are multicomponent, having both historical and precontact elements; and 33 are historic.

According to the *Draft Investigation of the Yakima Basin Integrated Plan*, the predam historical Keechelus Lake has legendary associations with the Yakama Nation (YCIP, 2014). The YCIP suggests that the lake and associated precontact archaeological resources may qualify as TCPs.

The area investigated in the field for the KKC consists of the locations of tunnel portals and associated intake and discharge features, and was surveyed with 100 percent coverage. This survey area includes locations at Keechelus Dam and on the west shore of Kachess Reservoir.

The conveyance route alternatives were sampled but not surveyed with 100 percent coverage since a tunnel is proposed below the depth with the potential to contain cultural resources.

Shovel tests were negative for cultural material, but one previously recorded site (WF303) was located within the survey corridor. Site WF303 is an extensive multicomponent site consisting of numerous features and artifacts, some of which are associated with construction of Keechelus Dam. During the cultural resources survey for KKC, a previously undocumented precontact component to the site was identified. The component consists of a modified lithic tool of chert material. A scatter of historical debris consistent with the original site documentation was also observed, consisting of a 50-gallon steel drum, a 1-quart oil can, a steel drum piece, and a galvanized pail.

3.19 Indian Sacred Sites

Executive Order 13007, Indian Sacred Sites (May 24, 1996), directs Federal agencies to accommodate access to, and ceremonial use of, Indian sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of such sacred sites on Federal land. The EO further directs agencies to provide reasonable notice for proposed land actions or policies that may restrict future access to or ceremonial use of, or adversely affect the physical integrity of, sacred sites. The EO defines a sacred site as a "specific, discrete, narrowly delineated location on Federal land that is identified by an Indian Tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion."

Sacred sites may include ceremonial areas and natural landmarks that are religious or symbolic representations. Sacred sites are typically identified during the Section 106 portion of the NHPA survey, or during Government-to-Government consultation. Further, staff from the YCIP prepared a draft Cultural Resources Report for the project (YCIP, 2014). To date, no sacred sites have been identified in the Proposed Action area.

3.20 Indian Trust Assets

Indian Trust Assets (ITAs) are legal interests in property held in trust by the United States for federally recognized Indian Tribes or individual Indians. ITAs may include land, minerals, federally reserved hunting and fishing rights, federally reserved water rights, and instream flows associated with trust land. The General Allotment Act of 1887 allotted land to some Tribes, while others were allotted land through treaty or specific legislation until 1934, when further allotments were prohibited. These allotments are ITAs.

Federally recognized Indian Tribes with trust land are beneficiaries of the Indian trust relationship. The U.S. Government acts as trustee. No one can sell, lease, or otherwise encumber ITAs without approval of the U.S. Government.

As stated in the 1994 memorandum, *Government-to-Government Relations with Native American Tribal Governments*, Reclamation is responsible for the assessment of project effects on Tribal trust resources and federally recognized Tribal Governments. Reclamation is tasked to actively engage and consult federally recognized Tribal Governments on a Government-to-Government level when its actions affect ITAs.

The U.S. Department of the Interior Departmental Manual Part 512.2 delegates the responsibility for ensuring protection of ITAs to the heads of bureaus and offices (Department of the Interior, 1995). The Department is required to "protect and preserve ITAs from loss, damage, unlawful alienation, waste, and depletion" (Department of the Interior, 2000). Reclamation is responsible for determining if a Proposed Action has a potential to affect ITAs.

While the majority of ITAs are located on-reservation, ITAs can also occur outside reservation boundaries. Consequently, several Tribes have a historical presence or cultural interest in the Proposed Action area. These include the Yakama Nation, the Colville Confederated Tribes, and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR).

The Proposed Action lies within land ceded in the Yakama Treaty of 1855. The treaty established the Yakama Reservation, which lies to the south of the Proposed Action area, and reserved the following:

> *The exclusive right of taking fish in all the streams, where running through or bordering said reservation, is further secured to said confederated tribes and bands of Indians, as also the right of taking fish at all usual and accustomed places, in common with the citizens of the Territory, and of erecting temporary buildings for curing them: together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land.*

The Yakama Nation is a major partner in the development and implementation of the Integrated Plan. The Yakama Nation has been involved in all aspects of the Integrated Plan, including the KDRPP, KKC and BTE.

3.21 Socioeconomics

Reclamation selected the primary study area for assessing socioeconomic impacts based on the location of KDRPP, KKC, and BTE and the areas where most of the direct impacts resulting from these proposals would occur, including affected agricultural areas. Based on these factors, Reclamation defined the extended study area for the socioeconomic analysis as the Yakima River basin region, encompassing Kittitas, Benton, Yakima, and Franklin counties in the State of Washington (referred to here as the four-county study area).

Key parameters of socioeconomic conditions used in this DEIS include commonly applied regional economic measures of industry output, personal income, and jobs (employment).

- Output is the broadest measure of economic activity and represents the value of production. Output includes intermediate goods plus the components of value added (including personal income), so the two measures (output and personal income) are not additive.
- Personal income consists of personal income and business income. Personal income represents wages and salaries, as well as other payroll benefits such as health and life insurance, retirement payments, and noncash compensation. Business income (also called proprietor's income) represents the payments received by small business owners or self-employed workers.
- Jobs are full- and part-time. In some instances, this analysis refers to "job years," which represents the equivalent of one full-time job for 1 year. Ten job years, for example, could refer to 1 job for 10 years, 5 jobs for 2 years, 10 jobs for 1 year, and so forth.

This analysis uses IMPLAN (Impact Analysis for PLANning) modeling software to examine the baseline conditions and economic impacts of the Proposed Action (IMPLAN, 2014). IMPLAN is an input-output (IO) model that works by tracing how spending associated with a specific project circulates through the defined impact area. Input-output models measure commodity flows from producers to intermediate and final consumers. Purchases for final use (final demand) drive the model. Industries produce goods and services for final demand and purchase goods and services from other producers. This buying of goods and services (indirect purchases) continues until "leakages" from the region (imports and value added) stop the cycle. These indirect and induced effects can be derived mathematically by using a set of multipliers. The multipliers describe the change of output for each regional industry caused by a $1 change in final demand for any given industry.

The IMPLAN data files were compiled from a variety of sources for the study area, including the U.S. Bureau of Economic Analysis, the U.S. Bureau of Labor, and the U.S. Census Bureau. Input-output models are static; they measure impacts based on economic conditions at any given point in time. The input-output models for this study were based on 2012 IMPLAN data, the most recent data available.

Socioeconomic elements key to the extended study area include: income and employment, total lodging supply, and property values, as discussed below.

3.21.1 Income and Employment

As of 2012, total employment across all industrial sectors within the IMPLAN data set used for impact analyses totaled 3.8 million for Washington State as a whole, and 272,584 for the four-county study area which contains the Yakima basin (Table 3-34 and Table 3-35).[4] Total employment in the agriculture sector in 2012 for the four-county study area was 34,948 with output of $4.4 billion. The service industry is responsible for the most employment at the State and four-county scales, and is roughly double the next largest sector, manufacturing, at each scale. Agriculture is the third largest sector at the four-county scale, but seventh at the state level, demonstrating the relatively greater importance of agriculture in the study area compared to the state as a whole.

Table 3-34. Washington State Economic Sectors, 2012

Aggregate Industry Sector	Output ($ millions)	Personal Income ($ millions)	Jobs	Average Annual Wage	Output/Job
Agriculture	$15,315	$3,081	127,832	$24,101	$119,804
Utilities	$5,946	$589	5,310	$110,915	$1,119,834
Construction	$31,223	$10,027	197,660	$50,727	$157,964
Manufacturing	$158,900	$25,512	296,995	$85,900	$535,028
Trade	$60,647	$23,721	529,263	$44,818	$114,587
Transportation and Information	$17,410	$5,808	108,610	$53,475	$160,301
Services	$297,514	$93,446	1,959,013	$47,701	$151,870
Government	$58,887	$40,985	606,529	$67,573	$97,088
Total	$660,325	$203,168	3,833,798	$52,994	$172,238

Source: IMPLAN, 2014; 2012 IMPLAN Washington State Data

[4] Klickitat County is not included because of the small portion of intersection between the county and watershed boundaries.

Table 3-35. Four-County Study Area Economic Sectors, 2012

Aggregate Industry Sector	Output ($ millions)	Personal Income ($ millions)	Jobs	Average Wage	Output/Job
Agriculture	$4,391	$1,019	34,948	$29,158	$125,653
Utilities	$561	$39	510	$76,956	$1,100,190
Construction	$2,054	$621	13,114	$47,349	$156,630
Manufacturing	$6,959	$880	16,228	$54,215	$428,844
Trade	$3,996	$1,260	37,022	$34,035	$107,926
Transportation and Information	$1,550	$540	12,189	$44,336	$127,170
Services	$15,844	$4,934	113,746	$43,378	$139,295
Government	$3,573	$2,497	44,826	$55,700	$79,715
Total	$38,929	$11,790	272,584	$43,254	$142,816

Source: IMPLAN, 2014; 2012 IMPLAN Washington State Data (Benton, Franklin, Kittitas, and Yakima counties).

3.21.2 Lodging Supply and Demand

The supply of rental housing within commuting distance of the Proposed Action is shown in Table 3-36. The most current data available on rental vacancy rates from the U.S. Census Bureau are from the period 2008 to 2012. Averaged over that time, the rental vacancy rate was about 2.5 percent in Cle Elum. For all of Kittitas County, the rate was 9 percent, and in Yakima County, it was almost 4 percent. At these rates, there were approximately 10 units available for rent in Cle Elum, and over 1,800 units available throughout Kittitas and Yakima Counties. The supply of available rental units can fluctuate throughout the year and over time based on local sources of demand for housing.

Table 3-36. Rental Housing Unit Availability, 2010

Geographic Area	Number of Rental Housing Units (2010)	Units Available for Rent (2012)	Rental Vacancy Rate (2012) (Percent)
Cle Elum, WA	427	10	2.5
Kittitas County, WA	7,433	721	9
Yakima County, WA	30,911	1,105	3.6

Source: U.S. Census Bureau, 2012

Numerous temporary accommodations are located within commuting distance of the Proposed Action. Table 3-37 shows the types of accommodations by location. Cle Elum, the largest community closest to the Proposed Action, has 10 hotels or motels, 3 recreational vehicle (RV) parks, and 29 campgrounds. Additional hotels and motels are also available in Ellensburg and Yakima, and a few additional RV parks and campgrounds are located in the vicinity of these communities. Additional hotel, motel, and RV park accommodations are available in the Tri-Cities area, at the southernmost extent of the study area.

Table 3-37. Temporary Accommodations

Location	Lodging Services			Commuting Distance from Cle Elum, WA[2]
	Hotels/Motels	RV Parks	Campgrounds[1]	
Cle Elum	10	3	29	0 Miles
Ellensburg	11	2	3	25 miles
Yakima	15 33,686	336,412	2,726	8% 60 miles

Source: Google Maps, 2014
[1] Campgrounds include sites where RVs and tent camping are permitted
[2] Distances are estimated using Google Maps.

The temporary accommodations in the Cle Elum area support the recreational uses in the region, and operate at or near capacity during the summer months. Hotels and motels are busy during the summer season, operating with few vacancies on weekends and about three-quarters full on weekdays. During the rest of the year, hotels and motels in Cle Elum operate with vacancy rates around 80 to 85 percent, though sometimes slightly lower on weekends.

Campgrounds in the primary study area (described in Section 3.14, Recreation) are primarily seasonal, generally open from Memorial Day to mid-September. The most popular campgrounds tend to stay open until the third week in September while smaller campgrounds tend to close the week after Labor Day.

Hotels and motels in Ellensburg and Yakima have more capacity and more availability throughout the summer season than those in Cle Elum. On average, they have a 25 percent vacancy rate during the summer, with occasional weekends with no vacancy. Occupancy drops off during nonsummer months, when hotels are booked at less than 50 percent.

3.21.3 Property Values

A mix of public and private property surrounds Keechelus and Kachess reservoirs. Table 3-38 and Table 3-39 show the characteristics of parcels within 0.1-mile of each reservoir. More private parcels surround Kachess Reservoir than Keechelus Reservoir, and the private property has a higher market value, both in total and average value per acre.

Table 3-38. Characteristics of Properties Surrounding Keechelus Reservoir

	Number of Parcels	Acres[1]	Total Market Value
Private	24	147	$2.4 Million
Public	24	5,798	N/A

Source: Kittitas County Assessor, 2014
[1] Total acres associated with parcels within 0.1-mile of the reservoir.

Table 3-39. Characteristics of Properties Surrounding Kachess Reservoir

	Number of Parcels	Acres[1]	Total Market Value
Private	197	1,394	$63.2 Million
Public	36	9,578	N/A

Source: Kittitas County Assessor, 2014
[1] Total acres associated with parcels within 0.1-mile of the reservoir.

3.22 Environmental Justice

The method used to analyze impacts on environmental justice is analysis of demographic information as described in Chapter 4. Based on this method, the primary study area for environmental justice is Kittitas County Census Tract 9751, which includes Keechelus and Kachess reservoirs and other areas within the construction footprint. The extended study area is the Yakima River basin as a whole, represented in the demographic analysis as Kittitas, Yakima, and Benton counties. The State of Washington is also included in the analysis for comparison.

3.22.1 Regulatory Setting

Environmental justice addresses the fair treatment of people of all races and incomes with respect to actions affecting the environment. Fair treatment implies that no group should bear a disproportionate share of negative impacts. EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,* dated February 11, 1994, requires agencies to identify and address disproportionately high and adverse human health or environmental effects of their actions on minorities and low-income populations and communities, as well as the equity of the distribution of the benefits and risks.

According to the Council on Environmental Quality (CEQ), to be considered a minority population, the population of the impacted area must either exceed 50 percent minority, or the minority population percentage of the impacted area must be meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. Low-income populations in an impacted area should be identified using the annual statistical poverty thresholds from the Census Bureau (CEQ, 1997).

3.22.2 Study Area Population Characteristics

Table 3-40 provides the numbers and percentages of population by racial category for Census Tract 9751, Yakima River basin counties, and the State of Washington. The information is based on the 2008 to 2012 U.S. Census American Community Survey, the most recent consistent source of information for the basin. The data have likely changed since the survey was taken, but this information is a reliable indicator of population percentages.

Table 3-40. Race and Ethnicity

Race	Primary Study Area Number (Percent)	Kittitas County Number (Percent)	Yakima County Number (Percent)	Benton County Number (Percent)	State of Washington Number (Percent)
Total Population	5,733 (100)	40,954 (100)	242,454 (100)	175,424 (100)	6,738,714 (100)
One race	5,625 (98.1)	40,021 (97.7)	234,123 (96.6)	170,055 (96.9)	6,427,398 (95.4)
White	5,439 (94.9)	36,731 (89.7)	180,685 (74.5)	143,741 (81.9)	5,304,864 (78.7)
Black or African American	7 (0.1)	311 (0.8)	1,888 (0.8)	2,437 (1.4)	238,255 (3.5)
American Indian and Alaska Native	50 (0.9)	340 (0.8)	9,741 (4.0)	1,787 (1.0)	93,416 (1.4)
Asian	34 (0.6)	1,074 (2.6)	2,397 (1.0)	4,710 (2.7)	484,047 (7.2)
Native Hawaiian and Other Pacific Islander	2 (0.0)	2 (0.0)	145 (0.1)	206 (0.1)	39,246 (0.6)
Some other race	93 (1.6)	1,563 (3.8)	39,267 (16.2)	17,174 (9.8)	267,570 (4.0)
Two or more races	108 (1.9)	933 (2.3)	8,331 (3.4)	5,369 (3.1)	311,316 (4.6)
Racial Minority	294 (5.1)	4,223 (10.3)	61,769 (25.5)	31,683 (18.1)	1,433,850 (21.3)
Hispanic or Latino (of any race)	204 (3.6)	3,164 (7.7)	108,920 (44.9)	32,471 (18.5)	754,366 (11.2)
Minority[1]	405 (7.1)	5,760 (14.1)	126,631 (52.2)	44,681 (25.5)	1,853,452 (27.5)

Source: US Census Bureau, 2012

[1] Population for the “Minority” category includes the U.S. Census categories “Nonwhite, not Hispanic or Latino” and “Hispanic or Latino”.

In comparison to the State of Washington and other Yakima River basin counties, the primary study area has a smaller percentage of total racial minority and ethnic (Hispanic or Latino) populations. Additional potentially affected minority populations include members of the Yakama Nation, the Colville Confederated Tribes, and the Confederated Tribes of the Umatilla Indian Reservation. While census data are available for recognized Indian reservations, specific data for Tribal members are not. Tribal members may be affected regardless of whether they reside on their reservations. Members of the Yakama Nation and other Tribes outside the primary or extended study areas may currently use natural resources in the Keechelus and Kachess reservoir areas and may do so in the future. They may use these resources disproportionately to the total population. The subsistence use of renewable natural resources (such as fish, wildlife, and vegetation) by Tribes or other populations in the reservoir areas has not been quantified. Recreational users of the area could potentially include minority populations, but no information is available on the demographics of recreationists.

Table 3-41 provides income, poverty, unemployment, and housing information for the same census tract (9751). Low-income populations are identified by several socioeconomic characteristics. As categorized by the 2008 to 2012 U.S. Census American Community Survey, specific characteristics include income (median family and per capita), percentage of the population below poverty (families and individuals), unemployment rates, and substandard housing. Median family income and per capita income for the primary study area are greater than those of Kittitas County as a whole, but less than those of the State. The primary study area has a lower percentage of families and individuals below the poverty level than do Kittitas County and the State.

Table 3-41. Income, Poverty, Unemployment, and Housing

	Primary Study Area	Kittitas County	Yakima County	Benton County	State of Washington
Income					
Median household income	$44,360	$41,739	$44,256	$60,300	$59,374
Per capita income	$27,971	$22,542	$19,610	$28,171	$30,661
Percent below poverty level					
Families	7.4	11.0	17.2	9.4	8.7
Individuals	11.8	21.8	22.3	12.9	12.9
Percent unemployed	12.5	9.9	10.8	6.7	8.9
Percent of Housing					
1.01 or more occupants per room	0.9	2.4	7.0	2.5	2.7
Lacking complete plumbing facilities	0.6	0.3	1.0	0.1	0.5

Source: US Census Bureau, 2012

Other measures of low income, such as unemployment and substandard housing, characterize demographic data in relation to environmental justice. The unemployment rates for the primary study area are slightly higher than those for the county and State. Substandard housing units are overcrowded and lack complete plumbing facilities. The percentage of housing units lacking complete plumbing facilities in the primary study area was slightly greater than that of the county and State, but not meaningfully so. The percentage of occupied housing units with 1.01 or more occupants per room in the primary study area was lower than the percentages for the county and State.

3.23 Environmental Health and Safety

The primary study area for environmental health and safety includes properties that could be disturbed during construction, the shorelines and beds of Kachess and Keechelus reservoirs, and locations within a 1.5-mile radius from proposed facilities, including Gold and Cold creeks. The extended study area is the entire Yakima River basin. Construction activities could expose hazardous materials remaining from agricultural, mining, construction, or other prior uses. Section 4.23 also examines the impacts of the potential drawdown of Kachess and Keechelus reservoirs on health and safety, such as steep banks and obstructions in the water. This section describes the results of database searches for known hazardous sites. Around the reservoirs, the public is currently exposed to existing safety hazards such as steep slopes to access to the reservoir bed, and submerged hazards for boaters. Refer to Section 3.2 Earth for more information regarding the geology and soil conditions.

3.23.1 Kachess Reservoir Area

There are no known National Priority List sites in the primary or extended study areas (EPA, 2014b). One hazardous materials site, an underground storage tank (UST) on private property in Easton, is located within the extended study area. There are no documented hazardous materials sites in the primary study area (Ecology, 2014f).

3.23.2 Keechelus Reservoir Area

There are no known National Priority List sites in the primary or extended study areas (EPA, 2014b). No hazardous materials sites are present within the primary study area (Ecology, 2014f). One UST is located at the WSDOT maintenance area near Gold Creek.

3.23.3 KKC Alignments

No known National Priority List or hazardous materials sites are located in the primary or extended study area (EPA, 2014b; Ecology, 2014f).

CHAPTER 4 - ENVIRONMENTAL CONSEQUENCES

Chapter 4 Environmental Consequences

4.1 Introduction

This chapter documents possible direct, indirect and cumulative environmental impacts that could result from implementing the Proposed Action and alternatives described in Chapter 2 and listed below:

- *Alternative 1 – No Action*
- *Alternative 2A – KDRPP East Shore Pumping Plant*
- *Alternative 2B – KDRPP South Pumping Plant*
- *Alternative 3A – KKC North Tunnel Alignment*
- *Alternative 3B – KKC South Tunnel Alignment*
- *Alternative 4 – Combined KDRPP and KKC*

This chapter considers the impacts of short-term construction activities and the impacts that could occur over the longer term (operation and maintenance activities) for each resource. This chapter identifies mitigation measures that could avoid or reduce adverse impacts for each resource. To help the reader, the footer of each page of this chapter identifies which resource is discussed on that page.

Sections at the end of the chapter include:

- Section 4.24 Relationship of the Proposed Action to the Integrated Plan
- Section 4.25 Cumulative Impacts
- Section 4.26 Unavoidable Adverse Impacts
- Section 4.27 Relationship between Short-Term and Long-Term Productivity
- Section 4.28 Irreversible and Irretrievable Commitments of Resources
- Section 4.29 Energy and Depletable Resources
- Section 4.30 Environmental Commitments

The impact analyses consider both the primary study areas and extended areas defined for each resource in Chapter 3. For many resources, impacts of the Proposed Action are confined to the primary study area and the impact analysis focuses on the primary study area. The terms “effects” and “impacts” as used in this document are synonymous and could be beneficial or detrimental.

For NEPA purposes, the Council on Environmental Quality (CEQ) regulations define direct effects as effects “…which are caused by the action and occur at the same time and place” and indirect effects as effects "…which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable" (40 CFR 1508.8(a)-(b)). Indirect effects may include growth-inducing effects, changes in land use, changes in population density, or changes in growth rate and related effects on natural systems. SEPA defines environmental impacts as "effects on the elements of the environment" (WAC 197-11-752). SEPA does not separate direct and indirect impacts.

CEQ regulations define a cumulative effect as "…the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions" (40 CFR 1508.7). Section 4.25 discusses cumulative impacts for resources impacted by the project and for the Proposed Action as a whole.

4.2 Earth

4.2.1 Methods and Impact Indicators

Impact indicators for Earth and criteria for determining impact significance to the Earth are shown in Table 4-1. All criteria were assessed relative to *Alternative 1 – No Action.*

Methods. Reclamation assessed short-term impacts on earth by estimating the soil area that would be temporarily disturbed for construction (e.g., construction of tunnel shafts, construction roads, staging areas), the duration of soil exposure, placement of spoils, the extent of construction activities (e.g., dredging and fill) that alter existing slopes, and the stability of Kachess Reservoir slopes. Information from site-specific geologic studies is incorporated.

Impact indicators. The extent and severity of impacts are influenced primarily by the magnitude of the area of soil exposure, the duration of exposure, and the effectiveness of measures employed to control erosion.

Operation impacts on earth are assessed based on project characteristics and proposed plans that consider seismic and slope stability risks associated with the proposed facilities and their long-term ability to withstand any future seismic event.

Operation impacts on earth are also based on the long-term erosion potential associated with each proposal, and the potential for operational changes to create adverse effects from increased erosion.

Table 4-1. Impact Indicators and Significance Criteria for Earth Resources

Impact Indicator	Significance Criteria
Erosion during construction	Erosion that may not be controlled using BMPs or sediment control measures.
Seismic and stability risks associated with the proposed facilities and their long-term ability to withstand future seismic events	High instability with a reasonable chance of substantial damage associated with proposed facilities. Low ability to withstand future seismic events without causing substantial damage, injury, or death.
Long-term reservoir rim stability risks associated with lowering Kachess Reservoir	High risk of slope instability around reservoir rim causing sediment production
Long-term erosion associated with proposed project	Increased erosion eventually leading to the undermining of improvements, foundations, roads and walkways, and increased turbidity. Incision on exposed Kachess Reservoir slope.

4.2.2 Summary of Impacts

With *Alternative 1 – No Action*, shoreline erosion, if any, and seismic hazards would continue as under existing conditions. Under the action alternatives, short-term impacts to earth could occur from erosion of sediments exposed to rainfall or wind during construction if appropriate erosion control measures are not implemented. Potential long-term impacts to earth resources include an increase in shoreline erosion, primarily from changes to reservoir levels from KDRPP or KKC, as well as potential adverse effects that could result from a seismic event (Table 4-2).

The BTE actions would be implemented as part of all the action alternatives and would have short-term impacts to earth if appropriate erosion control measures are not implemented. No long-term erosion problems are expected with the completed BTE actions. Gold Creek restoration actions and Cold Creek fish passage improvements would reduce erosion potential over existing conditions, and would not increase slope stability or seismic risk.

Table 4-2. Summary of Impacts for Earth Resources

Impact Indicator	Summary of Impact
Erosion during construction	Impacts not significant during construction for any of the action alternatives because of required erosion control BMPs.
Seismic and slope stability risks associated with the proposed facilities and their long-term ability to withstand any future seismic event	Impacts not significant during construction and operation because of implementation of geotechnical practices and code requirements. Operational impacts not anticipated because of seismic design standards and project characteristics.
Long-term reservoir rim stability risks associated with lowering Kachess Reservoir	Slope stability concerns on the reservoir rim may occur with a lowering of reservoir levels for *Alternatives 2A* and *2B*. These would likely be scattered around the reservoir rim and are unlikely to be prevented.
Long-term erosion	Impacts not significant during operation because of project design and proposed monitoring measures.

4.2.3 Alternative 1 – No Action Alternative

Under *Alternative 1 – No Action*, any existing areas of the two reservoirs that are experiencing erosion under current water levels and wave action would continue to erode unless stabilized through other habitat improvement measures. Erosion is not a major issue because Reclamation operates reservoir pool levels within an established operating range that supports stable conditions. Drainage patterns within the Yakima River basin that may be currently experiencing or causing erosion would also continue. Any future seismic activity would expose existing improvements to potential adverse effects or damage dependent on the magnitude and duration of the seismic events. As part of *Alternative 1 – No Action*, Reclamation would continue to implement its existing shoreline inventory program on the reservoirs including management of shoreline erosion. In considering the effects of the WSDOT I-90 Phase 2A project, the primary study area would remain largely unchanged (WSDOT, 2008). Potential temporary impacts from construction of Phase 2A would be mitigated with BMPs. No long-term impacts on earth resources are anticipated from the WSDOT I-90 Phase 2A project.

4.2.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.2.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Erosion during Construction

Short-term impacts on earth resources could occur related to clearing and vegetation removal, construction and use of access routes and staging areas (e.g., equipment staging, temporary concrete batch plant), stockpiling, soil compaction, excavation, filling, and hauling. These construction activities would expose bare ground through clearing and grading (up to a total of approximately 75 acres) and through the movement of large construction equipment. These activities could remove the vegetative root structure that stabilizes soil and helps to protect the soil surface from erosion. The newly exposed soil would have high erosion potential if exposed during the rainy season or in the presence of surface water that could mobilize sediment. Any areas that are disturbed during construction would be subject to increased erosion if proper control measures are not implemented, and these areas would remain vulnerable until post-construction site reclamation is completed. Reclamation would implement erosion control measures (described in Section 4.2.9.1) to reduce the potential for erosion during construction.

Construction of the pumping plant shaft would occur in stages beginning with excavation of the shaft perimeter, which essentially builds a slurry wall around the perimeter of the shaft location to allow for excavation of the shaft. The soil cuttings generated during this activity would be mixed with the slurry and pumped back up to the surface to a processing unit that separates the soil for offsite disposal. Use of this equipment would minimize the exposure of excavated materials to erosive forces by containing the soil cuttings in the processing unit. The center of the shaft would then be excavated using conventional excavation equipment. Other measures such as conveyors and cranes would be used to remove dirt from the excavation as it progresses farther beneath the surface beyond the reach of conventional excavation equipment. According to the preliminary geotechnical investigation, the subsurface conditions consist of 155 feet of soil overlying bedrock (known as the Swauk Formation, primarily sandstone and siltstone with coal seams) (Reclamation, 2014a). Once bedrock is encountered, excavation would be done with confined drilling and localized blasting and the materials removed through conveyors and cranes. The pumping plant would connect to a new intake line constructed within bedrock that is completed through horizontal drilling from a barge. The tunnel lining would be designed to withstand the maximum expected external pressure, which would be the highest of either the pressure due to earth loads and groundwater, or the estimated grouting pressures (Reclamation and Ecology, 2014m). Construction of the discharge line would consist of more traditional trench excavation for approximately 7,000 feet to the discharge point downstream using with conventional equipment such as excavators. An estimated total of approximately 117,000 cubic yards (cy) of material would be excavated under *Alternative 2A - KDRPP East*

Shore Pumping Plant. The transmission line would have minimal impacts to earth resources as it would follow existing road and transmission line rights-of-way to the extent feasible. Additional analysis would be conducted as part of PSE's route study and environmental analysis.

Reclamation would conduct all construction activities in accordance with a National Pollutant Discharge Elimination System (NPDES) General Construction Permit. As part of the NPDES permit, the contractor would prepare a Stormwater Pollution Prevention Plan (SWPPP) that would include best management practices (BMPs) that govern construction activities and contain erosion control measures. Implementation of these BMPs would reduce short-term erosion potential to less than significant levels because they have proven effective in minimizing erosion for construction project in similar environments.

Seismic and Slope Stability Risks

Construction would include dredging to remove sediment in a cone-shaped area centered on the intake location. Reclamation would monitor slope stability of submerged sediment to reduce the risk of instability of the exposed soil created by dredging. If Reclamation observes slope instability, it could implement contingency plans, such as slope flattening. In general, preliminary designs call for maintaining final slopes that are no greater than 3-to-1 (horizontal to vertical) which is widely considered a stable slope for most conditions. However, when subjected to subaqueous conditions, flatter slopes may be required. Reclamation would conduct final geotechnical studies of sediment stability and shear strength testing prior to construction and to finalize treatment options, and would perform monitoring following commencement of dredging.

A landslide is mapped near the east end of the intake tunnel about a half mile from Kachess Reservoir (Reclamation and Ecology, 2014l). Minimal aboveground improvements are proposed; therefore, the main potential impact of this mapped landslide would be during construction of the tunnel discharge. Reclamation would conduct a site-specific geotechnical investigation prior to commencement of construction in this area (Reclamation and Ecology, 2014l). The geotechnical investigation would include stability measures to reduce any identified hazards to less-than-significant levels. In addition, a qualified geotechnical engineer would design stable, engineered slopes at the intake and would be onsite during construction to ensure understanding of potential landslide hazards and recommend changes to construction methods if necessary.

Coal mine subsidence and issues with intake tunnel construction due to intersection with an old excavated coal seam are potential hazards that could compromise tunneling efforts. According to a search of records with the Washington Department of Natural Resources Geological Survey, no coal mines are mapped for this area (Reclamation and Ecology, 2014l). The nearest known coal mine is near Roslyn, approximately 12 miles to the east of the reservoir. Therefore, it is reasonable to conclude that there is no significant hazard related to the presence of historic coal mines at the project site.

Bull Trout Enhancement

Construction associated with stream restoration would require clearing and vegetation removal, excavation, hauling, and placement of wood and rock. Replacement of the NF-4382 Bridge would require heavy machinery to install the bridge supports and decking. These activities could increase erosion and cause soil compaction. Construction at Gold Creek would potentially expose large areas of bare ground, but construction would occur in phases and construction sites would be restored immediately after construction. Additional analysis of potential earth resource impacts will be developed as the design of these actions progresses.

Impacts to earth would be temporary. BMPs to reduce potential erosion during construction would be employed, the construction sites would be regraded and revegetated immediately following construction, and construction would not increase slope stability or seismic risks. Therefore, no significant impacts are anticipated.

4.2.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Long-term Erosion

Following construction, areas above the reservoir shoreline that were disturbed by construction would be stabilized by revegetation. Paved or other impervious surfaces such as the pumping plant would be designed to include drainage control features for management of stormwater, minimizing the potential for erosion (see Section 4.4).

During drought years, Reclamation would utilize KDRPP and to draw the reservoir down below the current low pool elevation, exposing previously submerged sediments to the effects of erosion. Precipitation, wave action, or wind could case surface erosion of these sediments. Where the 31 tributary creeks enter the main Kachess Reservoir, water in the creeks is likely to incise the newly exposed earth. The extent and depth of incision would depend on the underlying geologic unit and the volume and velocity of water. The mobilized sediment would be deposited at the toe of the steep slope and could create turbidity until the creeks reach equilibrium with their new conditions. Where the creeks find their original channels (abandoned about 100 years ago when the reservoir was inundated), erosion would be short-lived.

In the Little Kachess basin, the side slopes have had about 100 years to come to equilibrium with the 22 creeks that flow into it. The new drawdown conditions are unlikely to change conditions there because the Little Kachess basin becomes separated from the main reservoir at elevation 2,220 and little additional drawdown would occur in Little Kachess basin (Figure 4-1). The river between the two lake basins would incise down through sediment that has accumulated in the past 100 years on the 20- to 40-degree slope until it reaches its former natural channel. This incision would result in turbidity plumes in the reservoir, and may create unstable slopes and danger to people trying to access the river. Reclamation would monitor the areas with the potential for increased erosion as part of its existing annual shoreline inventory program. If erosion is identified as a problem, Reclamation would implement appropriate erosion control measures. See Section 4.4, Surface Water Quality, for a discussion of sedimentation and water quality.

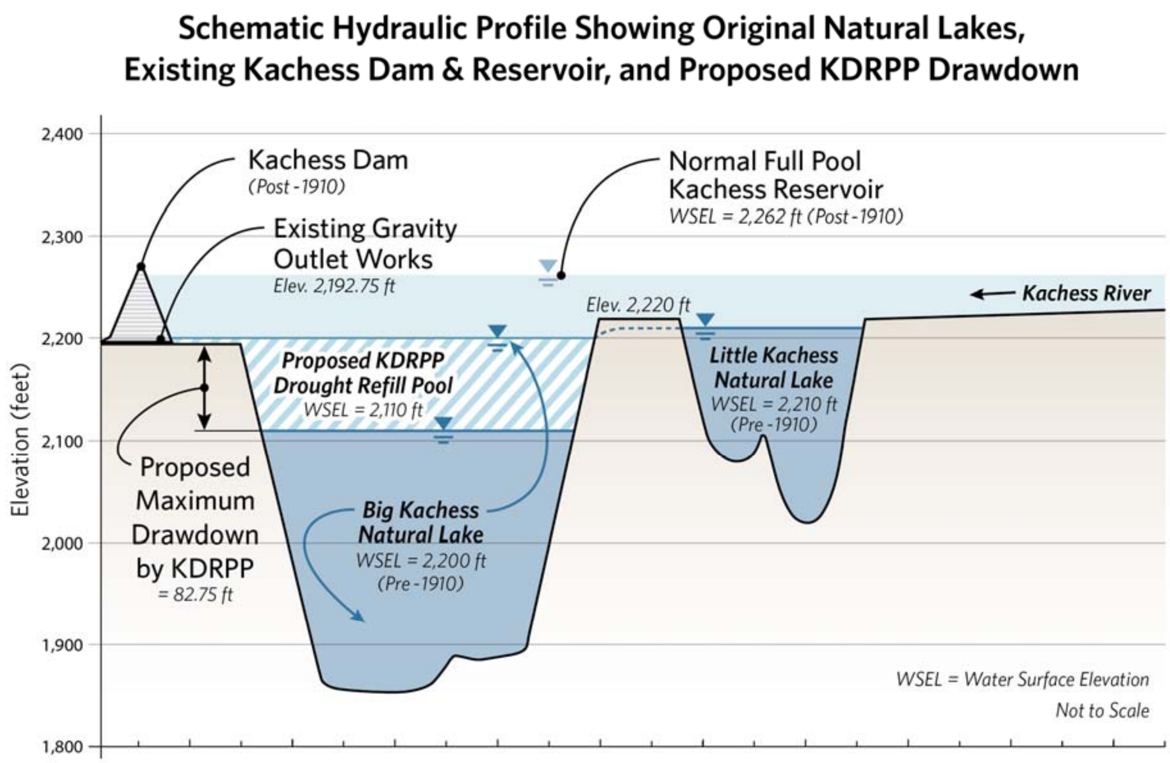

Figure 4-1. Kachess Hydraulic Profile

Seismic Risks

Kachess Reservoir is located within a seismically active area that could be susceptible to future earthquakes. Reclamation has conducted a probabilistic seismic hazard analysis (PSHA) for the area as a screening-level engineering analysis (Reclamation and Ecology, 2014m). Four seismic sources were considered, including local active and potentially active faults, background seismicity, megathrust earthquakes on the interface of the Cascadia Subduction Zone (CSZ), and interslab earthquakes occurring within the subducting slab (Reclamation and Ecology, 2014m). The potential seismic loadings at the site were calculated and include estimates of annual exceedance probability, or the reciprocal of average return period. These calculations were used to determine peak horizontal ground acceleration (PHA) values that indicate potential seismic forces that could be experienced at the site. The resultant PHA values[1] (0.23 g, 0.53 g, and 0.81 g for return periods of 1,000 years, 10,000 years, and 50,000 years, respectively, in bedrock conditions) are then used as seismic design criteria for all proposed improvements.

In general, aboveground structures are more susceptible to damage from ground shaking than subsurface improvements. Nevertheless, incorporation of seismic design criteria in accordance with current geotechnical practices and international building code standards would be effective in minimizing potential damage to proposed improvements.

Slope Stability Risks

Slope stability concerns would be limited to areas that would be exposed by lowering reservoir levels during drought conditions. If relatively steep or unstable areas are exposed, the change in conditions could result in slope instability. Such instability previously occurred during the excavation of the dam intake channel in 1996 where the slope was described as “slumping out” (Reclamation, 1996).

Four conditions could produce instability in the glacial soils that would be exposed to the elements for the first time since the initial reservoir inundation: rapid drawdown, heavy or steady rain, a rain-on-snow event, and earthquake shaking.

Rapid drawdown conditions arise when submerged slopes experience rapid reduction of the external water level. With this imbalance comes a tendency for the internal water pressures in the soil to move outward, causing slope failure. Because the soils on the slopes around the reservoir are not likely to be glacially overridden (overconsolidated), they may not be able to resist the failure. This could result in small to medium size slumps at the points where the pressures are greatest. However, Reclamation plans to draw down the reservoir at a rate of no more than 1 foot per day. This slow rate makes the risk of slumps unlikely. Therefore, no significant impact is expected.

Heavy rains, such as are common in the Snoqualmie Pass area, can cause saturation of exposed surface soils, resulting in shallow, skin landslides a few to several feet thick. They are likely to move quickly and may create sediment plumes in the lake but are not likely to cause substantive damage or injury. During or following prolonged storm periods, water can infiltrate deeper layers, causing deep-seated, rotational slope failures. Such landslides more are more likely to occur at contacts between soils of different permeabilities. This type of landslide commonly moves slowly, dropping down at its head (top) and bulging at the toe (bottom).

Rain-on-snow events are common in the Cascade Range, particularly in the 2,000- to 3,000-foot elevation range. Because a warm rain can melt a large volume of snow quickly,

[1] PHA is typically expressed as the percentage of the acceleration due to gravity (g), which is approximately 980 centimeters per second squared. In terms of automobile accelerations, one “g” of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds.

infiltration of water to the soil can be intense and cause shallow, rapid landslides of limited size. They would deliver sediment directly to the reservoir from the exposed, steep reservoir slopes, causing plumes.

Seismic events can exacerbate the likelihood and the severity of landslides that occur under the conditions described above. Some dry ravel (downslope surface movement of individual particles such as soil grains, aggregates, and rocks) and slumping can occur under relatively dry or drained conditions when earthquake shaking occurs, but it is more likely to cause greater damage to the ground surface if groundwater levels are high.

Potential impacts of the types of instability described above would likely be localized and include turbidity in the reservoir, undermining of docks and the public boat ramp along the western shoreline, and possibly danger to persons using the shoreline for fishing or boating. See Section 4.4 Surface Water Quality for further discussion of sedimentation and turbidity as well as Section 4.23 Environmental Health and Safety for public safety hazards.

Two landslides are mapped on the Landslide Hazard Zonation inventory (Powell, 2005). These dormant or relict features are located on the mountainside to the east of the reservoir. The toes of these features are above the area of impact of the project. They are not likely to reactivate owing to project activities; however, should they reactivate by other processes, they could cause a temporary increase in turbidity and potentially temporarily separate Little Kachess from the main body of the reservoir. Otherwise, as noted above, the slope stability hazards from the Proposed Action would be limited to areas exposed during drawdown of the reservoir and due to their localized effects are considered less than significant.

Bull Trout Enhancement

No long-term erosion problems are expected with the completed BTE actions. Gold Creek restoration actions and Cold Creek fish passage improvements would reduce erosion over existing conditions, so no long-term erosion is expected. The BTE actions would not increase slope stability or seismic risk. No significant operation impacts are anticipated.

4.2.5 Alternative 2B – KDRPP South Pumping Plant

4.2.5.1 Construction

KDRPP South Pumping Plant Facilities

Construction activities for this alternative would be similar to *Alternative 2A – KDRPP East Shore Pumping Plant* although the extent of impacts at the pumping plant location would be less. Construction activities would expose bare ground through clearing and grading of up to approximately 44 acres, instead of 75 acres under *Alternative 2A*. *Alternative 2B–KDRPP South Pumping Plant* also includes a shallower excavation for the pumping plant shaft but a much longer intake tunnel (approximately 3,800 feet compared to 800 feet in *Alternative 2A-KDRPP East Shore Pumping Plant*). In addition, there would be no need for a separate discharge, reducing associated earthwork.

Erosion during Construction
Reclamation would use erosion control BMPs and manage excavated materials during all construction activities to minimize erosion as described in Section 4.2.4.1. Soils at the south pumping plant location are predominantly soft surface soils. As a result, conventional excavation methods would be feasible and the reservoir intake tunnel would be constructed with a tunnel boring machine (TBM) rather than rock mining as used for 2A. An estimated total of approximately 115,000 cy of materials would be excavated under *Alternative 2B-KDRPP South Pumping Plant*. Any areas that are disturbed during construction would be subject to increased erosion if proper control measures are not implemented. However, as noted above, erosion control BMPs would be implemented during construction activities.

Seismic and Slope Stability Risks
As described above for *Alternative 2A – KDRPP East Shore Pumping Plant*, Kachess Reservoir is located within a seismically active area that could be susceptible to future earthquakes. Reclamation has conducted a probabilistic seismic hazard analysis (PSHA) for the area and determined peak horizontal ground acceleration (PHA) values that could be experienced at the site. As for *Alternative 2A – KDRPP East Shore Pumping Plant*, the resultant PHA values would be used to create seismic design criteria for all proposed improvements. *Alternative 2B – KDRPP South Pumping Plant* would require a shallower pumping plant shaft, longer intake tunnel, and no discharge line, but overall would be constructed to similar seismic design standards and may include soil stabilization (i.e., jet grouting) to provide ground improvements. As a result, despite some of these differences in construction characteristics, incorporation of seismic design criteria in accordance with current geotechnical practices and building code requirements would be effective in minimizing potential damage to proposed improvements from either seismicity or slope stability hazards.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.1).

4.2.5.2 Operation

KDRPP East Shore Pumping Plant Facilities
Long-term Erosion
Operational conditions related to erosion associated with increased drawdown of the reservoir would be the same as for *Alternative 2A – KDRPP East Shore Pumping Plant*. Areas exposed during lower reservoir levels in times of drought would likely be temporary as reservoir levels return to normal ranges when the drought ends. Regardless, Reclamation would monitor any areas with the potential for increased erosion as part of its existing shoreline inventory program. If erosion is identified as a problem, Reclamation would

implement appropriate erosion control measures prior to implementation. See Section 4.4, Surface Water Quality, for a discussion of sedimentation and water quality.

Seismic and Slope Stability Risks
Landslide and seismic hazards would be similar to those described above for *Alternative 2A-KDRPP East Shore Pumping Plant*. Implementing current geotechnical practices and meeting code requirements would reduce hazards to less-than-significant levels.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.2).

4.2.6 Alternative 3A – KKC North Tunnel Alignment

4.2.6.1 Construction

KKC North Tunnel Alignment Facilities
Erosion during Construction
Construction activities would include the clearing and grading of approximately 12 acres. Excavation within the types of soils anticipated at the KKC site should be possible using conventional earthmoving equipment (Reclamation and Ecology, 2014l). However, construction could encounter occasional oversized materials (i.e., boulders) as large as 6 feet in diameter. Excavation of the pipeline conveyance from the diversion structure to the Keechelus portal is intended to be above the rock surface, but this could depend on the location of the Keechelus Portal (Reclamation, 2014b). Some excavation into the shallow rock surface might be possible with ripping, rock buckets, or a hoe ram, but substantial excavation is likely to require localized blasting. Regardless, all ground disturbing activities would be accomplished in accordance with established construction BMPs to minimize erosion potential. An estimated total of approximately 115,000 cy of materials would be excavated under *Alternative 3A – KKC North Tunnel Alignment*.

Surface deposits in the area of the diversion structure likely include river alluvium overlying outwash (Reclamation and Ecology, 2014l). The anticipated soil types in the river alluvium, down to 30 to 50 feet below grade, include poorly graded gravel with silt, sand, cobbles, and boulders. The finer grained materials would be the most susceptible to erosion if appropriate BMPs are not implemented. Bedrock of the Naches Formation is anticipated beneath the diversion structure at depths approaching 150 feet below ground surface (Reclamation and Ecology, 2014l). Construction BMPs would be implemented throughout the construction period to minimize the exposure of disturbed areas to the effects of erosion to less than significant levels.

Seismic and Slope Stability Risks
The tunneling would be located within the Naches Formation unit, which consists primarily of a sedimentary sequence of sandstone, siltstone, conglomerate, and interbedded coal seams, as well as volcanic rocks including basalt, dacite, andesite, rhyolite, tuff, and volcanic breccia with varying densities and internal strengths. Additional rock support could be required in any encountered weak zones, shear or clay zones, or areas of concentrated high water inflows. As tunneling progresses, geotechnical engineers would monitor conditions and evaluate the need for and implement adaptive support measures that could include steel sets or pregrouting.

Preliminary designs call for 1.5-to-1 (horizontal to vertical) cut slopes down to a bench, with trench shoring from the bench to the pipeline invert. Trenches and cut slopes greater than 20 feet deep would require site-specific design by a qualified engineer based on a thorough geotechnical investigation along the alignment. Analysis would comply with appropriate safety standards (Reclamation, 2014e). Fill slopes would require a 3-to-1 (horizontal to vertical) slope that the geotechnical industry considers stable. With implementation of geotechnical practices and industry standards, the risk of creating unstable slopes would be reduced to less than significant levels.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.1).

4.2.6.2 Operation

KKC North Tunnel Alignment Facilities
Long-term Erosion
Following construction, disturbed areas would be stabilized through revegetation or placement of impervious surfaces (although most construction activities would occur underground).

The transfer of water supplies between reservoirs could cause changes in water levels and result in potential erosion. Surface erosion of sediments could depend on the timing and total volume of water transfer. Changes in reservoir elevation would be gradual minimizing potential shoreline erosion because the shoreline would adjust and establish equilibrium. In addition, monitoring of areas for increased erosion would be part of Reclamation’s routine inspection and monitoring program.

At the KKC outlet along the west shoreline of the Kachess Reservoir, high velocity and discharge flows could erode the 10- to 30-degree, newly exposed slopes. The proposed discharge structure includes an energy dissipater, weir and stilling basin to control the flow of discharges to minimize erosion at the discharge. If Reclamation identifies erosion problems at the outlet during its regular shoreline monitoring, appropriate erosion control would be implemented. See Section 4.4, Surface Water Quality, for a discussion of sedimentation and water quality.

Seismic and Slope Stability Risks
The two reservoirs are located within a seismically active area that could be susceptible to future earthquakes. Reclamation would incorporate the potential seismic loadings and peak PHA forces that could be experienced at the site into project design. Incorporation of seismic design criteria in accordance with current geotechnical practices and building code requirements would be effective in minimizing potential damage to proposed improvements.

Final geotechnical investigations would include recommendations for all proposed improvements including loading specifications, cut slope limits, fill limits, and any additional supportive measures to address identified geologic hazards along the alignment. Geotechnical recommendations would also include corrective measures for any areas where surface subsidence might be anticipated above the tunnel. Qualified geotechnical engineers would prepare these investigations in accordance with current practices and building code requirements. Implementation of these measures would reduce potential instability or other geotechnical hazards to less-than-significant levels.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.2).

4.2.7 Alternative 3B – KKC South Tunnel Alignment

4.2.7.1 Construction

KKC South Tunnel Alignment Facilities
Construction practices and implementation of BMPs would be similar to *Alternative 3A-KKC North Tunnel Alignment*, although the area of disturbance would be approximately 13 acres and include the existing disturbed and compacted site for the I-90 Exit 62 portal. The total excavated material is estimated at 130,000 cy. Industry standard practices and BMPs would be effective in minimizing exposure of excavated materials and the potential for erosion.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.1).

4.2.7.2 Operation

KKC South Tunnel Alignment Facilities
Following construction, long-term impacts would be much the same as those described above for *Alternative 3A – KKC North Tunnel Alignment*.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.2).

4.2.8 Alternative 4 – Combined KDRPP and KKC

4.2.8.1 Construction

KDRPP and KKC Facilities
Construction practices and BMPs would be the same as described for *Alternative 2A - KDRPP East Pumping Plant* together with those described for *Alternative 3A – KKC North Tunnel Alignment*. These measures would be effective in minimizing exposure of excavated materials and the potential for erosion. In addition, the two construction areas are separated geographically and therefore would not combine to increase any potential construction impacts. Therefore, construction impacts for the combined alternative would be the same as those described above for KDRPP and KCC.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.1).

4.2.8.2 Operation

KDRPP and KKC Facilities
KDRPP and KKC combined would have no additional hazards or additional impacts beyond those described for the individual actions and alternatives above. Generally, geologic and seismic hazards are site specific and localized. Reclamation would address these hazards through site-specific geotechnical investigations prepared by qualified geotechnical engineers and engineering geologists who make recommendations to mitigate identified hazards through site preparation and design criteria to ensure that the proposed elements maintain their integrity for the entire design life of the improvement.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.2).

4.2.9 Mitigation Measures

4.2.9.1 Construction

Reclamation would complete site-specific geotechnical studies to identify subsurface issues, unstable slopes, and other local factors that could contribute to slope instability and increase erosion potential. These studies would be used in the design of project-specific BMPs and temporary erosion and sediment control plans in accordance with Federal, State, and local requirements. Requirements for each construction project would be defined through review by State and local regulatory agencies. Reclamation would implement the following BMPs to minimize the potential for erosion and sediment production:

- Timing construction activities to avoid disturbing soils during wet weather
- Using straw bales, silt fencing, or other suitable sedimentation control or containment devices
- Washing truck tires to reduce tracking of sediments and aquatic invasive species from construction sites
- Covering exposed soil stockpiles and exposed slopes
- Using straw mulch and erosion control matting to stabilize graded areas where appropriate
- Retaining vegetation where possible to minimize soil erosion
- Seeding or planting appropriate vegetation on exposed areas as soon as possible after work is completed
- Constructing temporary sedimentation ponds to detain runoff water where appropriate
- Installing and operating dewatering facilities to eliminate the potential for slope stability impacts associated with excavation
- Using berms, ditching, and other onsite measures to prevent soil loss
- Monitoring downstream turbidity during construction to document the effectiveness of implemented measures
- Visually monitoring for signs of erosion and for correct implementation of control measures

Implementation of BMPs such as those described above has been widely proven effective in minimizing erosion and soil loss during construction activities. Reclamation would comply with all permit requirements and would monitor erosion during construction. Reclamation would implement additional mitigation if needed to address erosion problems.

4.2.9.2 Operation

Once constructed, continued monitoring of site conditions and erosion potential would be necessary to provide adaptive management of any identified seismic and stability risks, stability hazards on the reservoir rim, and long-term erosion. Reclamation would continue its existing shoreline monitoring program for Kachess and Keechelus reservoirs. If erosion problems are identified, Reclamation would implement appropriate erosion control to address the problems. Reclamation would comply with all soil protection requirements identified through Federal, State and local permits for project operations. Some of the measures that Reclamation would implement to minimize effects include:

- Limit drawdown rates to not more than 0.8 feet per day, to allow for drainage and pore pressure relief.
- Train tributary creeks back into their original channels on the flatter-gradient parts of the newly exposed reservoir rim.
- Perform an annual late spring and early summer reconnaissance of the reservoir rim to determine potential dangers to the public and plan mitigation corrective measures, if necessary.
- If incision of the Kachess River occurs at the head of the Big Kachess reservoir, evaluate the feasibility of placing riprap to reduce incision and install fences to prevent access by the public until side slopes are flattened.
- WDFW and Ecology would review and approve any corrective erosion control measures prior to implementation.

Implementation of BMPs such as those described above would be effective in minimizing safety hazards, unstable soils, and erosion and soil loss during operations of the project.

4.3 Surface Water Resources

4.3.1 Methods and Impact Indicators

This section describes the impacts of the Proposed Action on water storage in the Keechelus and Kachess reservoirs and on flows in the Yakima and Kachess rivers. Section 4.4 describes surface water quality and Section 4.5 describes groundwater and groundwater quality.

Methods. Reclamation used a hydrologic model known as RiverWare to evaluate potential effects on reservoir levels, releases, downstream flows, operations of the Yakima Project, and water supply. The initial step was to calibrate the model for the Yakima basin; for this process, Reclamation ran the model with data for the years 1925 to 2009 (referred to as the modeled years). These modeled years include the multiyear drought from 1992 to 1994 as well as the single year droughts in 2001 and 2005. The next step was to simulate effects of the different alternatives as if they had been operational during the same years. Output from RiverWare included the following quantitative data:

- Reservoir levels in Keechelus, Kachess and other Yakima Project reservoirs
- Streamflow in the Yakima River below Keechelus Reservoir, Kachess River below Kachess Reservoir, and other river reaches in the Yakima River basin
- Deliveries to proratable water users along the Yakima and Naches rivers who agree to participate in KDRPP, assumed for the EIS to be Kittitas Reclamation District (KRD), Roza Irrigation District (RID), and Wapato Irrigation Project (WIP)

Impact Indicators. Surface water resource impact indicators and criteria for determining impact significance are shown in Table 4-3. All criteria are assessed relative to *Alternative 1-No Action*.

Table 4-3. Impact Indicators and Significance Criteria for Surface Water Resources

Impact Indicator	Significance Criteria
Change in water supply in terms of deliveries to proratable water users	Increased deliveries to proratable water users in drought years contributing to the 70 percent goal.
Change in reservoir levels in Keechelus and Kachess reservoirs	Increased duration of time during which the water level in Kachess Reservoir is below elevation 2,192, the current low pool level at which the gravity outlet can operate. Increased duration of time during which the water level in Kachess Reservoir is below elevation 2,220, the elevation that separates the two historical Kachess lakes. Increased duration of time during which Kachess Reservoir is below elevation 2,226, the elevation that impedes tributary access for bull trout. Increased duration of time during which Keechelus Reservoir is below elevation 2,466, the elevation that impedes tributary access for bull trout.
Change in instream flow in the Yakima and Kachess rivers	Decreased artificially high summer streamflow in the Keechelus Reach of the Yakima River compared to the high priority instream flow need identified in the Integrated Plan goal of reducing streamflow in July to 500 cfs and ramping flows from 500 cfs on August 1 to 120 cfs by the first week of September. Changed flow in the Yakima and Kachess rivers to a degree that affects spawning, rearing, or migration of salmonids or other fish. If the change results in a flow that remains within the current operational flow range, then no effect would result.
Change in instream flow in Gold Creek and Cold Creek	Increased flow that would benefit fish passage.

Section 4.12 describes impacts from future climate change conditions on the alternatives using the indicators listed in Table 4-3.

4.3.2 Summary of Impacts

Change in Water Supply. The Integrated Plan establishes a goal for delivery of water to proratable irrigation districts during drought years. The goal is 70 percent of the district's entitlement; below that percent of entitlement, users are likely to suffer severe economic loss. Present water supply for these users is inadequate in drought years. *Alternative 1 – No Action* would result in continued inadequacy of water supply for proratable irrigators, especially during drought years. KDRPP (*Alternatives 2A* and *2B*) would improve water supply to proratable water users by 19 to 23 percent in the worst single-drought years, raising the proration percentage to about 64 percent of entitlement. This would be a significant benefit to water supply. In multiple drought years, such as occurred from 1992 to 1994, the improvement under *Alternatives 2A* and *2B* would be less (15 percent) because some of the inactive storage in Kachess Reservoir would be used in the first 1or 2 years of drought, leaving less for a third year of drought. KKC (*Alternatives 3A* and *3B*) would yield a very slight (less than 1 percent) improvement in water supply to proratable users in drought years. This would not be a significant benefit to water supply.

Alternative 4 – Combined KDRPP and KKC would increase proratable water supply to about 66 percent of entitlement during the worst single-drought years, also better than *Alternative 1 – No Action* but still below the 70 percent goal. In multiple drought years, such as occurred in 1992 to 1994, the improvement under *Alternative 4 – Combined KDRPP and KKC* would be less (17 percent) for the same reason as that for *Alternatives 2A* and *2B*.

Change in Reservoir Levels. Under all the action alternatives, Reclamation would operate Keechelus Reservoir to help Kachess Reservoir refill following a drought. Under *Alternatives 2A*, *2B*, and *4*, this action would result in slightly lower mean Keechelus Reservoir pool levels, with a maximum incremental reservoir drawdown of 15 feet in late summer compared to *Alternative 1 – No Action*. Under *Alternatives 3A* and *3B* during post-drought years, Keechelus Reservoir maximum pool elevations would be lower and minimum elevations higher.

The impacts of each alternative are assessed relative to the impacts of *Alternative 1 – No Action*, using both frequency (number of years during which the condition occurs) and duration (number of days per year during which the condition occurs).

When Keechelus Reservoir level falls below elevation 2,466, bull trout access to tributaries is adversely impacted. Compared to *Alternative 1 – No Action*, *Alternatives 2A* and *2B* would cause this adverse effect at the same frequency, but for a longer duration—a mean of 125 days for *Alternatives 2A* and *2B* versus 115 days for *Alternative 1*. This would be a significant impact on fish passage as described in Section 4.6.4.2. Under *Alternatives 3A* and *3B*, Keechelus Reservoir levels would fall below elevation 2,466 in 10 percent fewer years than under *Alternative 1 – No Action* and for 15 fewer days during those years. This would be a significant benefit to fish passage. Under *Alternative 4 – Combined KDRPP and KKC*, the reservoir level would reach this condition in 7 percent fewer years but for an additional 15 days per year. In all cases, the pool elevation would remain within the current operating range of the reservoir, and none of the alternatives would significantly affect Keechelus Reservoir operations.

Under *Alternatives 2A*, *2B,* and *4,* Kachess Reservoir would be drawn down by as much as 80 feet below existing low pool conditions (elevation 2,192). Reservoir levels were simulated to fall below elevation 2,192 in about one-third of the model years analyzed for a mean duration of between 179 and 191 days. The time for Kachess Reservoir to refill to normal operating levels would be 2 to 5 years following a drought.

The drawdown of Kachess Reservoir under *Alternatives 2A*, *2B*, and *4* would cause an increase in the occurrence and duration of reservoir pool levels below elevation 2,220, the elevation separating the Kachess and Little Kachess lake basins within Kachess Reservoir (Section 3.3.4). At water levels below that elevation, fish cannot pass between the two lake basins. Relative to *Alternative 1 – No Action*, the incremental frequency increase would be 5 percent, and incremental duration increase would be 56 days during those years. This would be a significant impact on fish passage.

The drawdown of Kachess Reservoir as a result of *Alternatives 2A*, *2B*, and *4* would also increase the duration of reservoir levels below elevation 2,226—the level at which access for bull trout to tributary streams is impacted. Frequency would remain unchanged, but duration would increase by 44 days (from means of 109 to 153) during those years, a significant impact on fish passage.

Change in Instream Flow. *Alternative 1 – No Action* would not change summer streamflows in the Keechelus Reach of the Yakima River and, therefore, summer flows would remain artificially high. Under *Alternatives 2A* and *2B*, all streamflow changes would remain within current operating ranges. *Alternatives 3A*, *3B*, and *4* would reduce summer streamflows in the Keechelus Reach by 400 cfs, greatly improving habitat conditions for fish (Section 4.6.4.2). This would be a significant benefit to instream flow conditions in the Keechelus Reach. Streamflow changes in other Yakima River reaches under Alternatives 3A, 3B, and 4 would not have significant effects because flow would remain within current operating ranges. During drought years, streamflow would increase slightly, and then decrease very slightly in the following years while Kachess Reservoir refills. That slight decrease would occur during winter or spring, when flows in the Yakima River are already high and therefore would not significantly affect streamflows. Streamflow in the Kachess River for all action alternatives would also change. Because the altered flows would fall within current operating ranges, no significant effect on streamflow conditions would result.

The BTE actions would be implemented as part of all the action alternatives and would improve streamflow in Gold Creek and Cold Creek during late summer and fall, when Keechelus Reservoir water levels are at their lowest levels. The BTE actions would provide a surface water connection from the streams to the reservoir pools, providing better seasonal passage conditions for bull trout and significantly benefiting fish passage.

4.3.3 Alternative 1 – No Action

Under *Alternative 1 – No Action*, Reclamation would not change the current operations of the Yakima Project and reservoir levels and streamflows would not change. Section 3.3 describes current operations.

Modeling results indicate that water supplies for proratable irrigators during drought years would continue to be inadequate, falling below 70 percent of their entitlement during drought years. Proratable irrigators have stated that 70 percent is the minimally acceptable level to prevent severe economic losses (Reclamation and Ecology, 2012, Section 1.4). With drought conditions predicted to worsen with climate change, water supplies for proratable irrigators could fall below 70 percent of entitlement more frequently (Section 4.12). As described in Sections 4.6.3 and 4.9.3, instream flow conditions in the Keechelus Reach of the Yakima River would continue to be detrimental to steelhead and other salmonids. *Alternative 1 –No Action* would provide limited flexibility to respond to irrigation needs during increasingly dry years.

Alternative 1 – No Action does not meet the purposes of the Proposed Action because it does not address water supply for proratable irrigators or instream flow conditions in the upper Yakima River basin. This alternative neither provides additional water supply nor improves aquatic resources for fish habitat, rearing, and migration in the Keechelus Reach of the Yakima River. As such, it is not consistent with the Record of Decision for the Integrated Plan (Reclamation, 2013).

The I-90 Phase 2A project would restore some of the natural hydrology and hydraulics in Price and Noble Creeks by removing culvert barriers and replacing them with long bridges. These replacements would improve hydrologic connectivity, channel migration, and animal crossing. Improvements would be made for managing stormwater, however the amount of runoff would increase due to an increase in surface area. Overall, the I-90 project is expected to improve water resources in the Price and Noble Creeks area.

4.3.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.3.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Construction of *Alternative 2A – KDRPP East Shore Pumping Plant* would not affect water releases from Kachess Reservoir (or therefore instream flow in the Kachess River) because no construction is planned for the current outlet or spillway gates. Reservoir levels and reservoir releases would not change relative to *Alternative 1 –No Action* because construction would occur either on land outside of the reservoir or during late summer and fall drawdown. Additional reservoir drawdown is not required for construction of the pumping plant. Construction of the transmission line from the PSE substation in Easton would use existing crossings of the Yakima River and installation of the new line is not expected to affect surface water. Additional analysis would be conducted as part of PSE's rate study and environmental analysis.

Bull Trout Enhancement

Construction of the BTE actions would not impact water levels in or releases from Keechelus or Kachess reservoir because the actions would be located above the reservoirs. Flows in Gold Creek and Cold Creek would be affected when the channels are rerouted around the construction areas (either by pipe or ditch) to avoid potential sediment input. In its environmental assessment of construction impacts caused by replacement of the NF-4832 Bridge, the USFS (2011a) identified increased potential for runoff to surface water through soil compaction, changes in drainage patterns, and clearing of vegetation. Construction BMPs would be used to reduce the potential for sediment input during construction as described in Section 4.3.9. Additional analysis of potential surface water impacts will be conducted as the design of these actions progresses.

No impact on Yakima River or Kachess River flows would occur because the rivers are controlled by releases from Keechelus and Kachess reservoirs, and construction would not change those reservoir operations.

4.3.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Water Supply

The primary purpose of KDRPP is to improve water supply for irrigation districts with proratable entitlements during drought years, with the goal of achieving the Integrated Plan's target of 70 percent of entitlements. When water supply for proratable irrigation districts is less than 70 percent, Reclamation would use KDRPP to access up to 200,000 acre-feet of storage that is not currently used because the water level is below the existing gravity outlet from Kachess Dam. The expected change in prorationing percentage is summarized in Table 4-4. The percentage shown in Table 4-4 for *Alternative 1 – No Action* includes the most recent drought years (1992 to 1994, 2001, and 2005). During single-drought years (e.g., 2001, 2005), the prorationing percentage would increase by 19 to 23 percent, yielding a water supply equal to 63 to 64 percent of entitlement. Although the water supply would not meet the 70 percent goal, it would represent a significant increase and benefit to water supply. The relative improvement in supply would be less during the final year of a multiyear drought such as that in 1992 to 1994. In the third year of such a drought (i.e., 1994 in Table 4-4), a 42 percent water supply would be provided. This would still be a significant benefit to water supply.

Table 4-4. Percent of Entitlement Available in Drought Years under *Alternative 2A - KDRPP East Shore Pumping Plant*

Modeled Drought Year	Alternative 1 – No Action[1]	Alternative 2A[1]	Change (Percent)
1992	67.2	66.7	-0.5
1993	58.6	70.0	11.4
1994	26.3	41.7	15.4
2001	39.6	63.0	23.4
2005	45.0	64.4	19.4

[1] Percent of prorationing

Reservoir Levels

This section describes the impacts on important reservoir elevations at Kachess Reservoir. As indicated in the accompanying text box, these pool levels either prevent outflow from the reservoir or preclude bull trout passage. These reservoir levels correspond to the significance criteria in Table 4-3. Figure 4-2 illustrates the extent of the elevations described below.

Alternative 2A – KDRPP East Shore Pumping Plant would change reservoir levels in both Kachess and Keechelus reservoirs compared to *Alternative 1 –No Action*. Modeling results indicate Kachess Reservoir levels would be lower than those under *Alternative 1* at a 51 percent frequency (i.e., during one-half of the years) and for a mean duration of 314 days during those years. Kachess Reservoir levels would be lower than *Alternative 1* levels both when Reclamation operates KDRPP in drought years and in years following droughts when the reservoir is refilling to its normal operating levels.

Kachess Reservoir Levels	Elevation
Current maximum reservoir level	2,262
Current level of maximum draw down (reservoir level is below gravity outlet)	2,192
Level of maximum draw down with KDRPP	2,112
Level at which bull trout access to tributaries is impeded	2,226
Level at which upper and lower lake basins are separated and fish passage is impeded	2,220

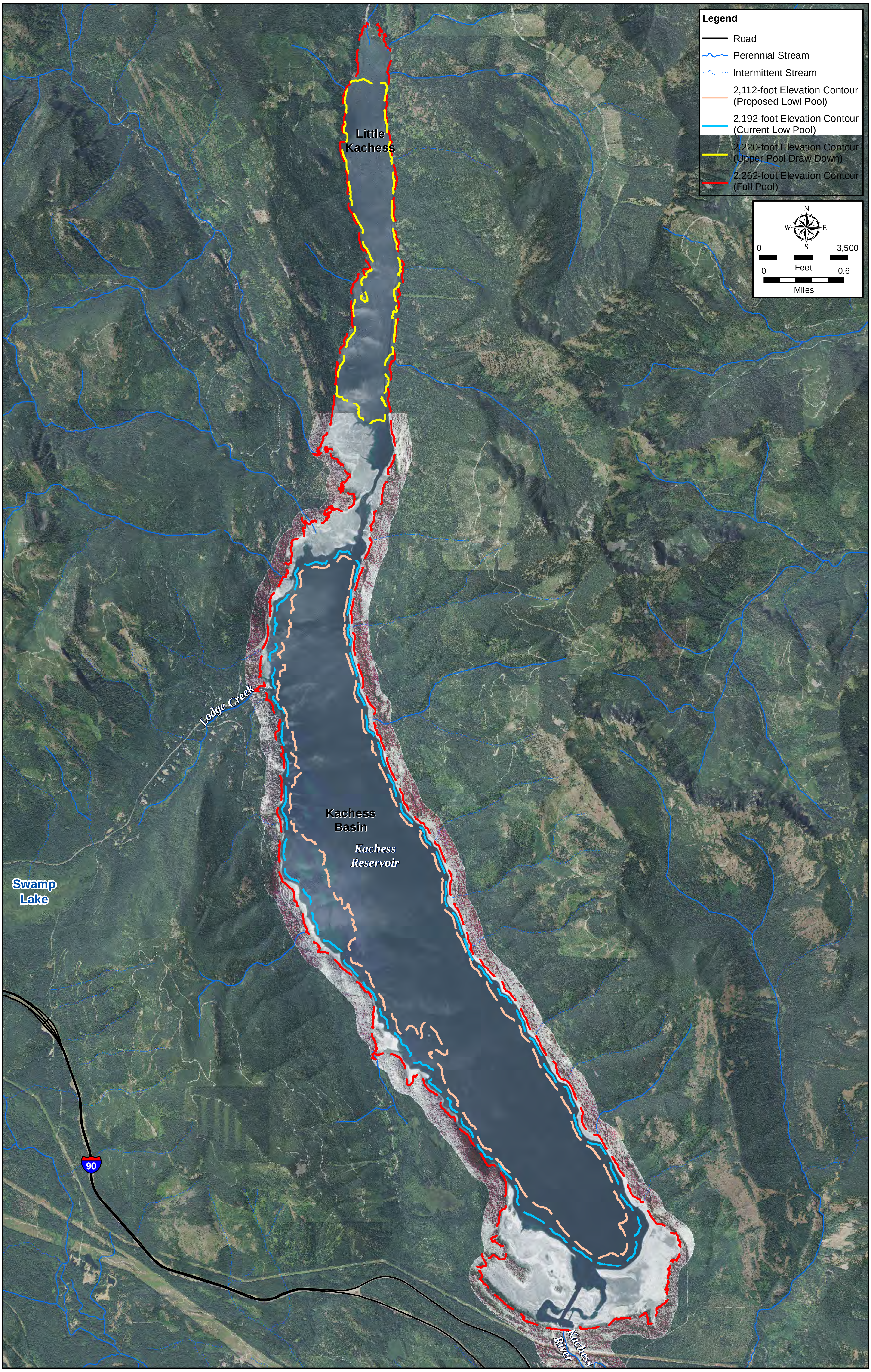

Figure 4-2. Kachess Reservoir Pool Elevations

Kachess Reservoir

Under *Alternative 2A – KDRPP East Shore Pumping Plant*, the pool elevation in Kachess Reservoir would be below the outlet elevation of 2,192 at a frequency of 36 percent (i.e., during about one-third of the years) and for a mean duration of 191 days. Current reservoir operations do not draw the reservoir below the outlet elevation. The increased drawdown would have a significant effect on water resources.

Kachess Reservoir would be below the level at which the two lake basins become separated (elevation 2,220) at a frequency of 74 percent of the years, an increase of 1 percent from *Alternative 1 –No Action*. The mean duration would be 165 days per year, an increase of 78 days per year. At pool elevations below 2,220, fish passage between the lake basins is inhibited (see Section 4.6.4.2). The increased frequency and duration would have a significant impact on fish passage.

Kachess Reservoir would be below the level at which bull trout access to tributary streams is impeded (elevation 2,226) in 89 percent of years, an increase of 1 percent from *Alternative 1 – No Action*. The mean duration would be 164 days per year, an increase of 55 days per year. The increased frequency and duration would have a significant impact on fish passage.

Figure 4-3 illustrates the difference in Kachess Reservoir levels between *Alternative 1 –No Action* and *Alternative 2A – KDRPP East Shore Pumping Plant*. During multiyear drought conditions such as those in 1992 to 1994, Reclamation would draw the reservoir down up to 80 feet below the existing minimum pool level. Following a drought comparable to that of 1992 to 1994, reservoir levels would recover to normal operating levels 2 years later when followed by a wet year such as 1996. In a single-year drought, such as occurred in 2001, the reservoir would be drawn down to 40 feet below existing minimum pool levels. Full recovery would not have been achieved until the wet year of 2006, because of a series of dry years (2003 and 2004) and a subsequent drought (in 2005). During the 2005 drought year, the reservoir level would have been 50 feet below the existing minimum pool level. The historical record of droughts indicates Kachess Reservoir would refill in 2 to 5 years following a drought. The increased drawdown and duration of drawdown would have a significant effect on water resources. Predicted water levels are tabulated in Table 4-5.

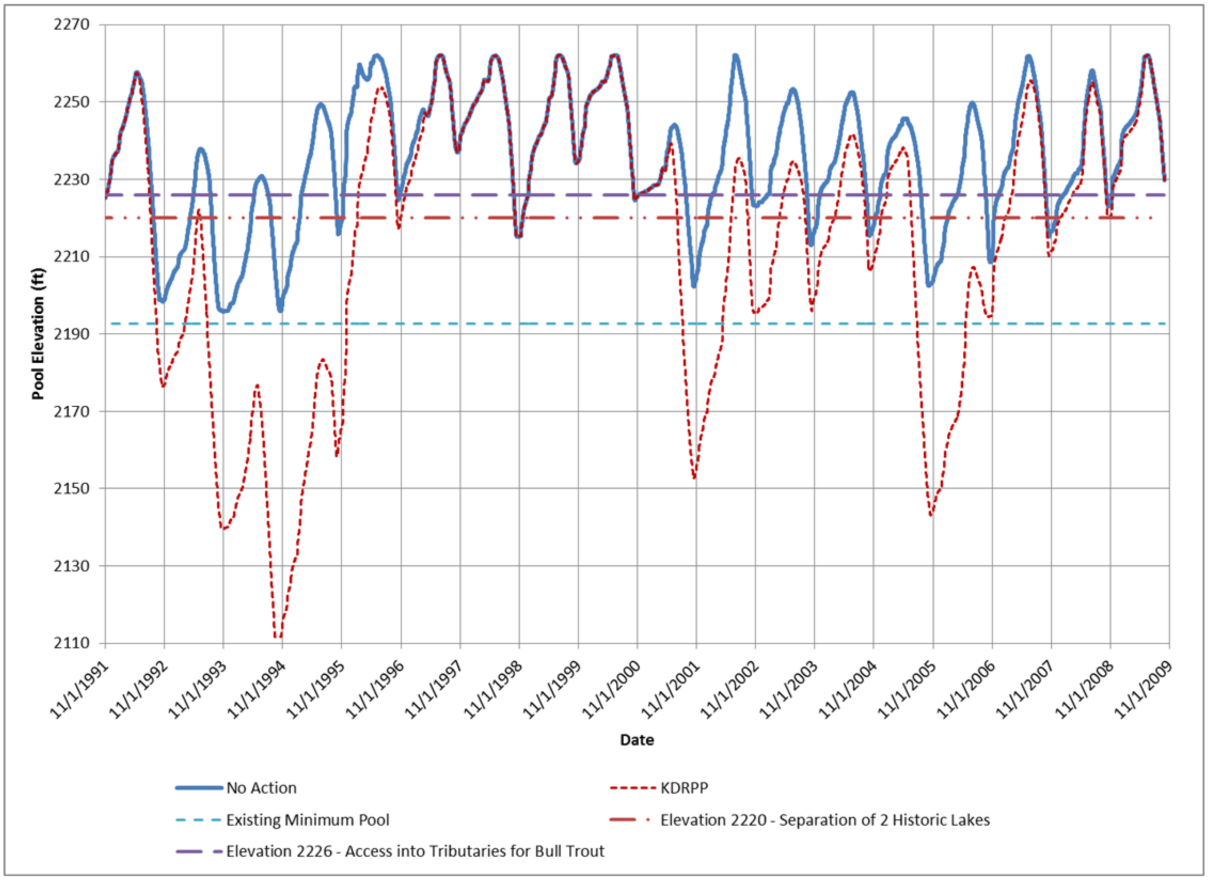

Figure 4-3. Kachess Reservoir Pool Elevations under *Alternative 2A – KDRPP East Shore Pumping Plant*

Table 4-5. Kachess Reservoir Pool Elevations under *Alternative 2A – KDRPP East Shore Pumping Plant*

Modeled Year	Pool Elevation (feet)		
	Alternative 1 – No Action	Alternative 2A	Change
1925-2009			
Mean	2,236.8	2,221.2	-15.6
Mean of Annual Maximum	2,254.8	2,242.7	-12.1
Mean of Annual Minimum	2,212.2	2,190.0	-22.2
1994 (Drought Year)			
Mean	2,211.5	2,146.2	-65.4
Maximum	2,230.8	2,176.7	-54.1
Minimum	2,195.8	2,111.6	-84.2
2001 (Drought Year)			
Mean	2,228.9	2,212.9	-16.0
Maximum	2,244.1	2,239.4	-4.7
Minimum	2,202.3	2,152.7	-49.6

Keechelus Reservoir

Keechelus Reservoir levels under *Alternative 2A* would be lower than those under *Alternative 1 –No Action* because Reclamation would withdraw more water from Keechelus Reservoir after a drought in order to refill Kachess Reservoir as quickly as possible. Simulations indicate that Keechelus Reservoir levels would be lower than those of *Alternative 1 –No Action* at a frequency of 50 percent (i.e., in one-half of the years) and for a mean duration of 232 days during those years. Figure 4-4 illustrates the difference in Keechelus Reservoir levels between *Alternative 1 – No Action* and *Alternative 2A – KDRPP East Shore Pumping Plant*. During a 2- to 3-year period following a drought, the peak water levels in Keechelus Reservoir would be close to those of *Alternative 1 –No Action* and the lowest level would about 15 feet lower. In other years, the reservoir level would not change from *Alternative 1 -No Action*. Table 4-6 summarizes and compares annual mean, maximum, and minimum water levels for the period of record and during drought years. Keechelus Reservoir levels under *Alternative 2A* would be within current operating levels and no significant effect on water resources would occur.

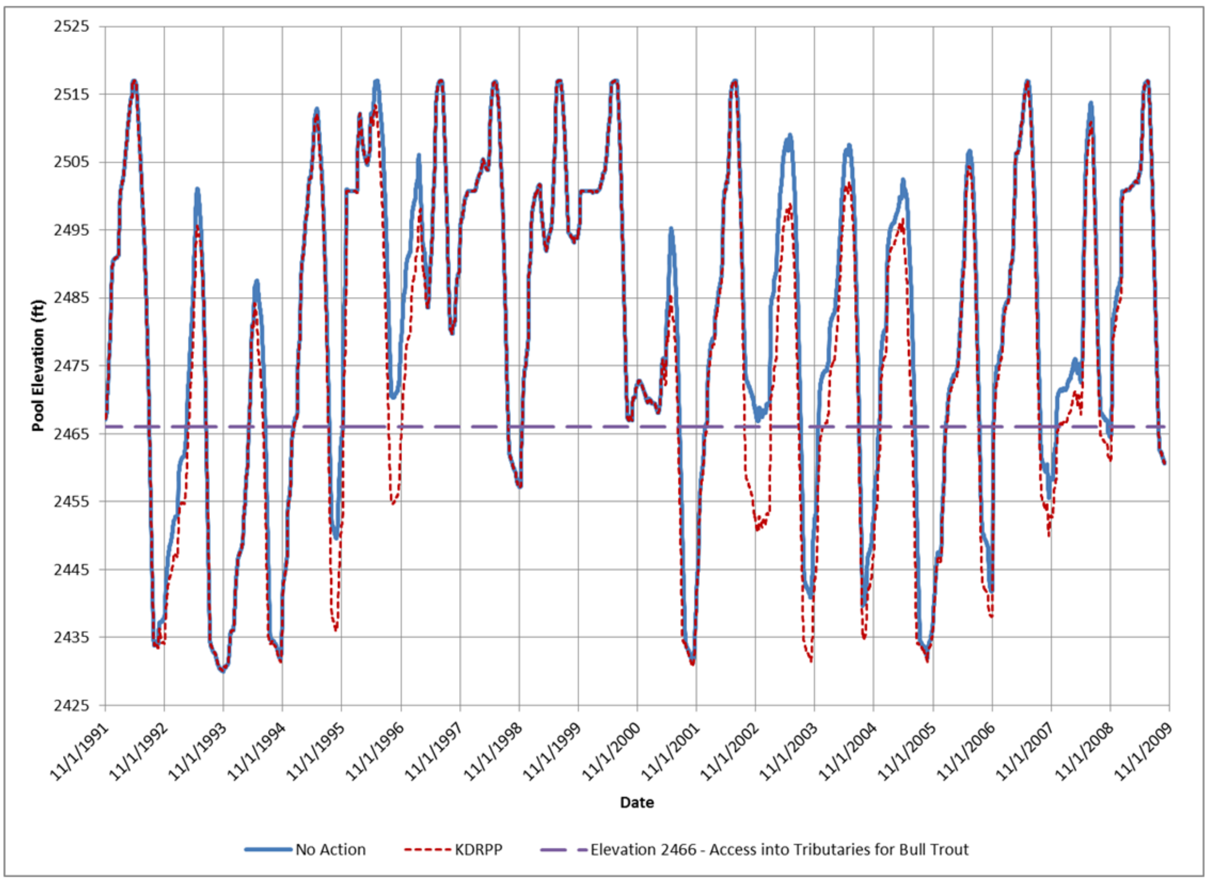

Figure 4-4. Change in Keechelus Reservoir Pool Elevation under *Alternative 2A - KDRPP East Shore Pumping Plant*

Table 4-6. Change in Keechelus Reservoir Levels under *Alternative 2A – KDRPP East Shore Pumping Plant*

Modeled Year	Pool Elevation (feet)		
	Alternative 1 – No Action	Alternative 2A	Change
1925-2009			
Mean	2,482.0	2,480.8	-1.2
Mean of Annual Maximum	2,510.3	2,509.2	-1.1
Mean of Annual Minimum	2,450.0	2,449.1	-0.9
1994 (Drought Year)			
Mean	2,452.0	2,449.7	-2.3
Maximum	2,487.6	2,484.3	-3.3
Minimum	2,430.0	2,430.1	0.1
2001 (Drought Year)			
Mean	2,465.4	2,462.3	-3.1
Maximum	2,495.3	2,485.6	-9.7
Minimum	2,431.3	2,430.7	-0.6

Keechelus Reservoir would be below the level at which bull trout access to tributary streams is impeded (elevation 2,466) in 82 percent of the years, an increase of 1 percent from *Alternative 1 –No Action*. This increased frequency would be matched by a 10-day increase in duration, to a mean of 125 days. The slight increase in frequency and duration would not have a significant effect on water resources.

Streamflow

Under KDRPP, water from the inactive storage of Kachess Reservoir would be pumped into the Kachess River for delivery to proratable water users (assumed for this EIS to be Kittitas Reclamation District (KRD), Roza Irrigation District (RID), and Wapato Irrigation Project (WIP). Streamflow under *Alternative 2A – East Shore Pumping Plant* would change in the Kachess and Yakima rivers during post-drought refilling on Kachess Reservoir and during conveyance to proratable water users. Figure 3-2 shows the locations of the reaches and diversion points for the proratable water users listed above. Appendix E includes hydrographs depicting streamflow under *Alternative 2A – East Shore Pumping Plant.*

Kachess River

Changes in Kachess River streamflow are summarized in Table 4-7 and depicted in Appendix E, Figure E-1. Overall, Kachess River streamflow would hardly change. The overall summer flow (i.e., July-to-August) would increase slightly because the river would convey water during drought years to downstream proratable water users. The overall 6.4 percent decrease in winter (i.e., January) flow from 37.3 cfs to 34.9 cfs would occur because minimum flows of 15 cfs would be provided for a longer period of time when the reservoir is either drawn down or refilling after a drought. During drought years (represented in Table 4-7 by 1994 and 2001), summer streamflow would be substantially higher (by about 450 to 550 cfs) because of releases from Kachess Reservoir. The maximum discharge to the Kachess River would be 1,000 cfs (the capacity of KDRPP). Total flows released during that time period (from existing outlets) would range up to 1,300 cfs and would fall within the normal operating range for July and August. The altered flows would fall within current operating ranges, so no significant effect on streamflow conditions would result.

Table 4-7. Change in Kachess River Flow below Kachess Reservoir under *Alternative 2A – KRDPP East Shore Pumping Plant*

Modeled Year	Mean Flow (cfs)		Percent Change
	Alternative 1 – No Action	Alternative 2A	
1925-2009			
Annual	293	293	0.0
July-August	566	579	2.3
January	37.3	34.9	-6.4
1994 (Drought Year)			
Annual	193	285	47.7
July-August	432	934	116.2
January	15.4	15.3	-0.6
2001 (Drought Year)			
Annual	265	439	65.7
July-August	651	1,143	75.6
January	35.1	35.1	0.0

Yakima River

Alternative 2A – East Shore Pumping Plant would change streamflow in the Keechelus Reach, Easton Reach, and Yakima River downstream to the Parker gage (Figure 3-2). Summer flows would increase during droughts because KDRPP would supply additional water to downstream proratable water users.

For the Keechelus Reach, streamflows would change slightly, as summarized in Table 4-8 and Appendix E, Figure E-2. Overall, flows change only slightly. During drought years, flows would be higher in early summer and then drop in later summer. Flows during the summer months of drought years (such as 1994 and 2001) would be reduced by approximately 130 cfs, from a mean of 608 to 715 cfs to a mean of 480 to 579 cfs. By comparison, normal operating flows during summer are over 800 cfs. Following drought years, flows would be about 100 cfs higher in summer to conserve Kachess Reservoir storage and help the reservoir refill as quickly as possible. Since the streamflow in Keechelus Reach under *Alternative 2A – East Shore Pumping Plant* would remain within current operating ranges with no decrease in most years, no benefit to instream flow in the Keechelus Reach would occur.

Table 4-8. Change in Keechelus Reach Flow under *Alternative 2A – KDRPP East Shore Pumping Plant*

Modeled Year	Mean Flow (cfs)		Percent Change
	Alternative 1 – No Action	Alternative 2A	
1925-2009			
Annual	**336**	**336**	**0.0**
July-August	828	817	-1.3
January	161	158	-1.9
1994 (Drought Year)			
Annual	230	231	0.4
July-August	608	480	-21.1
January	80.6	80.7	0.1
2001 (Drought Year)			
Annual	285	286	0.3
July-August	715	579	-19.0
January	131	131	0.0

For the Easton Reach, streamflows would change slightly from *Alternative 1 –No Action*, as summarized in Table 4-9 and illustrated in Appendix E, Figure E-3. The increase in summer (July to August) flow during drought years would be 70 to 149 cfs. Water for the KRD would be diverted at Lake Easton, and water for the RID would be diverted at Roza Dam. Any remaining increased supply could be diverted by WIP at Wapato Dam. Because the slight flow increase during drought years in the Easton Reach and downstream along the Yakima River to Roza Dam would remain within current operating flows experienced in most years, no significant impact on flow conditions would result. Downstream from Roza Dam to Parker gage, the relative change in streamflow would be less than in upstream reaches because some or most of the additional water supplied by KDRPP would have been diverted. The small change in streamflow downstream from Parker gage on the Yakima River would occur as Kachess Reservoir refills after a drought. The change would occur in winter and spring. Appendix E, Figure E-4 illustrates the difference in flow between *Alternative 2A – KDRPP East Shore Pumping Plant* and *Alternative 1 –No Action* at the Parker gage. The drought-year changes in flow downstream of Roza Dam would not have a significant effect on flow conditions, since all would remain within current operating flows experienced in most years.

Table 4-9. Change in Yakima River Flow at Easton under *Alternative 2A – KDRPP East Shore Pumping Plant*

Modeled Year	Mean Flow (cfs)		Percent Change
	Alternative 1 – No Action	Alternative 2A	
1925-2009			
Annual	449	445	-0.9
July-August	528	506	-4.3
January	443	437	-1.4
1994 (Drought Year)			
Annual	341	400	17.3
July-August	628	777	23.7
January	289	289	0.0
2001 (Drought Year)			
Annual	420	497	18.3
July-August	883	953	7.9
January	220	220	0.0

Bull Trout Enhancement

The BTE actions are expected to improve streamflow in Gold Creek and Cold Creek during late summer and fall, when Keechelus reservoir is at its lowest level. The actions would provide a surface water connection from the streams to the reservoir pools, providing better seasonal passage conditions for bull trout.

Replacing the existing NF-4832 Bridge over Gold Creek with a wider structure would also improve floodplain connectivity. This change would allow high flows to access floodplain areas, thereby reducing channel velocities and promoting natural channel processes (USFS, 2011a). The Gold Creek actions would also fill or partially fill the artificial Gold Creek and Heli's ponds, reducing the area of impounded water and reducing the capture of groundwater that diminishes surface water flow in Gold Creek. The filling of these ponds could ultimately contribute to increased Gold Creek streamflow.

A perched culvert that blocks fish passage would be removed at Cold Creek. Removal of the barrier would not affect streamflow or surface water.

No change in Keechelus Reservoir levels or releases or Yakima River flows would occur because the enhancement actions would not affect reservoir operations.

4.3.5 Alternative 2B – KDRPP South Pumping Plant

4.3.5.1 Construction

KDRPP South Pumping Plant Facilities

Construction would cause no impacts on reservoir levels or releases as described for *Alternative 2A – KDRPP East Shore Pumping Plant.* No construction would occur at the current outlet or spillway gates. Construction would occur either on land outside of the reservoir and above the Kachess River shoreline or when the reservoir is drawn down in late summer and fall.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.1).

4.3.5.2 Operation

KDRPP South Pumping Plant Facilities

Operational impacts from *Alternative 2B* would be the same as those for *Alternative 2A – KDRPP East Shore Pumping Plant* because operations would be the same regardless of the location of KDRPP facilities.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.2).

4.3.6 Alternative 3A – KKC North Tunnel Alignment

4.3.6.1 Construction

KKC North Tunnel Alignment Facilities

Construction of the KKC would not affect water releases from the reservoirs or streamflow in the Yakima or Kachess rivers. Construction would not affect current outlets or spillway gates in either reservoir and would be isolated from Yakima River flows. Construction would not block flows or require any special reservoir drawdown period to construct the entrance of the KKC tunnel to Kachess Reservoir. Reservoir levels and reservoir releases would not change from *Alternative 1 –No Action* conditions.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.1).

4.3.6.2 Operation

KKC North Tunnel Alignment Facilities

The KKC would reduce streamflow in the Keechelus Reach by up to 400 cfs during summer to improve fish habitat. It would also balance water storage between Keechelus and Kachess reservoirs to promote a faster post-drought refill of Kachess Reservoir. Keechelus Reservoir refills more rapidly than Kachess Reservoir (runoff to storage ratio 1.55 to 1 for Keechelus compared to 0.9 to 1 for Kachess). In most years, Reclamation spills water from Keechelus Reservoir because it cannot store all of the runoff from its watershed.

Table 4-10 provides additional detail on the modeled water transfers under KKC for the period of record used in the hydrologic model. Hydrographs illustrating the time and rate of transfer of flow through KKC are provided in Appendix E.

Table 4-10. Volume of Water Transferred by KKC under *Alternative 3A – KKC North Tunnel Alignment*

Parameter	Quantity
Average annual volume transferred (1925-2009) (acre-feet)	83,948
Number of years flow is transferred (Out of 85 model years)	85
Average number of days volume transfer occurs (of 85 Years)	171
Maximum annual volume transferred (1933) (acre-feet)	147,134
Minimum annual volume transferred (1941) (acre-feet)	14,561
Volume transferred in water year 1994 (acre-feet)	39,853
Volume transferred in water year 2001 (acre-feet)	69,797

Water Supply

Hydrologic modeling indicates *Alternative 3A – KKC North Tunnel Alignment* would provide a very small (less than 1 percent) improvement in water supply for proratable water users during drought years. Table 4-11 summarizes the expected change in prorationing percentage. Water supply would remain well below the 70 percent of entitlement goal. Therefore, KKC would not have a significant benefit to water supply.

Table 4-11. Change in Prorationing under *Alternative 3A – KKC North Tunnel Alignment*

Modeled Drought Year	Percent of Proratable Entitlements		Percent Change
	Alternative 1 – No Action	Alternative 3A	
1992	67.2	68.0	0.8
1993	58.6	59.1	0.5
1994	26.3	26.6	0.3
2001	39.6	39.3	-0.3
2005	45.0	45.5	0.5

Reservoir Levels
Under *Alternative 3 – KKC North Tunnel Alignment*, pool levels in both Keechelus and Kachess reservoirs would change by less than 5 feet relative to *Alternative 1 –No Action*.

Kachess Reservoir. In Kachess Reservoir, the maximum water level would be slightly higher and the minimum water level would be lower during most years. Annual maximum Kachess Reservoir levels would be higher than *Alternative 1 –No Action* levels in about 50 percent of the years, with a mean duration of 230 days during those years. The mean increase in annual maximum water levels would be 2.1 feet, while the mean decrease in minimum water levels would be 0.9 feet. During droughts, the maximum level would be 2 to 4 feet higher and the minimum level nearly 5 feet lower than *Alternative 1 –No Action* levels. These findings are summarized in Table 4-12 and Figure 4-5. Kachess Reservoir levels would remain within current operating ranges and no significant effect on water resources would occur.

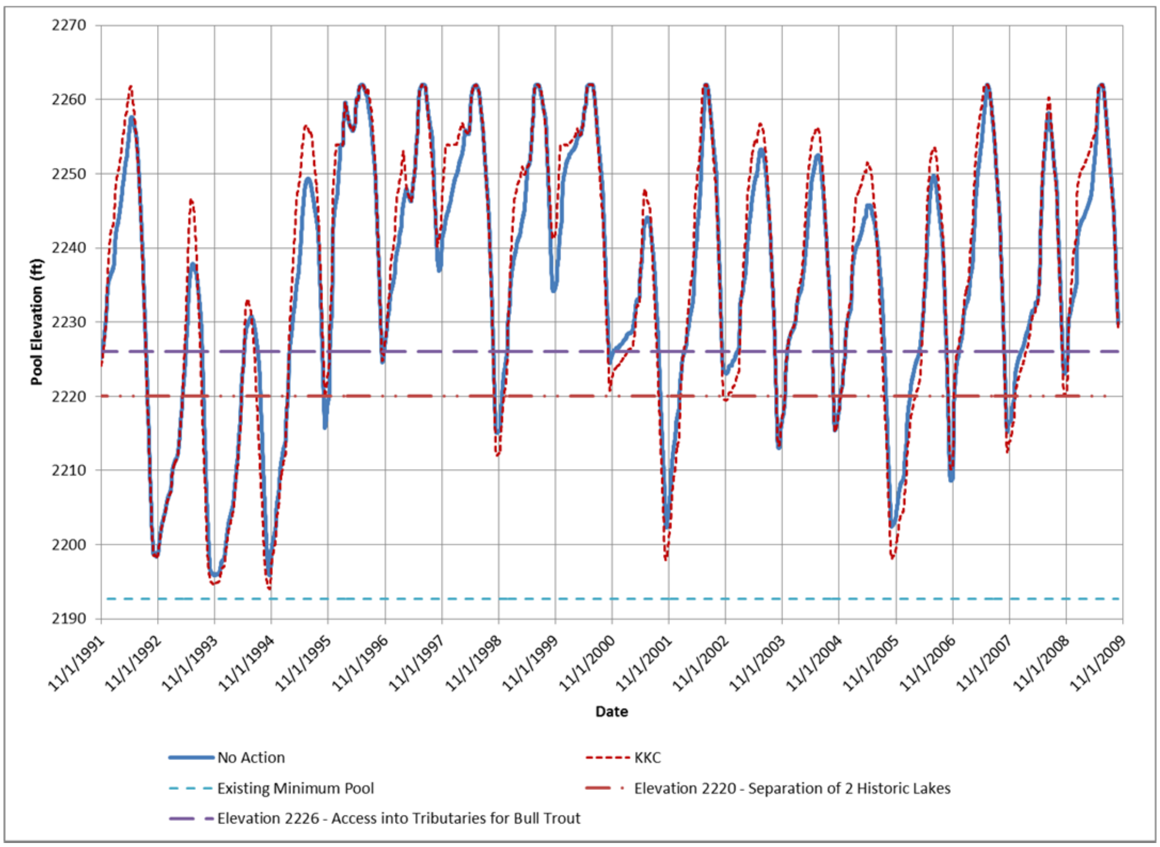

Figure 4-5. Kachess Reservoir Pool Elevation under *Alternative 3A – North Tunnel Alignment*

Table 4-12. Change in Kachess Reservoir Levels under *Alternative 3A – KKC North Tunnel Alignment*

Modeled Year	Pool Elevation (feet)		Change (feet)
	Alternative 1 – No Action	Alternative 3A	
1925-2009			
Mean	2,236.8	2,238.2	1.4
Mean of Annual Maximum	2,254.8	2,256.9	2.1
Mean of Annual Minimum	2,212.2	2,211.3	-0.9
1994 (Drought Year)			
Mean	2,211.5	2,209.3	-2.2
Maximum	2,230.8	2,233.1	2.3
Minimum	2,195.8	2,194.1	-1.7
2001 (Drought Year)			
Mean	2,228.9	2,226.9	-2.0
Maximum	2,244.1	2,247.9	3.8
Minimum	2,202.3	2,197.9	-4.4

Kachess Reservoir levels would not fall below the existing low pool elevation of 2,192 (the elevation of the gravity outlet) under *Alternative 3A – KKC North Tunnel Alignment*; KKC does not use storage in the reservoir below that level.

Kachess Reservoir pool level would be below the elevation at which the two lake basins become separated (elevation 2,220) (and at which fish can no longer pass between the two) in 75 percent of years, an increase of 2 percent from *Alternative 1 – No Action*. The mean duration of this condition would be 92 days per year, an increase of 5 days per year relative to *Alternative 1*. The slight increase in frequency and duration would not have a significant effect on fish passage.

In most years (88 percent), Kachess Reservoir would be below the level that impedes bull trout access to tributary streams (elevation 2,226), representing no change from *Alternative 1 – No Action*. The mean duration of this effect would be 112 days per year, an increase of 3 days per year. The slight increase in duration would not have a significant effect on fish passage to Kachess Reservoir tributaries.

Keechelus Reservoir. During drought years and the years when Kachess Reservoir is refilling, water levels in Keechelus Reservoir would have a slightly lower maximum and higher minimum. Annual maximum Keechelus Reservoir levels would be lower than *Alternative 1 – No Action* levels in about 46 percent of the years, with a mean duration of 181 days during those years. The mean reduction in annual maximum water levels would be 2.8 feet, while the mean increase in minimum water levels would be 4.5 feet. During droughts, the maximum level would be about 5 feet lower and the minimum level up to 14.3 feet higher than *Alternative 1 – No Action* levels. These findings are summarized in Table 4-13 and Figure 4-6.

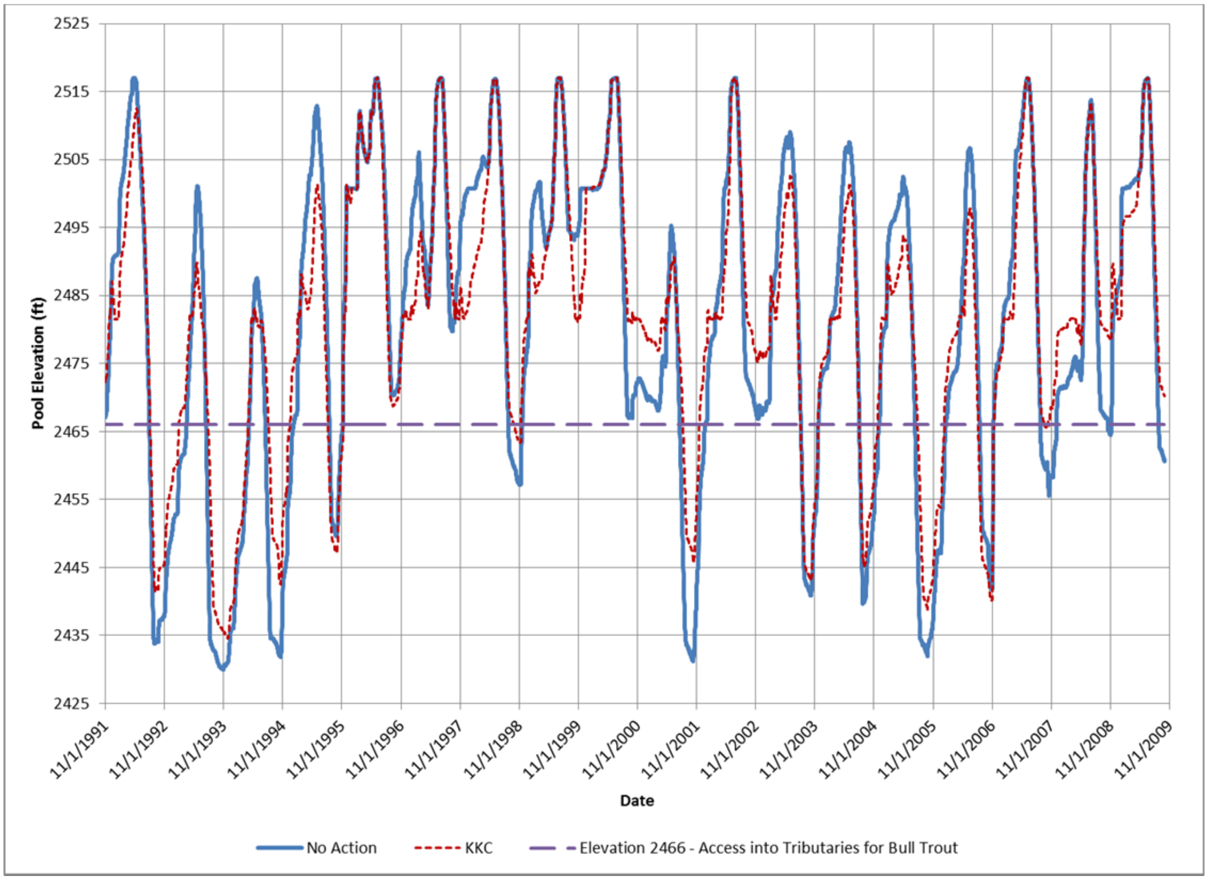

Figure 4-6. Keechelus Reservoir Pool Elevation under *Alternative 3A – KKC North Tunnel Alignment*

Table 4-13. Change in Keechelus Reservoir Levels under *Alternative 3A – KKC North Tunnel Alignment*

Modeled Year	Pool Elevation (feet)		Change (feet)
	Alternative 1 – No Action	Alternative 3A	
1925-2009			
Mean	2,482.0	2,482.0	0.0
Mean of Annual Maximum	2,510.3	2,507.5	-2.8
Mean of Annual Minimum	2,450.0	2,454.3	4.3
1994 (Drought Year)			
Mean	2,452.0	2,457.9	5.9
Maximum	2,487.6	2,483.3	-4.3
Minimum	2,430.0	2,434.6	4.6
2001 (Drought Year)			
Mean	2,465.4	2,473.9	8.5
Maximum	2,495.3	2,490.7	-4.6
Minimum	2,431.3	2,445.6	14.3

Pool elevation in Keechelus Reservoir would be below the elevation that impedes bull trout access to tributary streams (elevation 2,466) in 71 percent of the years, a decrease of 10 percent from *Alternative 1 – No Action*. The mean duration of this condition would be 100 days per year, a decrease of 15 days per year, resulting in an improvement for access to tributary streams. This would be a significant benefit for fish passage.

Streamflow

Alternative 3A – KKC North Tunnel Alignment would divert water just downstream from Keechelus Reservoir and convey it directly to Kachess Reservoir. This would change streamflow in the Yakima and Kachess rivers compared to *Alternative 1 – No Action*.

Table 4-14 summarizes the changes in Kachess River streamflow. Flow in Kachess River would increase relative to *Alternative 1 – No Action* because the water diverted to Kachess Reservoir would be released to the river. Overall, the mean flow in the Kachess River would increase by 54 cfs (18.4 percent). The July-to-August mean would increase by 127 cfs (22.4 percent). During drought years, the increase would be greater, ranging from 189 to 233 cfs (36 to 43 percent). The mean winter flow would increase by about 38 cfs (101 percent). During drought years, winter flows would be similar to existing conditions because Reclamation would only release minimum flows to conserve storage and allow the reservoir to refill. No significant effect on overall flow conditions in the Kachess River would result from *Alternative 3A – KKC North Tunnel Alignment* because the changed streamflows would remain within the current operational range.

Table 4-14. Change in Kachess River Flow below Kachess Reservoir under *Alternative 3A- KKC North Tunnel Alignment*

Modeled Year	Mean Flow (cfs)		Percent Change
	Alternative 1 – No Action	Alternative 3A	
1925-2009			
Annual	293	347	18.4
July-August	566	693	22.4
January	37.3	75.0	101.1
1994 (Drought Year)			
Annual	193	217	12.4
July-August	432	621	43.8
January	15.4	15.4	0.0
2001 (Drought Year)			
Annual	265	326	23.0
July-August	651	884	35.8
January	35.1	32.5	-7.4

Alternative 3A – KKC North Tunnel Alignment would change streamflow in the Keechelus Reach, the Easton Reach, and downstream to the Yakima River at Parker gage. During July and August, the diversion of up to 400 cfs through KKC tunnel would reduce peak flows.

Streamflow reduction in summer months to improve fish habitat in the Keechelus Reach would be the primary benefit of *Alternative 3A – KKC North Tunnel Alignment*. The peak flow in July in the Keechelus Reach would be about 500 cfs. In August, Reclamation would gradually reduce the high summer flows to the fall and winter base flow of 100 cfs in order to simulate a more natural falling hydrograph. The high priority instream flow for fall and winter identified in the Integrated Plan is 120 cfs; *Alternative 3A –KKC North Tunnel Alignment* would maintain the current fall and winter base flow of 100 cfs. Overall, streamflow in the Keechelus Reach would be reduced by 35 percent, a reduction of over 50 percent in summer. This pattern of flow changes would achieve the goal of reducing the artificially high summer Keechelus Reach streamflows and provide a significant benefit. These changes are summarized in Table 4-15 and Appendix E, Figure E-7.

Table 4-15. Change in Keechelus Reach Flow under *Alternative 3A – KKC North Tunnel Alternative*

Modeled Year	Mean Flow (cfs)		Percent Change
	Alternative 1 – No Action	Alternative 3A	
1925-2009			
Annual	336	219	-34.8
July-August	828	396	-52.2
January	161	101	-37.3
1994 (Drought Year)			
Annual	230	166	-27.8
July-August	608	354	-41.8
January	80.6	80.0	-0.7
2001 (Drought Year)			
Annual	285	186	-34.7
July-August	715	369	-48.4
January	131	100	-23.7

In the Easton Reach, summer streamflows would increase in drought years because of the enhanced water supply for proratable water users, as summarized in Table 4-16. This increase would be 39 to 52 cfs (4.4 to 8.3 percent). In other times of year and in normal or wet years, flows would not appreciably change. Flows in the Yakima River at Parker gage are not expected to change after the water is diverted by RID or WIP. The increase in streamflow during drought years would not have a significant effect on overall Yakima River streamflow conditions because the flows would be within current operating ranges.

Table 4-16. Change in Easton Reach Flow under *Alternative 3A – KKC North Tunnel Alignment*

Modeled Year	Mean Flow (cfs)		Percent Change
	Alternative 1 – No Action	Alternative 3A	
1925-2009			
Annual	449	450	0.2
July-August	528	515	-2.5
January	443	444	0.2
1994 (Drought Year)			
Annual	341	352	3.2
July-August	628	680	8.3
January	289	289	0.0
2001 (Drought Year)			
Annual	420	424	1.0
July-August	883	922	4.4
January	220	220	0.0

Bull Trout Enhancement
Operation impacts of the BTE actions would be the same as described for *Alternative 2A-KDRPP East Pumping Plant* in Section 4.2.4.2.

4.3.7 Alternative 3B – KKC South Tunnel Alignment

4.3.7.1 Construction

KKC South Tunnel Alignment Facilities
Construction of *Alternative 3B – KKC South Tunnel Alignment* would not affect water releases from Keechelus or Kachess reservoirs or streamflow in the Yakima or Kachess rivers. Present outlets and spillway gates would not be involved and construction activity would be isolated from Yakima River flows. Construction would not block flow or require any special reservoir drawdown period. Reservoir levels and reservoir releases during construction would not differ from existing conditions.

Bull Trout Enhancement
Construction impacts associated with the BTE actions are the same as described for *Alternative 2A- KDRPP East Pumping Plant* in Section 4.2.4.1.

4.3.7.2 Operation

KKC South Tunnel Alignment Facilities
Operational impacts would be the same as those for *Alternative 3A – KKC North Tunnel Alignment* because operations would be the same regardless of the tunnel location.

Bull Trout Enhancement
Operation impacts of the BTE actions would be the same as described for *Alternative 2A-KDRPP East Pumping Plant* in Section 4.2.4.2.

4.3.8 Alternative 4 – Combined KDRPP and KKC

4.3.8.1 Construction

KDRPP and KKC Facilities
Construction impacts would be the same as described for the individual actions in *Alternative 2A – East Shore Pumping Plant* and *Alternative 3A – North Tunnel Alignment*. Construction for neither KDRPP nor KKC would affect reservoir levels or releases because present outlets and spillway gates would not be involved and activity would be isolated from Yakima River flows. Construction would not block flows or require any special reservoir drawdown period. Reservoir levels and reservoir releases would not differ from those of *Alternative 1-No Action*.

Bull Trout Enhancement
Construction impacts associated with the BTE actions are the same as described for *Alternative 2A- KDRPP East Pumping Plant* in Section 4.2.4.1.

4.3.8.2 Operation

KDRPP and KKC Facilities
Alternative 4 – Combined KDRPP and KKC would improve water supply for irrigation districts with proratable entitlements during drought years, reduce streamflow in the Keechelus Reach during summer, and balance water storage between Keechelus and Kachess reservoirs in order to more rapidly refill Kachess Reservoir after a drought. The combined KDRPP and KKC would be complementary and provide additional benefits beyond their individual benefits.

Under *Alternative 4 – Combined KDRPP and KKC*, the KKC would have the same capacity as described for Alternative 3A and 3B (400 cfs); however, the KKC would convey slightly less volume to Kachess Reservoir. Table 4-17 provides additional detail on the modeled volume transferred under KKC for the period of record used in the hydrologic model. Hydrographs illustrating the time and rate of transfer of flow through KKC are provided in Appendix E, Figures E-5 and E-6.

Table 4-17. Volume of Water Transferred under *Alternative 4 – Combined KDRPP and KKC*

Parameter	Quantity
Average annual volume transferred (1925-2009) (acre-feet)	81,460
Number of years flow is transferred (out of 85 model years)	82
Average number of days volume transfer occurs (of 82 years utilized)	164
Average number of days volume transfer occurs (of 85 model years)	158
Maximum annual volume transferred (1933) (acre-feet)	143,243
Minimum annual volume transferred (1930, 1941, 1944) (acre-feet)	0
Volume transferred in water year 1994 (acre-feet)	4,438
Volume transferred in water year 2001 (acre-feet)	53,548

Water Supply

Depending on the year, improvements in percent of entitlements available would range from nominal (0.3 percent) to 23 percent, as summarized in Table 4-18. The resulting prorationing percentages during single-drought years (63 to 67 percent) represent a significant increase in water supply although they are still below the 70 percent goal. During the third year of a multiyear drought like that of 1992 to 1994, water supply would also significantly improve (from 26 to 43 percent of entitlements), but remain below the target. The increase in prorationing for drought years would be a significant benefit to water supply.

Table 4-18. Percent of Entitlement Available in Drought Years under *Alternative 4 -Combined KDRPP and KKC*

Modeled Drought Year	Alternative 1– No Action[1]	Alternative 4[1]	Percent Change
1992	67.2	67.5	0.3
1993	58.6	70.0	11.4
1994	26.3	43.3	17.0
2001	39.6	62.6	23.0
2005	45.0	66.5	21.5

[1]Percent of prorationing

Reservoir Levels

Alternative 4A – Combined KDRPP and KKC would change reservoir levels in both Kachess and Keechelus reservoirs from *Alternative 1 – No Action*.

Kachess Reservoir. Kachess Reservoir levels would be lower than *Alternative 1 – No Action* levels in most years. This status would occur during drought years as water is withdrawn for proratable water users and in subsequent years when the reservoir is refilling.

Table 4-19 and Figure 4-7 summarize predicted Kachess Reservoir levels under *Alternative 4 – Combined KKC and KDRPP*. Both the degree of drawdown and the time elapsed from drawdown to full refill would vary, depending on the degree, duration, and frequency of drought. For example, during a multiyear drought similar to that of 1992 to 1994, the reservoir level would be drawn down to 80 feet below the existing minimum pool level, with recovery 2 years later, if the second year of refill was a wet year, as was the case in 1996. In a single-year drought such as 2001, the reservoir would be drawn down to 40 feet below existing minimum pool levels, with full recovery delayed by a second drought (as modeled, in 2005) and not achieved until a wet year (2006, as modeled). During the second drought year (2005, as modeled), the reservoir level would be 50 feet below the existing minimum pool level.

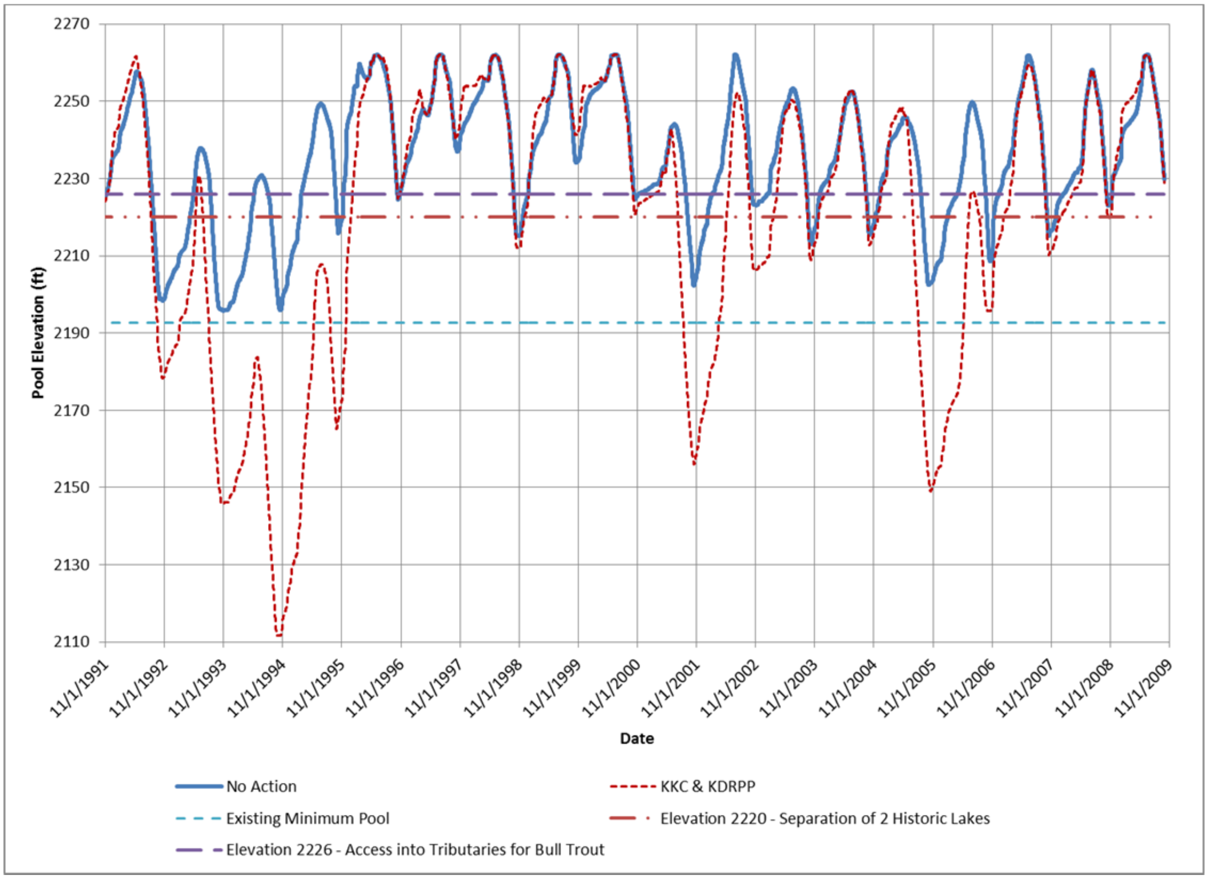

Figure 4-7. Kachess Reservoir Pool Elevation under *Alternative 4 – Combined KDRPP and KKC*

Table 4-19. Kachess Reservoir Pool Elevations under all Alternatives

Modeled Year	Alternative 1 – No Action	Alternatives 2A and 2B	Change[1] (feet)	Alternatives 3A and 3B	Change[a] (feet)	Alternative 4	Change[1] (feet)
1925-2009							
Mean	2,236.8	2,221.2	-15.6	2,238.2	1.4	2,225.4	-11.4
Mean of Annual Maximum	2,254.8	2,242.7	-12.1	2,256.9	2.1	2,248.0	-6.8
Mean of Annual Minimum	2,212.2	2,190.0	-22.2	2,211.3	-0.9	2,191.7	-20.5
1994 (Drought Year)							
Mean	2,211.6	2,146.2	-65.4	2,209.3	-2.3	2,151.6	-60.0
Maximum	2,230.8	2,176.7	-54.1	2,233.1	2.3	2,183.8	-47.0
Minimum	2,195.8	2,111.6	-84.2	2,194.1	-1.7	2,111.6	-84.2
2001 (Drought Year)							
Mean	2,228.9	2,212.9	-16.0	2,226.9	-2.0	2,213.4	-15.5
Maximum	2,244.1	2,239.4	-4.7	2,247.9	3.8	2,242.8	-1.3
Minimum	2,202.3	2,152.7	-49.6	2,197.9	-4.4	2,156.1	-46.2

Note: All pool elevations in feet

[1] Change from *Alternative 1 – No Action*

Kachess Reservoir levels under *Alternative 4 – Combined KDRPP and KKC* would be similar to those for *Alternative 2A – KDRPP East Shore Pumping Plant*; however, the magnitude of change from *Alternative 1 – No Action* would be reduced by up to 6.9 feet.

Three pool elevations serve as benchmarks for potential impacts:

- 2,192, elevation of the gravity outlet, minimum pool
- 2,220, pool level that separates the two historic lake basins
- 2,226, pool level that impedes bull trout access to tributaries

The time during which Kachess Reservoir pool elevation would be below these benchmarks is summarized in Table 4-20.

Table 4-20. Frequency and Duration of Kachess Pool Elevation below Benchmark Elevations, All Alternatives

Elevation	Unit	Alternative 1 – No Action	Alternatives 2A and 2B	Change[1]	Alternatives 3A and 3B	Change[1]	Alternative 4	Change[1]
2,192[2]	Percent of years	0	36	36	0	0	33	33
2,192[2]	Mean duration, days	0	191	191	0	0	179	179
2,200[3]	Percent of years	73	74	1	75	2	78	5
2,200[3]	Mean duration, days	87	165	78	92	5	143	56
2,226[4]	Percent of years	88	89	1	88	0	88	0
2,226[4]	Mean duration, days	109	164	55	112	3	153	44

[1]Change compared to *Alternative 1 – No Action*

[2]Elevation of gravity outlet; minimum pool

[3]Elevation at which the two lake basins separate and interbasin fish passage is impeded

[4]Elevation at which bull trout access to tributary streams is impeded

Kachess Reservoir would be below the existing minimum pool elevation of 2,192 for 33 percent of the modeled years, with a mean duration of 179 days. Under *Alternative 1 – No Action*, the pool would not fall below this elevation. The drawdown below elevation 2,192 would have a significant effect on Kachess Reservoir.

The number of years during which the two lake basins of Kachess Reservoir would become separated (elevation 2,220) would be 5 percent greater under Alternative 4 than under *Alternative 1 – No Action* (78 versus 73 percent), and for an additional 56 days (143 versus 87 days). Bull trout access to tributary streams would be impeded (elevation 2,226) in 88 percent of the modeled years, representing no change from *Alternative 1 – No Action*. However, the mean duration would be 153 days, an increase of 44 days. The increased frequency and duration of reservoir levels below 2,220 and 2,226 would have a significant impact on fish passage.

Although *Alternative 4 – Combined KDRPP and KKC* would impact the ability of bull trout to access the upper lake basin in Kachess Reservoir and tributary streams, it would perform slightly better than *Alternatives 2A* and *2B*. In either case a significant impact on fish passage would occur.

Keechelus Reservoir. Keechelus Reservoir levels would be lower following a drought than those of *Alternative 1 – No Action* because more water would be withdrawn in the first 2 or 3 post-drought years to allow the fastest possible refilling of Kachess Reservoir. As shown in Table 4-21 and Figure 4-8, the peak water levels in Keechelus Reservoir would be reduced by 10 to 25 feet and the lowest level reduced by about 15 feet during the post-drought refilling years. Keechelus Reservoir levels would still be within its current operating range.

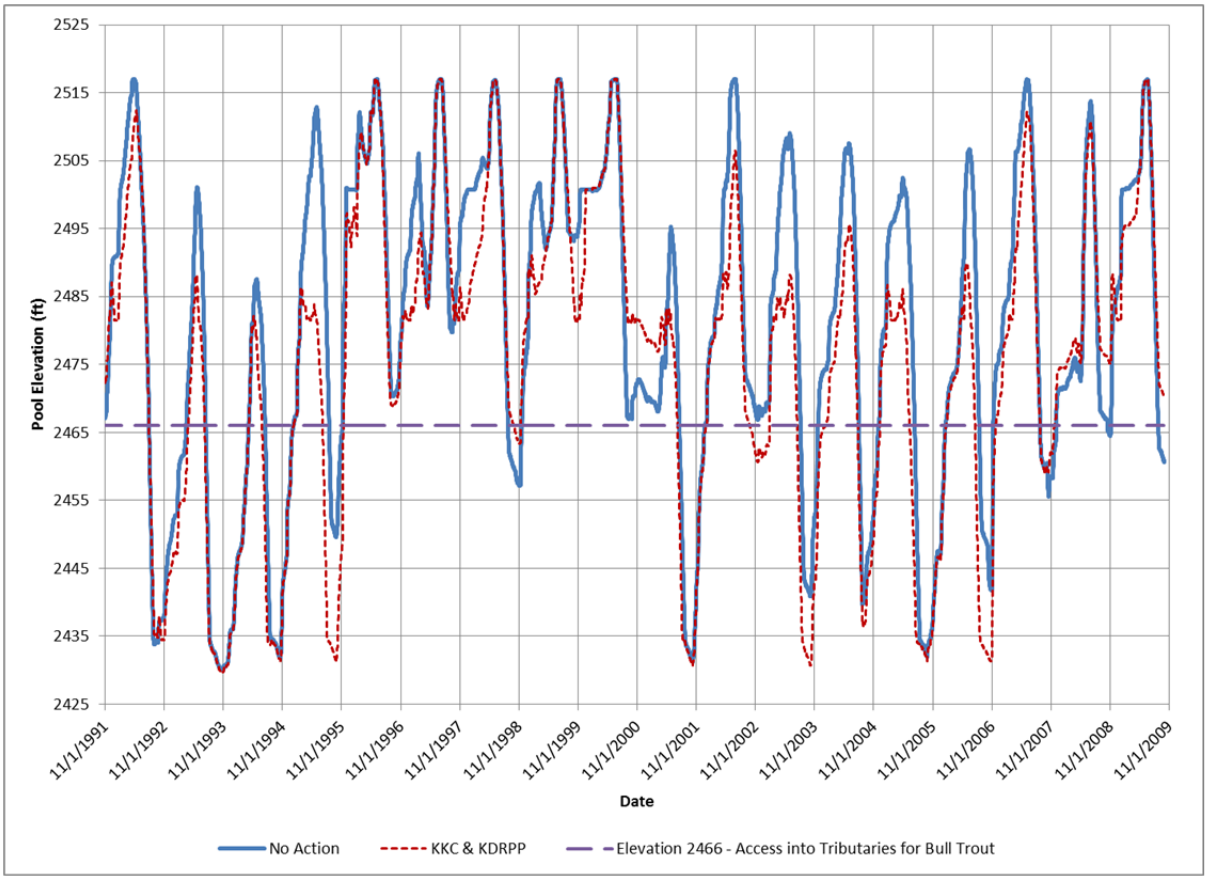

Figure 4-8. Keechelus Reservoir Pool Elevation under *Alternative 4 – Combined KDRPP and KKC*

Table 4-21. Keechelus Reservoir Pool Elevations under All Alternatives

Modeled Year	Alternative 1 – No Action	Alternatives 2A and 2B	Change[1] (feet)	Alternatives 3A and 3B	Change[1] (feet)	Alternative 4	Change[1] (feet)
1925-2009							
Mean	2,482.0	2,480.8	0.0	2,482.0	-1.2	2,478.3	-3.7
Mean of Annual Maximum	2,510.3	2,509.2	-2.8	2,507.5	-1.1	2,504.4	-5.9
Mean of Annual Minimum	2,450.0	2,449.1	4.3	2,454.3	-0.9	2,450.5	0.5
1994 (Drought Year)							
Mean	2,452.0	2,449.7	5.9	2,457.9	-2.3	2,448.6	-3.4
Maximum	2,487.6	2,484.3	-4.3	2,483.3	-3.3	2,482.2	-5.4
Minimum	2,430.0	2,430.1	4.6	2,434.6	0.1	2,429.7	-0.3
2001 (Drought Year)							
Mean	2,465.4	2,462.3	8.5	2,473.9	-3.1	2,466.0	0.6
Maximum	2,495.3	2,485.6	-4.6	2,490.7	-9.7	2,483.5	-11.8
Minimum	2,431.3	2,430.7	14.3	2,445.6	-0.6	2,430.7	-0.6

Note: All pool elevations in feet

[1] Change from *Alternative 1 – No Action*

Mean Keechelus Reservoir levels for *Alternative 4 – Combined KDRPP and KKC* would be lower than those for other alternatives by 2.5 feet (relative to *Alternative 2*) to 3.7 feet (relative to *Alternatives 1* and *3*), although the annual minimum would be slightly (0.5 feet) higher than that for *Alternative 1 – No Action*. During drought years, Keechelus Reservoir levels would differ by a maximum of 2 feet from those for *Alternatives 2A* and *2B* (i.e., with KDRPP alone in place). Predicted reservoir levels for all alternatives would fall within the range that would occur under *Alternative 1 – No Action*.

As summarized in Table 4-22, bull trout access to tributary streams of Keechelus Reservoir would be impeded (below elevation 2,466) in 74 percent of the modeled years for *Alternative 4 – Combined KDRPP and KKC*, a decrease of 7 percent from *Alternative 1 – No Action*. The duration of this condition would be 130 days per year, an increase of 15 days per year, representing a greater change than would occur under any other action alternative. Overall, the slight change in frequency and duration would not have a significant effect on fish passage.

Table 4-22. Frequency and Duration of Keechelus Pool Level below Elevation 2,466, All Alternatives

Unit	Alternative 1 – No Action	Alternatives 2A and 2B	Change[1]	Alternatives 3A and 3B	Change[1]	Alternative 4	Change[1]
Percent of years	81	82	1	71	-10	74	-7
Mean duration, days	115	125	10	100	-15	130	15

Note: At elevation 2,466, bull trout access to tributary streams is impeded.

[1] Change relative to *Alternative 1 – No Action*

Streamflow
Under *Alternative 4 – Combined KDRPP and KKC*, Reclamation would pump water from the inactive storage of Kachess Reservoir and discharge it to the Kachess River for delivery to participating proratable water users—likely KRD, RID, and WIP. Streamflow in the Kachess River and in the Yakima River would change compared to *Alternative 1 – No Action* conditions. In addition, streamflow would change as Kachess Reservoir is being refilled after droughts. Appendix E includes hydrographs depicting streamflow under *Alternative 4 – Combined KDRPP and KKC.*

Kachess River. Table 4-23 summarizes the change in Kachess River streamflow. In general, the pumping of inactive storage in the reservoir would increase flow in the Kachess River. Overall, the mean flow would increase by 56 cfs (19.1 percent), with an increase in the July-to-August mean of 142 cfs (25.1 percent). During a drought year, the July-to-August streamflow in the Kachess River would more than double relative to *Alternative 1 – No Action*. With existing summertime flow releases ranging up to 1,300 cfs, the maximum discharge of 1,000 cfs (capacity of KDRPP) would not alter the normal operating range of river flow.

Table 4-23. Kachess River Flow below Kachess Reservoir under *Alternative 4-Combined KDRPP and KKC*

Modeled Year	Mean Flow (cfs)		Percent Change
	Alternative 1 – No Action	Alternative 4	
1925-2009			
Annual	293	349	19.1
July-August	566	708	25.1
January	37.3	65.7	76.1
1994 (Drought Year)			
Annual	193	313	62.2
July-August	432	961	122.5
January	15.4	15.3	-0.6
2001 (Drought Year)			
Annual	265	446	68.3
July-August	651	1,172	80.0
January	35.1	32.5	-7.4

The mean winter flow would increase by about 29 cfs (76 percent). During drought years, winter flows would be very similar to those of *Alternative 1 – No Action* because in the interest of conserving storage and promoting refill, Reclamation would release only minimum flows. Kachess River streamflow conditions under *Alternative 4 – Combined*

KDRPP and KKC would be similar to those of *Alternative 2A – KDRPP East Shore Pumping Plant*, remaining within the current operating range of flows in the river. Therefore, no significant effect on Kachess River streamflow would result.

Yakima River. *Alternative 4 – Combined KDRPP and KKC* would change streamflow in the Keechelus Reach, the Easton Reach, and downstream to the Yakima River at the Parker gage. The change in streamflow in the Keechelus Reach is summarized in Table 4-24 and illustrated in Appendix E, Figure E-8. During July and August of most years, Reclamation would divert up to 400 cfs through KKC to reduce peak flows in the Keechelus Reach, similar to *Alternative 3 – KKC North Tunnel Alignment*. The peak flow in July in the Keechelus Reach would be 500 cfs. In drought years, the mean annual flow would be higher for *Alternative 4 – Combined KDRPP and KKC*. The KKC would also allow Reclamation to gradually taper high summer flows to fall and winter flow levels of 100 cfs, simulating a natural reduction of flow over the summer. The high priority instream flow for fall and winter identified in the Integrated Plan is 120 cfs; *Alternative 4 – Combined KDRPP and KKC* would maintain the current fall and winter base flow of 100 cfs. Overall, mean summer flows would be reduced by over 50 percent and provide a significant benefit to instream flow conditions in the Keechelus Reach.

Table 4-24. Change in Yakima River Flow in Keechelus Reach under *Alternative 4 - Combined KDRPP and KKC*

Modeled Year	Mean Flow (cfs)		Percent Change
	Alternative 1 – No Action	Alternative 4	
1925-2009			
Annual	336	223	-33.6
July-August	828	392	-52.7
January	161	100	-37.9
1994 (Drought Year)			
Annual	230	224	-2.6
July-August	608	437	-28.1
January	80.6	80.7	0.1
2001 (Drought Year)			
Annual	285	234	-17.9
July-August	715	351	-50.9
January	131	100	-23.7

Overall, for the Easton Reach, streamflows would change slightly from *Alternative 1 – No Action*, as summarized in Table 4-25, and would be similar to conditions under *Alternative 2A – KDRPP East Shore Pumping Plant*. In drought-year summers, flow would increase 70 to 120 cfs (8 to 19 percent) with Reclamation's operation of KDRPP. The increase in flow caused by operation of KDRPP would be moderated at the diversion for KRD which is at the head of the Easton Reach. The change in flows would be within current operating ranges and would not have a significant effect on streamflow in the Easton Reach.

Table 4-25. Change in Yakima River Flow at Easton with *Alternative 4 – Combined KDRPP and KKC*

Modeled Year	Mean Flow (cfs)		Percent Change
	Alternative 1 – No Action	Alternative 4	
1925-2009			
Annual	449	442	-1.6
July-August	528	482	-8.7
January	443	429	-3.2
1994 (Drought Year)			
Annual	341	398	16.7
July-August	628	745	18.6
January	289	289	0.0
2001 (Drought Year)			
Annual	420	496	18.1
July-August	883	951	7.7
January	220	220	0.0

The increase in flow caused by operation of KDRPP would be further moderated at Roza Dam, at the diversion for the Roza Irrigation District. Any remaining increased flow would be diverted by WIP at Wapato Dam. A small decrease in streamflow downstream of Parker gage on the Yakima River would occur as Kachess Reservoir refills after a drought. The change would occur during winter and spring, when flows in the Yakima River are high relative to summer months. The overall reduction in streamflow from Parker gage downstream would be about 1 percent. The change in streamflow downstream of Parker gage is summarized in Table 4-26.

Overall, streamflow in the Yakima River in the Easton Reach and in downstream reaches under *Alternatives 2, 3,* and *4* would not cause flows to extend outside of current operational ranges and the alternatives would not significantly affect streamflow conditions.

Table 4-26. Change in Yakima River Flow at Parker under *Alternative 4 – Combined KDRPP and KKC*

Modeled Year	Mean Flow (cfs)		Percent Change
	Alternative 1 – No Action	Alternative 4	
1925-2009			
Annual	2,307	2,290	-0.7
July-August	784	773	-1.4
January	2,915	2,893	-0.8
1994 (Drought Year)			
Annual	966	955	-1.1
July-August	492	486	-1.2
January	1,441	1,442	0.1
2001 (Drought Year)			
Annual	824	764	-7.3
July-August	518	394	-23.9
January	1,084	1,084	0.0

Bull Trout Enhancement

Operation impacts of the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.2.4.2).

4.3.9 Mitigation Measures

Implementation of *Alternatives 2* through *4* would have a positive impact on instream flow and water supply, which is consistent with the goals of the Proposed Action. No mitigation is needed.

In lengthening the period of drawdown below benchmark elevations in Kachess Reservoir, implementation of *Alternatives 2* and *4* could cause adverse effects to bull trout, which would not be able to access upstream tributaries below elevation 2,226 or move freely between the two historical lake basins below elevation 2,220. Mitigation in the form of fish passage improvements is described in Section 4.6.9.

In lengthening the period of drawdown below elevation 2,466 in Keechelus Reservoir, implementation of *Alternatives 2* and *4* could cause adverse effects to bull trout by preventing access to upstream tributaries. The BTE actions included as part of the Proposed Action, would improve fish passage and connectivity between Gold Creek and Cold Creek and Keechelus Reservoir and no additional mitigation is needed.

4.4 Surface Water Quality

4.4.1 Methods and Impact Indicators

Surface water quality impact indicators and criteria for determining impact significance are shown in Table 4-27. Reclamation assessed all criteria relative to *Alternative 1 – No Action*.

Methods. The assessment of potential water quality impacts on receiving waters is based on existing water quality data, water body characteristics (e.g., reservoir depth, river flow), and anticipated changes to these conditions from the Proposed Action. The assessment incorporates professional judgment and experience. State water quality standards (Chapter 173-201A WAC) specify limits for numerous water quality parameters.

Impact Indicators. The impact indicators for water quality are increased sedimentation (as suspended sediment), turbidity, temperature, nutrients, fecal coliform bacteria, total dissolved gas (TDG), decreased DO, PCBs, oil and grease, and total petroleum hydrocarbons (TPH) (Table 4-27). The significance criteria are based on State water quality standards (Chapter 173-201A WAC).

Table 4-27. Impact Indicators and Significance Criteria for Surface Water Quality

Impact Indicator	Significance Criteria
Turbidity	State standard is maximum of 5 nephelometric turbidity units over background, values above this standard is considered a negative impact
Temperature[1]	State standards are as follows: <16°C (60.8°F) suitable for aquatic life use for core summer salmonid habitat <12°C (53.6°F) suitable for aquatic life use for char spawning and rearing (Keechelus Reservoir and Little Kachess basin) 13°C from September 15 to June 15 for the Yakima River downstream from Keechelus Reservoir to confluence of Kachess River 13°C from September 15 to May 15 for the Yakima River downstream from Kachess River confluence to confluence of Cle Elum River Noncompliance with these standards is considered a negative impact
Dissolved oxygen	State standard is >9.5 mg/L For lakes, human actions considered cumulatively may not decrease the DO concentration more than 0.2 mg/L below natural conditions Noncompliance with these standards is considered a negative impact
Suspended Sediment	No State standard; noncompliance with the turbidity standard used as a general indicator of water clarity
Nutrients (nitrogen and phosphorus) and change in trophic state	No State standards; a change from current water quality conditions or trophic state is considered a negative impact
Total dissolved gas	State standard is not to exceed 110 percent; levels in excess of this is considered a negative impact

Table 4-27. Impact Indicators and Significance Criteria for Surface Water Quality

Impact Indicator	Significance Criteria
Fecal coliform	State standard is not to exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than 10 sample points exist) obtained for calculating the geometric mean value exceeding 100 colonies/100 mL; exceedance of this standard is considered a negative impact
pH	State standard is within the range of 6.5 to 8.5; pH values outside of this range is considered a negative impact
Polychlorinated biphenyls	State standards for freshwater (24-hour average not to be exceeded): Acute – 2.0 µg/L Chronic – 0.014 µg/L Clean Water Act Section 303(d) human health criterion[2] is 5.3 µg/kg PCB levels in excess of these standards would be considered a negative impact
Oil, grease, and total petroleum hydrocarbons	No State standard; visible sheen used as an indicator

[1]When the background condition of the water is cooler than the standards defined in Chapter 173-201A WAC, the allowable rate of warming up to, but not exceeding, the numeric criteria from human actions are restricted as follows:

(A) Incremental temperature increases resulting from individual point source activities must not, at any time, exceed 28/(T+7) as measured at the edge of a mixing zone boundary (where "T" represents the background temperature in degrees Celsius as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge); and

(B) Incremental temperature increases resulting from the combined effect of all nonpoint source activities in the water body must not, at any time, exceed 2.8°C (5.04°F).

[2]Human health criterion is 5.3 µg/kg (as specified in Ecology, 2007)

4.4.2 Summary of Impacts

No changes would occur to current reservoir operations, reservoir levels, or streamflows with *Alternative 1 – No Action*. However, if a severe long-term drought occurs, or conditions worsen because of climate change, water levels in reservoirs could significantly drop and, with warmer air temperatures, affect long-term water quality conditions for such parameters as DO and water temperature.

No changes from existing water quality conditions would be expected as a result of *Alternative 2A – KDRPP East Shore Pumping Plant* or *Alternative 2B – KDRPP South Pumping Plant*. Kachess Reservoir operations during nondrought years would remain similar to those of *Alternative 1 – No Action*. Additional exceedances of State surface water quality standards (described in Section 3.4) would not occur.

Lower reservoir pool levels predicted during drought and post-drought recovery periods could cause turbidity, temperature, and DO in the Kachess Reservoir to be out of compliance with corresponding State surface water quality standards more often than predicted under *Alternative 1 – No Action*. However, no long-term significant impacts would be expected because suspended material would be localized in distribution and settle out as the reservoir bed stabilizes.

After a drought and its recovery, the potential for water heating (from the warmer air temperatures that occur during a drought) and depressed DO concentrations would diminish as the reservoir pool level rises and operations approach nondrought conditions. However, if a severe long-term drought occurs or conditions worsen because of climate change resulting DO and water temperatures could potentially cause significant impacts under these conditions.

Exceedance of the State surface water quality standard for water temperature may occur at the outlet to Kachess River during extended drought and drought recovery. However, DO concentrations are not expected to fall below the minimum standard because turbulence at the spillway would introduce oxygen. Short-lived exceedances of turbidity in the Kachess River could occur until the upstream reservoir stabilizes.

No water quality impacts due to KDRPP operations would occur in Keechelus Reservoir or downstream in the Yakima River (Keechelus, Easton, and Parker reaches) or Lake Easton. The possible exception would be during drought and drought recovery years when the Kachess River could exceed the temperature standard (16°C). A potential increase in warming during drought recovery may occur in the Keechelus Reservoir because reservoir pool elevations are predicted to be lower than what is expected under *Alternative 1 – No Action.* Warm river temperatures would influence Lake Easton temperatures.

Under the KKC, water would be transferred to Kachess Reservoir from Keechelus Reservoir. Operations under *Alternative 3A – KKC North Tunnel Alignment* and *Alternative 3B – KKC South Tunnel Alignment* would not cause an increase in contaminants. However, if a severe long-term drought occurs or conditions worsen because of climate change, water levels in the reservoirs could significantly drop, affecting long-term water quality conditions in Kachess Reservoir for DO and temperature. Water quality in Kachess Reservoir could be modified by that of the Keechelus Reservoir inflow. Keechelus Reservoir is currently listed as 303(d) Category 5 for PCBs and dieldrin in fish tissue. Ecology's upcoming 303(d) list for fresh waters also identifies Kachess Reservoir as 303(d)-listed for PCBs (for fish tissue) (Norton, 2014). This proposed listing indicates that PCBs are already present in Kachess Reservoir. Existing data indicate that Kachess Reservoir has higher concentrations of PCBs than Keechelus Reservoir. The transfer from Keechelus Reservoir could thus lower (dilute) Kachess Reservoir PCB concentrations. Over time, however, the total load of PCBs in Kachess Reservoir could increase.

As a result of project operations, water quality impacts are not expected in Kachess Reservoir, the Kachess River, Lake Easton, or the Easton and Parker Reaches of the Yakima River. Keechelus Reservoir is located upgradient of the Yakima River diversion, and reservoir operations would remain similar to those of *Alternative 1 – No Action*, resulting in no water quality impacts.

During nondrought conditions, water quality impacts under *Alternative 4 – Combined KDRPP and KKC* would be similar to those described for *Alternative 3A – KKC North Tunnel Alignment* and *Alternative 3B – KKC South Tunnel Alignment*. During drought and drought recovery years, water quality impacts on Kachess Reservoir and Kachess River due to lower Kachess Reservoir pool levels would be similar to those described for *Alternative 2A – KDRPP East Shore Pumping Plant* and *Alternative 2B – KDRPP South Pumping Plant*. Water quality impacts on the Keechelus Reach of the Yakima River would be similar to those described for *Alternative 3A – KKC North Tunnel Alignment*. During drought recovery, Keechelus Reservoir pool elevations may be lower than existing conditions, potentially resulting in more surface heating during the summer months as the reservoir pool level recovers to nondrought conditions.

For all action alternatives, oil, grease, total petroleum hydrocarbons, suspended sediment, nutrients, and construction wastewater could enter receiving water during construction. With BMPs these contaminants would be minimized.

The BTE actions would be implemented as part of all the action alternatives and could cause increased sediment and turbidity in Gold and Cold Creeks during construction, with the potential for exceedance of the State surface water quality standard. BMPs would minimize potential for contaminants entering the streams. No long-term water quality impacts are expected from operation of the BTE actions following construction. Stream restoration may enhance water quality by improving the depth and flow conditions in the Gold Creek, which may help to lower peak water temperatures and improve DO conditions.

Table 4-28 summarizes impacts for the impact indicators.

Table 4-28. Summary of Impacts for Surface Water Quality

Impact Indicator	Summary of Impacts
Turbidity, temperature, DO, suspended sediment, nutrients, and total dissolved gas, and fecal coliform	For *Alternatives 2A, 2B*, and *4* lower reservoir pool levels during drought and post-drought recovery periods could cause turbidity, temperature, and DO in the Kachess Reservoir to be out of compliance with State surface water quality standards. No long-term significant impacts would be expected because suspended material would be localized in distribution and settle out as the reservoir bed stabilizes. After a drought and its recovery, the potential for water heating and depressed DO concentrations would diminish as the reservoir pool level rises and operations approach nondrought conditions. If a severe long-term drought occurs or conditions worsen because of climate change, water levels in the reservoir could drop significantly, affecting DO and water temperatures resulting in potentially significant impacts under these conditions. For *Alternatives 3A* and *3B* operations would not cause an increase in sedimentation, turbidity, temperature, nutrients, fecal coliform bacteria, or TDG, or a decrease in DO. However, if a severe long-term drought occurs or conditions worsen because of climate change, water levels in the reservoirs could drop, affecting long-term water quality conditions in Kachess Reservoir for DO and temperature. With the transfer of water, water quality in Kachess Reservoir could be modified by the Keechelus Reservoir inflow.

4.4.3 Alternative 1 – No Action Alternative

Under *Alternative 1 – No Action*, the reservoirs and their outflows would be managed similar to existing conditions, with peak flow releases in the summer to support downstream irrigation demands. Ambient water quality conditions in the reservoirs, their tributaries, and outflows would remain similar to existing conditions (see Section 3.4). However, if a severe long-term drought occurs, or conditions worsen because of climate change, water levels in the reservoirs could drop substantially, with significant effects on long-term water quality conditions for such parameters as DO and water temperature.

Keechelus and Kachess reservoirs would remain oligotrophic (nutrient-poor). Reservoir waters are cool and clear, with warmer water temperatures and lower DO concentrations in the surface layer during the summer months when the thermocline is present. Downstream in the Yakima River, implementation of the existing and proposed total maximum daily loads (TMDL)s would help improve water quality for temperature, sediment, turbidity, and organochlorine pesticides.

The Phase 2A expansion of I-90 would generate stormwater during construction and use. The resulting runoff, which may contain oil, grease, TPH, metals (e.g., cadmium, zinc, copper), nutrients, and sediment, would be collected and treated to applicable criteria before discharge to receiving water. All stormwater would ultimately be routed to Keechelus Reservoir and Yakima River or their tributaries (WSDOT, 2008). Because all stormwater would be treated, no overall impacts on quality of receiving water are expected (WSDOT, 2008).

4.4.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.4.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

During construction, oil, grease, TPH, suspended sediment, nutrients, and construction wastewater could enter receiving water. With BMPs such as effective isolation of the work area and proper collection, treatment, and management of wastewater and stormwater, water quality impacts from these contaminants would be minimized. During construction, water quality would be monitored in receiving water as required by project permits.

Oil, Grease, and Total Petroleum Hydrocarbons

As pollutants, oil, grease, and TPH are generated by the maintenance and fueling of construction equipment and vehicles. Heavy equipment and vehicles can leak oil and grease, and petroleum products can spill during refueling activity. Onsite storage of petroleum products, required for the use of heavy equipment, could introduce the risk of a leak from storage containers. Refueling and product storage operations would occur in specified areas outside the ordinary high water mark of the Kachess River and maximum pool elevation of the Kachess Reservoir. BMPs would be implemented to minimize potential water quality risks.

Sediment and Turbidity

Surface runoff that moves across disturbed soils could pick up sediment and create turbid conditions in receiving water. Unsurfaced roadways used by construction vehicles and heavy equipment can generate runoff with high levels of sediment. BMPs would be implemented to reduce the creation of sediment-laden runoff and prevent its discharge to receiving water.

Nutrients

Sediment entering surface waters has the potential to deliver nutrients from naturally occurring phosphorus and nitrogen found in soil and sediment. In fresh waters, phosphorus is the limiting nutrient that controls the eutrophication (nutrient enrichment) and trophic state of the water body. BMPs would be employed to minimize the discharge of nutrients from the construction area.

Construction Wastewater
Construction wastewater would likely be generated in isolated or enclosed work areas, such as the Kachess Reservoir pool, which would be protected by cofferdams. Runoff or water that comes into contact with cement while it is curing is also considered to be construction wastewater. The high turbidity, oil, grease, TPH, and suspended sediment often found in such water would be collected and conveyed to an appropriate location for treatment and disposal or discharge.

Alternative 2A – KDRPP East Shore Pumping Plant would include construction of the following main facilities near or in Kachess Reservoir or Kachess River:

- Reservoir inwater work elements – reservoir intake, tunnel, fish screens, pumping plant, and construction basin and boat launch
- Spoils disposal area
- Temporary access roads and parking
- Staging areas
- Concrete batch plant
- Pipeline
- Outlet works and Kachess River discharge

Reservoir Inwater Work Elements
Inwater work (i.e., below the reservoir pool elevation) would be required for construction of the reservoir intake, intake tunnel (625-foot length), fish screens, pumping plant, and construction basin and boat launch. While these facilities are being built, oil and grease, TPH, suspended sediment, nutrients, and construction wastewater could enter receiving water. To minimize water quality impacts, these inwater work areas would be isolated from the Kachess Reservoir pool.

BMPs and dewatering plans implemented during construction would isolate the work area from the reservoir pool, dewater the construction area, and prevent collected water in the construction area from entering the Kachess Reservoir pool. Collected water would be conveyed to an appropriate location for necessary treatment and disposal or discharge. Fresh concrete can have a high pH; where concrete is poured, it would be allowed to cure before coming into direct contact with water in the Kachess Reservoir.

During construction, barges would move equipment and materials to and from open-water work areas and be used during the construction of the intake. If any of this material contained oil, grease, petroleum products, or other contaminants, a spill could affect local water quality conditions in Kachess Reservoir. Containment measures during loading and unloading would prevent unintended releases. In addition, turbidity and sediment could enter the reservoir as part of the intake construction from disturbance and removal of the reservoir bed. Appropriate inwater BMPs would be implemented in accordance with permit requirements to minimize any potential turbidity impacts to the reservoir and downstream in the Kachess River.

A construction basin and boat launch on either the south shore or east shore could be necessary for inwater work elements. All work areas below the maximum pool elevation of Kachess Reservoir would be isolated from the reservoir to minimize potential water quality impacts.

Spoils Disposal Area
Approximately 117,000 cubic yards of excavated soil and rock would be generated during the construction phase of *Alternative 2A – KDRPP East Shore Pumping Plant*. If Reclamation opts to place the spoils in a historical spillway channel at the southeast corner of Kachess Reservoir, BMPs would be implemented to prevent stormwater and untreated effluent from entering any receiving water. The historical channel spillway would be isolated from the Kachess Reservoir pool by a cofferdam.

Temporary Staging, Access Roads, and Parking
Access road construction, access road use, staging area use, and areas of construction vehicle and heavy equipment use can generate runoff contaminated by oil, grease, and sediments. BMPs would be implemented to reduce potential water quality impacts from such runoff.

Concrete Batch Plant
At the concrete batch plant construction site, erosion and sedimentation control measures would be implemented during clearing and grading. In addition, BMPs would be implemented to isolate the work area from the reservoir pool and surrounding areas to capture, convey, and treat any runoff generated from the work area

Pipeline
A pipeline would be buried along the perimeter of the reservoir bed to convey pumped water to the Kachess River. Construction would occur when the reservoir pool is lower than the elevation of the proposed pipeline alignment. BMPs would be implemented to isolate the work area from the reservoir pool and surrounding areas to capture, convey, and treat any runoff generated from the work area.

Outlet Works and Kachess River Discharge
The Kachess River outlet works would require construction below the ordinary high water mark of the Kachess River. Inchannel work and bank clearing would likely generate sediment with the potential to enter the Kachess River. Runoff could mobilize disturbed sediment and carry it to the Kachess River, resulting in turbid water conditions. Sedimentation and turbidity effects would be minimized by using BMPs to isolate the work area from the river and capture, convey, and treat any runoff generated from the work area.

Bull Trout Enhancement

Construction activities associated with the BTE actions could cause oil, grease, TPH, suspended sediment, nutrients, and construction wastewater to run off into Gold or Cold Creeks or downstream in Keechelus Reservoir. Implementation of BMPs, such as effective isolation of the work area and proper collection, treatment, and management of wastewater and stormwater, would minimize impacts from these contaminants. Where necessary, Gold Creek and Cold Creek would be rerouted around the construction areas (by either pipe or ditch) to avoid the areas directly impacted by construction (e.g., cleared and graded areas). This would prevent construction-generated sediment and runoff from directly entering the streams and Keechelus Reservoir.

Replacement of the NF-4832 Bridge over Gold Creek would require inchannel work for foundation replacement as well as clearing of riparian areas for construction access, staging, and heavy equipment operation. BMPs would limit the potential for impacts to Gold Creek during bridge construction. Where construction requires inwater work, increased sediment and turbidity in the stream would occur, with the potential for exceedance of the State surface water quality standard. However, because construction is short-term and BMPs would be implemented to minimize turbidity, no long-term turbidity impacts would occur. During construction, water quality would be monitored in receiving water as required by project permits.

4.4.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Alternative 2A – KDRPP East Shore Pumping Plant operations would have the potential to directly impact Kachess Reservoir, Keechelus Reservoir, and Kachess River water quality. Under this alternative, the management of these resources would change from current conditions. For the other water resources located in the expanded study area, potential water quality impacts would result from these upstream operational changes. Changes in upstream water quality could affect downstream water quality. Changes in streamflow could indirectly affect downstream water quality, with increased streamflow generally improving downstream water quality.

Kachess Reservoir

Reservoir operations during nondrought years would be similar to those of *Alternative 1 – No Action*. Neither changes from existing water quality conditions nor additional exceedances of State surface water quality standards would be expected. In its surface layers, Kachess Reservoir currently exceeds State DO and temperature criteria during the warm summer months (Section 3.4).

Reservoir water quality is dependent on such factors as residence time, pool elevation, surface area, and pool volume. These properties influence the physical processes that control changes in water temperature and the DO capacity of the water—the two primary impact indicators most susceptible to changes in volume and pool elevation. The amount of reservoir heating is influenced by solar radiation, air temperatures, and wind conditions. During severe drought years, warmer corresponding air temperatures would result in more surface heating of the epilimnion (surface layer). During droughts, as water is pumped from the reservoir's bottom layer (hypolimnion), the volume of the cooler water found in the hypolimnion would decrease, potentially resulting in an earlier fall mixing of the reservoir (Lay, 2014).

During drought years and drought recovery years, Kachess Reservoir operations would result in pool elevations significantly lower than would be the case under *Alternative 1 – No Action*. Reservoir modeling predicts that the mean reservoir pool elevation would decrease by 15.6 feet from 2,236.8 to 2,221.2 (Section 4.3.4). Under *Alternative 2A – KDRPP East Shore Pumping Plant*, the mean residence time would fall from 686 days to 628 days, a decrease of 58 days (Section 4.6.4). Effects on water quality are discussed below, based on the water quality impact indicators (Table 4-27). If water levels drop significantly in the reservoir because of climate change, long-term water quality conditions for DO and water temperatures would be affected throughout the reservoir.

Turbidity. As the reservoir pool levels lower, the area of exposed reservoir bed increases, particularly during drought conditions. This increased exposure of unvegetated areas could be a source of sediment input to the lowered reservoir pool. The reservoir bed would continue to be exposed as the reservoir refills. If the bed is exposed during storm events, particles on the bed may be carried by surface runoff events as suspended sediment, enter the reservoir, and cause turbid conditions. During periods of drawdown, more down-cutting and erosion would occur as tributary streams create longer and deeper channels to flow into the reservoir pool (Section 4.2.4.2). Short-term exceedances of State surface water quality criteria for turbidity may occur during and immediately following runoff events (no more than a few days) but end when the reservoir bed stabilizes. No long-term significant impacts would be expected because suspended material would be localized in distribution and settle out as the reservoir bed stabilizes.

Suspended Sediment. Sources of suspended sediment are the same as those described above for conditions contributing to elevated turbidity. No State standard exists for suspended sediment, but it affects water clarity which is regulated by the State turbidity criteria. Similar to turbidity, high suspended sediment concentrations would occur during and immediately following runoff events and would end as the reservoir bed stabilizes. No long-term significant impacts would be expected because suspended material would be localized in distribution and settle out as the reservoir bed stabilizes.

Water Temperature. As the reservoir pool elevations lower during drought conditions coupled with warmer weather, a smaller volume and larger proportion of surface area (relative to volume) would be exposed to heating by solar radiation, causing the reservoir to warm more quickly than it would at higher pool elevations. Based on predicted operations for *Alternative 2A – KDRPP East Shore Pumping Plant*, the mean hydraulic residence time during drought years (235 to 616 days) would be less than that during nondrought years (628 days) (see Section 4.3). This decreased residence time during droughts would help to limit solar heating. However, this limit would be offset during extended droughts or drought recovery, by the sustained low reservoir pond volume and longer reservoir residence times creating conditions where heating may occur. Increases in water temperature could exceed the criteria of 16°C (60.8°F) for Kachess Reservoir and <12°C (53.6°F) for the Little Kachess basin of Kachess Reservoir during the warm months of June through September for extended periods of time, resulting in a potentially significant impact. After a drought and drought recovery, the potential for excess heating would diminish as the reservoir pool level rises and operations approach nondrought conditions.

Dissolved Oxygen. As water temperature increases, the DO capacity of water decreases. During droughts and drought recovery years, smaller water volumes in the reservoir and warmer weather would heat the reservoir more quickly during peak summer months, resulting in lower summer DO concentrations. However, during drought years, the residence time of the reservoir is predicted to decrease. Decreased residence time would help to limit potential heating that decreases DO concentrations. Longer residence times during periods of drought recovery could cause higher temperatures and lower DO concentrations to below the State criterion (DO standard set to greater than 9.5 mg/L). However, if a severe long-term drought and drought recovery occurs, water levels in the reservoir could drop significantly, lowering DO concentrations in the warm summer months for extended periods of time, resulting in a potentially significant impact including the hypolimnion. When reservoir levels have recovered, the potential for depressed DO concentrations would diminish.

Nutrients. Nutrients (phosphorus and nitrogen) can enter the reservoir via tributary surface waters and sediment particles carried in surface runoff. As noted above for turbidity, sediment can enter when the reservoir bed area is exposed during drawdown. However, the temporary increase in sediment input during runoff events would not have a significant water quality impact. Even combined, the nutrient fractions of the runoff and the existing pool are believed to be very small, and would not alter the reservoir's trophic state. The reservoir would remain oligotrophic.

The expectation that the lake would remain nutrient-poor is corroborated by phosphorus dynamics in lake sediments. These dynamics depend on various factors including DO, redox conditions, and sediment depth. In most lakes, the net phosphorus movement is from water into sediment, especially under aerobic conditions (Wetzel, 1983); under anaerobic conditions, phosphorus can be released back into the water column. When measured mid-lake in August 1998, DO was 9.4 mg/L at a depth of 122 meters (400 feet) (Reclamation, 1999). DO at this concentration indicates that aerobic conditions are present at depth during peak summer months and that any phosphorus contributed by runoff is likely sequestered in sediment and thus unavailable to raise water column nutrient levels.

Fecal Coliform Bacteria. Operation of *Alternative 2A – KDRPP East Shore Pumping Plant* would not affect existing fecal coliform counts. Changes in reservoir water volumes or residence time would not raise fecal coliform counts above those that would be present under *Alternative 1 – No Action*. KDRPP would not introduce new sources of fecal coliforms to the reservoir. No exceedance of the State surface water quality criteria would occur as a result of *Alternative 2A.*

pH. Reservoir pH is controlled by a combination of biological, chemical, and physical interactions. The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of nutrients and heavy metals. Like DO concentrations, pH may change with depth in a lake, due to changes in photosynthesis and other chemical reactions. The vertical distribution of pH is inversely related to the vertical distribution of total inorganic carbon (Wetzel, 1983). Because KDRPP would not alter overall chemical or biological properties of the reservoir, effects on pH resulting in exceedances of the State water quality criteria are not expected.

Kachess River

Reservoir operations during nondrought years would remain similar to those under *Alternative 1 – No Action*. No changes in existing water quality or exceedances of State surface water quality standards would occur in the Kachess River as a result of operating *Alternative 2A – KDRPP East Shore Pumping Plant*.

During drought years, summer streamflow in the Kachess River is predicted to increase significantly (Section 4.3.4). Changes in river flow due to project operations may alter physical conditions that affect water quality. Increases in flow translate to an increase in hydraulic width or depth, which in turn can alter the amount of heating or cooling of the water. Increases in flow may increase the amount of turbulence, and thus influence the DO content and TDG. Other parameters (e.g., fecal coliform, nutrients) are not affected by changes in depth and width of the channel, and changes in flow would not affect associated water quality. Sediment could be generated during periods of channel expansion (widening or down-cutting) from the erosive action of the water; however, this is not expected in the Kachess River because predicted flows fall within the existing flow regime.

Turbidity. Although summer streamflow during drought years would be higher than under *Alternative 1 – No Action*, it would remain within the river's existing range. Resulting adjustments to the bed and banks, if any, would be minimal. No significant increase would occur in channel erosion, bank erosion, sediment load, or turbidity.

Short-lived turbidity increases in the Kachess Reservoir could deliver sediment-laden water to the Kachess River. Brief exceedances (lasting no more than a few days) of State surface water quality standards for turbidity may occur until the reservoir stabilizes. No exceedance of the State surface water quality standards for turbidity would occur in the long term under operations of *Alternative 2A – KDRPP East Shore Pumping Plant.*

Suspended Sediment. Although summer streamflow during drought years would be higher than under *Alternative 1 –* No Action, it would remain within the river's existing range. Resulting adjustments to the bed and banks, if any, would be minimal. No significant increase would occur in channel erosion, bank erosion, or sediment load. Short-lived suspended sediment increases in the Kachess Reservoir could deliver sediment-laden water to the Kachess River. Elevated levels (lasting no more than a few days) could occur until the reservoir stabilizes.

Water Temperature. During droughts, the KDRRP would pump water from a lower level in the reservoir. This level would be below the thermocline of reservoir that seasonally separates warmer surface water from cooler water at depth. The relatively cool water discharged into the Kachess River would likely cause cooler downstream water temperatures during these operational periods.

During extended droughts, however, residence time in the reservoir may decrease, the thermocline may sink lower in the water column, and the water temperature at the reservoir intake may be relatively warmer; these combined factors could result in warmer river temperatures relative to *Alternative 2B* in nondrought years. With a post-drought refill of Kachess Reservoir lasting for up to 5 years, additional heating of the reservoir may cause further increases in water temperature in the Kachess River. Exceedances of the State surface water quality criterion of 16°C could occur during the summer months of June through September for extended periods of time, resulting in a potentially significant impact if conditions are persistent. After a drought and drought recovery, the potential for peak water temperatures would diminish as the Kachess Reservoir pool level rises and operations approach nondrought conditions.

Dissolved Oxygen. As the reservoir's intake source would be low in the water column during periods of drought, DO concentrations could be higher in the Kachess River inflow relative to *Alternative 1 – No Action*. During summer stratification, the cooler water below the thermocline of an oligotrophic lake likely has a higher DO concentration than the overlying shallower water. An extended drought or drought recovery period, could depress DO concentrations at the intake point. However, turbulence at the spillway at the entry to the Kachess River would reoxygenate the inflow. Therefore, operation of *Alternative 2A - KDRPP East Shore Pumping Plant* would not generate exceedances of the State DO standard in the Kachess River.

Nutrients. Because overall nutrient levels do not vary significantly with depth in an oligotrophic lake (Wetzel, 1983), the depth from which reservoir water would be pumped during drought and post-drought recovery years would not introduce new long-term sources of nutrients to the river. Therefore, changes in nutrient concentrations relative to *Alternative 1 - No Action* would not occur.

Total Dissolved Gas. High TDG concentrations are associated with dam spillways. High TGD, and its associated gas bubble disease, can have detrimental and sometimes lethal effects on incubating embryos and larvae, resident fish species, and other aquatic organisms, including salmonids (McGrath et al., 2006). The proposed flow rates from the reservoir would remain within the range of existing conditions (Section 4.3.4). For *Alternative 2A – KDRPP East Shore Pumping Plant,* TDG concentrations at the Kachess River discharge would be similar to those under *Alternative 1 – No Action*, and no impacts would occur.

Fecal Coliform Bacteria. The change in reservoir pool operations as a result of *Alternative 2A – KDRPP East Shore Pumping Plant* would not affect existing fecal coliform counts, and exceedances of the State surface water quality standard would not occur. Changes in flows would not change the low levels of fecal coliform that currently exist in the river. KDRPP would not introduce sources of fecal coliform bacteria to the river.

Lake Easton

The Kachess River is a major tributary inflow into Lake Easton. During drought years, more inflow to Lake Easton from the Kachess River would occur. This inflow is expected to be cool and well-oxygenated, meeting State surface water quality standards.

However, during extended drought and drought recovery years, the Kachess River may experience some warming (from inflow of warmer Kachess Reservoir water). The river's water temperatures would likely be cooler than those of Lake Easton during an extended drought because Lake Easton would also be heated by solar radiation during this warm period. When it enters Lake Easton, the river's inflow of cooler water would mix with Lake Easton water, possibly resulting in lower reservoir water temperatures. The amount of mixing may depend on actual water temperature and water density differential between the lake's warmer water and river's cooler water. Cooler water is denser, and therefore inflow would likely sink to hypolimnion until enough mixing has occurred and equilibrium is reached. However, temperature and DO concentrations in Lake Easton are controlled primarily by the physical characteristics of the lake itself (such as depth, surface area, volume) and residence time, and not by Kachess River inflow. Therefore, temperature effects due to the potentially cooler water of the Kachess River inflow during drought and post-drought recovery years are not expected.

Keechelus Reservoir

Water quality impacts on the Keechelus Reservoir from operation of *Alternative 2A - KDRPP East Shore Pumping Plant* would not occur with the exception of a potential increase in surface heating during drought recovery years when reservoir pool elevations are predicted to be lower than those under *Alternative 1 – No Action*. Reservoir management operations would continue similar to conditions under *Alternative 1 – No Action*, with minimal changes to surface water elevations and residence times. KDRPP would not alter the quantity or quality of reservoir inflows, resulting in no changes to water quality. As part of mitigation (Section 4.4.9.2), a water quality monitoring program would be implemented to document changes in water quality.

Yakima River

Keechelus Reach. Water quality within the Keechelus Reach would be similar to conditions under *Alternative 1 – No Action*. Water quality impacts on the Yakima River would not occur from operation of *Alternative 2A – KDRPP East Shore Pumping Plant*. Flow regimes within the river would be similar to those under *Alternative 1 – No Action* because upstream Keechelus Reservoir operations would not change. During drought years, flows within the river are predicted to decrease, but would remain within the current range of variability. Therefore, no impacts on water quality would occur as result of *Alternative 2A – KDRPP East Shore Pumping Plant.*

Easton Reach. During drought years, streamflow through the Easton Reach would increase because of higher streamflow in the Kachess River. Based on the modeling results using data from two recent drought years, 1994 and 2001, the mean July-to-August increase in flow would be 23.7 percent and 7.9 percent, respectively (Section 4.3.4). The existing range of flow would not be changed by this flow increase. No water quality impacts are expected in the Easton Reach as a result of *Alternative 2A – KDRPP East Shore Pumping Plant* operations.

Parker Reach. A slight decrease in flows (0.5 percent) is predicted for flows in the Parker reach of the Yakima River relative to *Alternative 1 – No Action* (Section 4.3.4). Water quality impacts on Parker Reach would not occur as result of *Alternative 2A – KDRPP East Shore Pumping Plant*. Mean flow regimes within this reach of river would be similar to those of *Alternative 1 – No Action*.

Access Roads and Parking

Permanent access roads and parking areas would be provided for maintenance of KDRPP elements. These features could generate runoff containing oil, grease, TPH, metals (e.g., cadmium, zinc, copper), nutrients, and sediment. However, vehicle use and parking during project operations would be minimal, resulting in light pollutant loadings, if any, from these surfaces. The project would incorporate BMPs for stormwater treatment in accordance with applicable regulations prior to discharge to receiving water. These measures would reduce pollutant concentrations and minimize water quality impacts. No significant water quality impacts are expected from the vehicle use and parking.

Bull Trout Enhancement
No long-term water quality impacts are expected from operation of the BTE actions following construction. Stream restoration may enhance water quality by improving the depth and flow conditions in the Gold Creek, which may help to lower peak water temperatures and improve DO conditions.

4.4.5 Alternative 2B – KDRPP South Pumping Plant

4.4.5.1 Construction

KDRPP South Pumping Plant Facilities
Construction impacts under *Alternative 2B – KDRPP South Pumping Plant* would be similar to those described for *Alternative 2A – KDRPP East Shore Pumping Plant*, with the exception that the buried pipeline would not be constructed on the reservoir bed along the southern perimeter. Instead, a tunnel (constructed as a directional bore) would extend from the intake located in the reservoir approximately 3,250 feet to the south pumping plant.

The construction footprint would be smaller than that of *Alternative 2A – KDRPP East Shore Pumping Plant* because it would not include the pipeline along the reservoir bed, resulting in less disturbance along the shoreline. Construction impacts associated with the following elements would be similar to those described for *Alternative 2A – KDRPP East Shore Pumping Plant*:

- Reservoir inwater work elements
- Spoils disposal area
- Temporary staging area, access roads, and parking
- Concrete batch plant
- Outlet works and Kachess River discharge

The *Alternative 2B – KDRPP South Pumping Plant* pipeline would be constructed as a directional bore under the reservoir from the intake to the pumping plant site on the south shore. Avoiding the use of open-cut construction would eliminate the need to clear a corridor along a 7,775-foot length of reservoir, as is required for *Alternative 2A – KDRPP East Shore Pumping Plant*. *Alternative 2B – KDRPP South Pumping Plant* would have a smaller construction area footprint with less ground disturbance adjacent to the reservoir, reducing the potential to generate runoff and sediment. The types of potential construction impacts would be similar to, but occur to a lesser extent than, those described for *Alternative 2A – KDRPP East Shore Pumping Plant*. BMPs similar to those described for *Alternative 2A – KDRPP East Shore Pumping Plant* would be implemented. *Alternative 2B – KDRPP South Pumping Plant* would employ jet grouting during intake construction. Appropriate construction BMPs would be developed to mitigate for any potential water quality impacts related to the use of jet grouting during construction.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.4.4.1).

4.4.5.2 Operation

KDRPP South Pumping Plant Facilities
Water quality impacts due to operation of the alternative would be similar to those described for *Alternative 2A – KDRPP East Shore Pumping Plant* because Reclamation would operate KDRPP the same regardless of the location of the pumping plant. The shorter overall length of access road required (690 feet versus 2,425 feet for *Alternative 2A*) would generate a lesser degree of impact associated with the potential for suspended solids and accompanying turbidity from impervious surfaces.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.4.4.2).

4.4.6 Alternative 3A – KKC North Tunnel Alignment

4.4.6.1 Construction

KKC North Tunnel Alignment Facilities
A detailed description of potential construction contaminants (i.e., oil, grease, TPH, suspended sediment, nutrients, and construction wastewater) that could enter receiving water is provided above for *Alternative 2A – KDRPP East Shore Pumping Plant*. BMPs to be employed would limit the potential construction water quality impacts on the Kachess Reservoir and Kachess River. Water quality monitoring would be conducted during the construction to ensure that receiving water meets applicable permit provisions and applicable State surface water quality standards. *Alternative 3A – KKC North Tunnel Alignment* would include construction of the following main facilities near or in Keechelus Reservoir, Kachess Reservoir, and the Yakima River:

- Yakima River diversion, intake, and fish screens
- Kachess Reservoir discharge structure
- Access roads
- Kachess Road realignment
- KKC tunnel alignment

Yakima River Diversion, Intake, and Fish Screens
The Yakima River diversion and intake structure would require work below the ordinary high water mark of the river. If the work area is not isolated from the river, inchannel disturbance and bank clearing could generate sediment that could enter the Yakima River. In addition, runoff generated from cleared areas can readily mobilize disturbed sediment and

carry this material to the river, resulting in turbid water conditions. Reclamation would implement BMPs that isolate the work area from the river; therefore, significant water quality impacts on the river are not expected.

Kachess Reservoir Discharge Structure
Inwater work (below the reservoir pool elevation) may be necessary for construction of the reservoir spillway channel, construction of the stilling basin, and placement of riprap. Without effective isolation of the work area and proper collection and management of runoff or water generated from the work area, water quality could be affected. Construction work would occur during a period of low reservoir pool elevations. A sheetpile cofferdam would isolate the work area from the reservoir pool. If necessary, dewatering of the work area would occur. Water captured in this work area would be collected and conveyed to an appropriate location for any necessary treatment, disposal, or discharge. With implementation of work area isolation measures and proper containment, treatment, and discharge of construction runoff, water quality impacts on the reservoir would be minimized.

Access Roads
Temporary access roadways would be built and utilized for the duration of construction. Some of these roads could eventually serve as long-term access roads to the facilities for inspection and maintenance. In addition, staging areas and storage and stockpile areas would be used by construction vehicles and equipment. BMPs would be implemented to minimize potential contamination of stormwater runoff from pollutants on access roadways, equipment staging, and storage areas. With implementation of work area isolation BMP measures, impacts would be minimized.

Lake Kachess Road Realignment
Temporary realignment of Lake Kachess Road would require clearing and construction of a new temporary roadway segment. Potential construction water quality impacts would be similar to those described above for access roads.

KKC Tunnel Alignment
The KCC tunnel would be underground and would not require any inwater work. No surface disturbance would occur along the alignment during construction. Therefore, no surface water impacts would occur as a result of KKC alignment construction.

Surface disturbance would be limited to construction of the tunnel portals. With implementation of work area isolation BMP measures, impacts would be minimized.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.4.4.1).

4.4.6.2 Operation

KKC North Tunnel Alignment Facilities

Alternative 3A – KKC North Tunnel Alignment operations could impact water quality in Kachess and Keechelus reservoirs and the Kachess and Yakima rivers. Under this alternative, management of these resources would change relative to *Alternative 1 – No Action*. For the downstream water resources located in the study area, potential indirect water quality impacts would result from these upstream operational changes.

Kachess Reservoir

Piping water from Keechelus Reservoir to Kachess Reservoir could change water quality in Kachess Reservoir (See Section 4.3.6). Reservoir modeling indicates that, relative to *Alternative 1 – No Action,* the annual daily mean Kachess Reservoir pool elevation would increase by 1.4 feet. Reservoir modeling results based on drought years 1994 and 2001 predict an increase in the maximum reservoir pool elevations by 2.3 and 3.8 feet during drought years (Section 4.3.6, Table 4-12). If a severe long-term drought occurs, or conditions worsen because of climate change, long-term conditions for DO and water temperature would be affected.

Transfer of water from Keechelus Reservoir to Kachess Reservoir could change water quality in Kachess Reservoir. Keechelus Reservoir is currently 303(d) Category 5-listed for PCBs in fish tissue. With the transfer of water to Kachess Reservoir, the potential exists for PCB contamination to transfer to the Kachess Reservoir and accumulate in fish tissue. Ecology's upcoming 303(d) list for fresh waters identifies Kachess Reservoir as 303(d)-listed for PCBs for fish tissue, indicating that PCBs are already present in Kachess Reservoir (Norton, 2014). Data in support of the proposed upcoming 303(d) list show that tissues of fish from Kachess Reservoir contain higher concentrations of PCBs (17 to 26 μg/kg [parts per billion]) than do tissues of fish from Keechelus Reservoir (5 to 20 μg/kg [parts per billion]) (Norton, 2014). These data indicate that Kachess Reservoir has higher concentrations of PCBs than Keechelus Reservoir. The transfer from Keechelus Reservoir waters may actually have a diluting effect in Kachess Reservoir. Over time, however, the total load of PCBs in Kachess Reservoir could increase.

Turbidity. Under *Alternative 3A – KKC North Tunnel Alignment*, impacts from water turbidity are not expected. During drought and drought recovery, the reservoir drawdown would remain within the current range and no new reservoir bed would be exposed. No change in reservoir turbidity levels are expected because reservoir management operations would remain similar to those of *Alternative 1 – No Action*.

Suspended Sediment. Under *Alternative 3A – KKC North Tunnel Alignment*, impacts from sediment delivery are not expected. During drought and drought recovery, the reservoir drawdown would remain within the current range and no new reservoir bed would be exposed. No change in reservoir suspended sediment levels are expected because reservoir management operations would remain similar to those of *Alternative 1 – No Action*.

At entry to the Kachess Reservoir, the piped inflow would be routed through an energy dissipation spillway channel, into a stilling basin, and then over riprap directly into the Kachess Reservoir. These measures would prevent erosion of the Kachess Reservoir bed and shoreline at the discharge location.

Water Temperature. Water conveyed from Keechelus Reservoir would provide cool water to Kachess Reservoir. While transiting through the tunnel during summer, the water would remain protected from the relatively warmer air. Upon entry into the reservoir, this inflow would likely be cooler than the Kachess Reservoir summer ambient surface water temperatures. This cooler water would mix with reservoir water, providing a cooling effect in the area of the outfall. This cooling effect would likely not extend throughout the entire reservoir.

During the summer months, solar radiation would heat the reservoir surface. The heating would be a function of reservoir residence time, volume, and surface area. Under *Alternative 3A – KKC North Tunnel Alignment,* Kachess Reservoir would remain relatively full (from the Keechelus inflow) and the hydraulic residence time would decrease. During nondrought years, these conditions would help limit heating of the reservoir pool. During droughts and drought recovery periods, water temperatures could increase during periods of lower reservoir pool elevations, as is the case for current conditions and under *Alternative 1 – No Action*. The inflow of cool Keechelus water during the summer may help to limit this heating. The amount of mixing (in either the surface layer or bottom) is undetermined and would depend on such factors as the temperature and density differentials between the piped inflow and the receiving reservoir waters, and the reservoir pool elevation. If the water temperature and water density differentials are great, the cooler inflow may quickly sink to the hypolimnion to reach equilibrium with the denser cooler water found there. This circumstance would result in limited to no mixing in the reservoir. No increase would be expected under *Alternative 3A – KKC North Tunnel Alignment* in the amount of heating or number of exceedances of State water criteria for temperature (<16°C [60.8°F] for Kachess Reservoir and <12°C [53.6°F] for Little Kachess basin). However, during drought recovery, as Kachess Reservoir fills, the reservoir would begin to back up into the Little Kachess basin. The piped inflow may potentially push warmer surface water into Little Kachess basin, causing exceedance of that basin's State surface water criterion (<12°C [(53.6°F]).

Dissolved Oxygen. Inflows from the Keechelus Reservoir would likely be well-oxygenated by the discharge outlet at the Kachess Reservoir due to the riprap conveyance at the Kachess Reservoir discharge structure. *Alternative 3A – KKC North Tunnel Alignment* is not expected to increase water temperatures in Kachess Reservoir, so no related increase in DO would occur. No impacts on DO concentrations would occur during operations of *Alternative 3A – KKC North Tunnel Alignment*.

Nutrients. Nutrients (phosphorus and nitrogen) can enter the reservoir via Keechelus Reservoir inflow, tributary surface waters, and sediment particles in runoff. The upstream watershed is generally undeveloped and tributary water quality is expected to be generally good (i.e., low in phosphorus). In data collected between 1999 and 2012, total phosphorus concentrations ranged from undetected (at a detection limit of 0.01 mg/L) to 0.023 mg/L (at a depth of 21.5 meters [70.5 feet]) (Section 3.4.4). Given these generally low phosphorus concentrations and the absence of project-generated nutrient additions, nutrient concentrations would remain within existing range of concentrations and the reservoir would remain oligotrophic.

Fecal Coliform Bacteria. Fecal coliform counts in samples collected in 1996 and 2011 from the Kachess Reservoir are low (1 to 2 colonies/100 mL) (EPA, 2014a). Since the Keechelus Reservoir is the source of the KKC inflow under *Alternative 3A – KKC North Tunnel Alignment*, impacts on fecal coliform levels in Kachess Reservoir are not expected.

Kachess River

Relative to *Alternative 1 – No Action,* no changes in river water quality from existing conditions would occur as a result of *Alternative 3A – KKC North Tunnel Alignment* operations; flow would remain within the range of existing conditions (Section 4.3.6) and channel capacity. The river would remain cool and well-oxygenated, similar to conditions under *Alternative 1 – No Action*. No changes are expected in river nutrient concentrations or fecal coliform counts.

Keechelus Reservoir

Keechelus Reservoir management operations would resemble those under *Alternative 1 – No Action*. KKC would not alter water quantity or quality of the reservoir's inflow tributaries. Hydraulic modeling predicts no change in the annual mean reservoir pool elevations and the mean annual hydraulic residence time is predicted to decrease slightly (by 1 day) to 127 days (Section 4.3.6). These changes would not result in long-term water quality impacts on Keechelus Reservoir.

Water Temperature. During drought conditions, mean average and minimum pool elevations are expected to increase (Section 4.3.6). This increase in water volume during drought years would limit heating at depth. The reservoir would continue to stratify during the warm summer months, with a thermocline and underlying cool water. Surface heating would continue to be controlled by solar radiation. For these reasons, significant impacts on water temperature are not expected from operation of *Alternative 3A – KKC North Tunnel Alignment*.

Sediment and Turbidity. Sources of sediment would not increase with *Alternative 3A – KKC North Tunnel Alignment*. The mean annual reservoir pool elevations would remain similar to those under *Alternative 1 – No Action*, and large reservoir drawdowns would not occur (Section 4.3.6). The absence of additional drawdown would limit the sediment input from exposed reservoir bed and open ground. Based on the modeling results for drought years, the maximum reservoir elevations are predicted to drop 4.3 to 4.6 feet, increasing the area of reservoir bed exposed. This increase would occur during summer and during drought conditions, when potential for surface runoff from a rain event would be at a minimum. Turbidity increases due to a runoff event during drought conditions, if any, would be short-lived. Operation of A*lternative 3A – KKC North Tunnel Alignment* would not cause significant turbidity impacts on Keechelus.

Yakima River
Keechelus Reach. Under *Alternative 3A – KKC North Tunnel Alignment*, the hydraulic model predicts the river's mean annual flow would decrease from existing conditions (Section 4.3.6). Below the diversion, flows within Keechelus Reach would be lower during the summer months (July and August). Lower flows within the river would create shallower water depths that may heat more easily by solar radiation during peak summer months. However, the water would be moving through the channel, with few locations to pool and warm. Limited heating is expected through this reach during peak summer months of reduced streamflow. Additional exceedance of State temperature standards is not expected.

Easton Reach. Water quality impacts on the Easton Reach from operation of *Alternative 3A – KKC North Tunnel Alignment* would not occur. Water quality within this reach would remain similar to that of *Alternative 1 – No Action*. Predicted minor changes in river flow are not expected to alter existing water quality conditions.

Parker Reach. Water quality impacts on the Parker Reach from operation of *Alternative 3A – KKC North Tunnel Alignment* would not occur. Flow regimes within the Parker Reach would be similar to those of *Alternative 1 – No Action*. A nominal decrease (0.1 percent) is predicted for flow in the maim reach of the Yakima River (Section 4.3.6). Therefore, no water quality impacts are expected downstream in this reach.

Lake Easton
Water quality impacts on Lake Easton from operation of *Alternative 3A – KKC North Tunnel Alignment* would not occur because lake inflow water quality (Yakima River and Kachess River) would remain similar that of *Alternative 1 – No Action*.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.4.4.2).

4.4.7 Alternative 3B – KKC South Tunnel Alignment

4.4.7.1 Construction

KKC South Tunnel Alignment Facilities

Potential construction water quality impacts would be similar to those described for *Alternative 3A – KKC North Tunnel Alignment,* with the exception of the Kachess Road realignment and the location of Kachess Reservoir discharge structure. The Kachess Reservoir discharge would be a box weir structure built into the shoreline. Access to the construction site would be along a new access road. Containment measures would be implemented to prevent unintended release of oil, grease, petroleum products, and other contaminants. Construction on the shoreline could cause increased erosion, but the application of appropriate BMPs would reduce the potential impact.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.4.4.1).

4.4.7.2 Operation

KKC South Tunnel Alignment Facilities

Water quality impacts from operating KKC would be the same as those described for *Alternative 3A – KKC North Tunnel Alignment.* Reclamation would operate KKC the same regardless of the tunnel alignment.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.4.4.2).

4.4.8 Alternative 4 – Combined KDRPP and KKC

4.4.8.1 Construction

KDRPP and KKC Facilities

Construction impacts on water quality under *Alternative 4 – Combined KDRPP and KKC* would be the same as those described above for the *Alternative 2A – KDRPP East Shore Pumping Plant* and *Alternative 3A – KKC North Tunnel Alignment*. Construction would include all the elements described for each of these alternatives in Sections 4.4.4.1 and 4.4.6.1. Work in and adjacent to the Kachess Reservoir includes the combined elements for both alternatives, increasing the amount of work both inwater and along the shoreline. The project would employ BMPs for all work elements in and near the water, minimizing the potential for water quality impacts to the reservoir.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.4.4.1).

4.4.8.2 Operation

KDRPP and KKC Facilities

During nondrought years, Reclamation would operate KKC without KDRPP. Therefore, water quality would be similar to conditions described for *Alternative 3A – KKC North Tunnel Alignment* where water quality impacts are not expected in Kachess Reservoir, Kachess River, Keechelus Reservoir, Lake Easton, or the Easton or Parker Reaches of the Yakima River. The following text describes impacts during drought years.

Kachess Reservoir

During periods of drought and drought recovery , water quality impacts on the Kachess Reservoir would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* because reservoir pool elevations are predicted to be similar to those under Alternative 2A (i.e., lower than those of *Alternative 1 – No Action*) (Section 4.3.8).

Kachess River

During periods of drought and drought recovery, water quality impacts on the Kachess River would be same as those described for *Alternative 3A – KKC North Tunnel Alignment* because river flows would be similar (Section 4.3.8).

Yakima River

Keechelus Reach. Water quality impacts on the Keechelus Reach would be the same as those described for *Alternative 3A – KKC North Tunnel Alignment* because predicted flows would be similar (Section 4.3.8). However, during extended drought and during an extended refill period, conditions within the river would be similar to *Alternative 2A – KDRPP East Shore Pumping Plant* (lower intake elevation) where the river may experience elevated water temperatures.

Easton Reach. With *Alternative 4 – Combined KDRPP and KKC* operations, water quality within the Easton Reach would be similar to that under *Alternative 1 – No Action*. Predicted flow increases would remain below existing maxima (Section 4.3.8) and are not expected to alter existing water quality conditions.

Parker Reach. With *Alternative 4 – Combined KDRPP and KKC* operations, water quality and flow regimes within the Parker Reach would remain similar to those under *Alternative 1 – No Action* (Section 4.3.8) and are not expected to alter existing water quality conditions.

Lake Easton

During periods of drought and drought recovery, water quality impacts on Lake Easton would be similar to those described separately for *Alternative 3A – KKC North Tunnel Alignment* because inflows and reservoir levels would be similar (Section 4.3.8). However, during an extended drought and during an extended refill period, conditions within Lake Easton would be similar to *Alternative 2A – KDRPP East Shore Pumping Plant* (lower intake elevation) where the lake may experience elevated water temperatures and depressed DO oxygen concentrations during these periods.

Keechelus Reservoir
Water quality impacts on Keechelus Reservoir would be similar to those described for *Alternative 3A – KKC North Tunnel Alignment* because reservoir levels and conditions would be similar. However, during drought recovery (Figure 4-7, Surface Water Resources), reservoir pool elevations may be lower than existing conditions, potentially resulting in more heating during the summer months. As part of mitigation (Section 4.4.9.2), a water quality monitoring program would be implemented to document potential heating as a result of reservoir water level management changes.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.4.4.2).

4.4.9 Mitigation Measures

4.4.9.1 Construction

Construction activities associated with the Proposed Action have the potential to impact water quality. During construction, Reclamation would implement BMPs and other techniques to minimize potential erosion and sedimentation in the reservoir, such as working during low reservoir conditions, and applying erosion control measures (e.g., silt fencing) around perimeters of the work areas, access roads, and borrow areas. When working within Kachess Reservoir, Reclamation would take measures to isolate the work area from the reservoir pool. Additional measures outlined in the project permits to protect water quality would be implemented, as well, including but not limited to construction water quality monitoring in area receiving water.

Reclamation would employ the following measures during construction to prevent receiving water impacts:

- Stormwater Pollution Prevention Plan – Mitigation for potential stormwater effects would be provided by implementing a Storm Water Pollution Prevention Plan and Temporary Erosion and Sediment Control Plan during construction. These plans would outline erosion and sediment control BMPs for site-specific work activities, such as the following:
    - Temporary covering of exposed soils with straw mulch (or similar)
    - Silt fencing
    - Temporary sedimentation ponds or traps
    - Street sweeping

  - o Temporary covering of stockpiled materials

- Spill Response Plan – A spill response plan would be developed for construction. This plan would outline measures and procedures to respond to spills of hazardous materials such as fuel, and to prevent these substances from entering any receiving water.
- Construction Water Management – Extensive dewatering may be necessary with some work elements, such as the new intake construction in the Kachess Reservoir. The work area would be isolated from the reservoir pool. If surface water and groundwater are encountered during any excavation, the water would be pumped out of the work area and treated to meet applicable standards prior to discharge.

4.4.9.2 Operation

To address any anticipated water quality impacts, Reclamation would coordinate with Ecology to develop a surface water quality monitoring program for changes in water quality due to the project. As warranted, Reclamation and Ecology would develop appropriate mitigation to address water quality impacts.

4.5 Groundwater Quantity and Quality

4.5.1 Methods and Impact Indicators

Methods. Reclamation and Ecology evaluated impacts on groundwater by analyzing potential changes to groundwater aquifers in the primary study area associated with construction and operation of the alternatives. Downstream impacts on groundwater in the extended study area were also considered.

Impact Indicators. Two potential impact indicators are associated with the alternatives: changes in groundwater contribution to streams, springs, wetlands, or nearby wells, and introduction of contaminants from spills during construction or operation (Table 4-29). Impacts would be expected if lower groundwater levels resulted in a decrease in water supply to wetlands, rivers, springs, or wells; or if there was a decline in groundwater quality. Impacts were evaluated using available hydrogeologic data and investigations developed for the project feasibility design reports (see Section 3.5 for additional information).

Table 4-29. Impact Indicators and Significance Criteria for Groundwater

Impact Indicator	Significance Criteria
Changes in groundwater contribution to streams, springs, wetlands, or nearby wells	Lowering of groundwater levels, potentially decreasing the water supply to wetlands, springs, rivers, or nearby wells
Introduction of contaminants from spills	A decrease in groundwater quality as measured against groundwater quality standards

4.5.2 Summary of Impacts

Alternative 1 – No Action would not result in impacts on groundwater because no construction or changes to reservoir operations would occur. In addition, there are no known adverse impacts on groundwater resources caused by current reservoir operations. Existing groundwater conditions as described in Section 3.5 would remain the same. Less surface water flow would be available to irrigators during drought years, resulting in potentially increased demands on groundwater. The I-90 Phase 2A project would not be expected to significantly impact groundwater because project elements would not directly interact with groundwater, and BMPs would be implemented to protect groundwater from inadvertent spills during construction (WSDOT, 2008).

Alternative 2A – KDRPP East Shore Pumping Plant construction is not expected to require dewatering or to affect groundwater contributions to streams, springs, wetlands, or nearby wells. *Alternative 2B – KDRPP South Pumping Plant, Alternative 3A – KKC North Tunnel Alignment, Alternative 3B - KKC South Tunnel Alignment,* and *Alternative 4 - Combined KDRPP and KKC* would likely require dewatering and could result in temporary impacts on groundwater levels. In turn, these effects of groundwater level could cause temporary impacts on groundwater contributions to streams, springs, and wetlands, and water levels in nearby wells. Construction activities could impact groundwater quality through inadvertent spills; however, these potential impacts would be minimized through the use of construction BMPs.

Operation of *Alternatives 2A, 2B,* and *4* may lower groundwater levels in adjacent aquifers and potentially decrease water supply to wetlands, springs, or rivers and potentially interrupt well operations. Operation of *Alternative 3A* and *3B* would not impact groundwater contributions to streams, springs, wetlands, or water levels in nearby wells.

The BTE actions would be implemented as part of all the action alternatives and could reduce groundwater seepage into Gold Creek, which could have a beneficial impact on groundwater contributions to wetlands, streams, springs, and wells. The BTE actions are not expected to require dewatering or to negatively affect groundwater contributions to streams, springs, wetlands, or nearby wells.

Table 4-30 summarizes potential impacts in relation to impact indicators.

Table 4-30. Summary of Impacts for Groundwater

Impact Indicator	Summary of Impact
Changes in groundwater contribution to streams, springs, and wetlands	*Alternative 1* would not affect groundwater contributions to streams, springs, wetlands, or wells. *Alternative 2A* and the BTE construction are not expected to require dewatering or affect groundwater contributions to streams, springs, wetlands, or wells. *Alternatives 2B, 3A, 3B,* and *4* could require dewatering and could result in temporary impacts on groundwater levels, potentially decreasing the water supply to wetlands, springs, streams, or wells. Operation of *Alternatives 2A, 2B*, and *4* may result in decreased groundwater levels in aquifers adjacent to the reservoirs, potentially decreasing the water supply to wetlands, springs, streams, or wells. Operation of *Alternatives 3A* and *3B* would not impact groundwater contributions to streams, springs, wetlands or wells.
Introduction of contaminants from spills	All action alternatives could result in inadvertent spills that affect groundwater quality. These impacts would be prevented or minimized through the use of construction BMPs; therefore, no significant impacts are anticipated during operations.

4.5.3 Alternative 1 – No Action Alternative

Under *Alternative 1 – No Action*, groundwater levels and conditions in the primary study area would remain the same as or better than those that exist today, as described in Section 3.5.

As analyzed in its 2008 EIS, WSDOT would construct the I-90 Phase 2A project near the primary study area. As part of that project, special measures would be implemented to restore hydrologic connectivity under I-90 that was disrupted during the original construction of the highway. These measures would provide continuity between areas of subsurface water flow that are currently impeded. Overall, the I-90 Phase 2A project was not expected to significantly impact groundwater because project elements would not directly interact with groundwater, and BMPs would be implemented to protect groundwater from inadvertent spills during construction.

As described in Section 3.12, climate change could affect future water availability in the Yakima River basin. Under *Alternative 1 – No Action*, current trends in water supply for the proratable irrigation districts would continue. Climate change could result in reduced groundwater recharge because of the reduced recharge volume of water available to apply to crops and accompanying reduced seepage to groundwater during drought years. Groundwater pumping during droughts would continue, requiring continued and potentially increased use of drought relief wells, most of which are located downstream of the Parker stream gage and serve proratable water users. Additionally, climate change will likely affect the occurrence and extent of wetlands and springs due to the increase in temperatures, extended low-flow periods in surface water, and changes in runoff patterns. Additional detail about the potential effects of climate change is provided in Section 4.12.

4.5.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.5.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Construction of the shafts and portals for the pumping plant would involve the use of construction methods (such as interlocking concrete secant pile walls) that do not require large-scale dewatering to lower groundwater levels to the base of the shaft or portal. The pipeline and associated discharge structures would be constructed above ground without the need for dewatering. The transmission line would also not require any dewatering. The intake tunnels would be constructed using tunnel boring machines. The tunnel would be sealed as it is constructed, and major dewatering that would influence groundwater levels would not be required. The *Alternative 2A – KDRPP East Shore Pumping Plant* elements would be isolated from groundwater; construction of this alternative would not affect groundwater levels. Therefore, no changes to groundwater contributions to streams, springs, wetlands, or nearby wells are anticipated.

Construction activities could affect groundwater quality due to inadvertent spills that result in groundwater contamination. Possible sources of groundwater contamination associated with construction activities include minor spills of petroleum products and construction-related hazardous materials, and leaks of fuel or fluids from construction equipment. Spills could occur at construction sites, along access routes for construction vehicles, or at staging areas. BMPs would be implemented to prevent and minimize the potential for spills, as described in Section 4.4; therefore, groundwater quality impacts are unlikely.

Bull Trout Enhancement

Construction of the BTE actions at Cold Creek and Gold Creek would not be expected to significantly impact groundwater. The BTE includes filling a portion of Gold Creek Pond and all of the artificial Heli’s Pond as a means to restore local groundwater flow and connectivity. This filling would result in a beneficial impact on groundwater resources by reducing seepage of groundwater into Gold Creek. No decreases in water levels in groundwater levels or nearby wells are anticipated. No decreases in groundwater quality from spilled contaminants are anticipated; BMPs would be implemented to protect groundwater from inadvertent spills during construction.

4.5.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Operation of KDRPP is estimated to lower the surface water levels in Kachess Reservoir up to an additional 80 feet beyond the current maximum allowable drawdown, and the drawdown could last up to 4 years. The lowered surface water levels in the reservoir may decrease groundwater levels in shallow sedimentary aquifers adjacent to the reservoir. This could potentially decrease the water supply to nearby wetlands, springs, streams, or wells. As described in Section 3.5, approximately 46 wells are located at depths of 100 feet or less in the primary study area. KDRPP reservoir drawdown may reduce water levels in these wells, including the well at the USFS Kachess Campground, during the drought and 2- to 5-year refill period for the reservoir, depending on the hydraulic connection between the reservoir and the shallow aquifer in which the wells are located. Reclamation would monitor water levels in wells and develop appropriate mitigation as described in Section 4.5.9 if monitoring shows that water levels are impacted. The potential impacts on wells would be mitigated using the methods described in Section 4.5.9.

Implementation of KDRPP would increase streamflow during the irrigation season (April to October) in the Yakima River from Easton to the Wapato Dam during drought years. In addition, proratable irrigation districts (KRD, RID, and WIP) would have an increased water supply during drought years (Section 4.3). The increased streamflow could potentially increase groundwater recharge along the Yakima River because of the greater wetted perimeter of the river and greater depth of flow, which increases the potential recharge area. The increase in water supply for proratable irrigation districts could also increase groundwater recharge in drought years because the greater volume of water available would increase seepage to groundwater. These beneficial effects related to increases in groundwater recharge in drought years would be relatively small, but would help maintain groundwater levels. Increased water supply to proratable irrigators could also reduce the use of drought relief wells. Most drought relief wells are located downstream of Parker and serve proratable water users.

Bull Trout Enhancement
No effects from the operation of the BTE at Cold Creek and Gold Creek are anticipated on groundwater resources because no project elements would interact with groundwater.

4.5.5 Alternative 2B – KDRPP South Pumping Plant

4.5.5.1 Construction

KDRPP South Pumping Plant Facilities
The shafts and portals for the pumping plant would be constructed using a method (interlocking concrete secant pile walls) that does not require dewatering because the shaft is sealed off from groundwater. Some minor dewatering and lowering of groundwater levels (estimated at up to 5 feet) may be required for construction of the channel, spillway, and stilling basin between the pumping plant and the Kachess River. If dewatering is required, the pumped groundwater would be routed into a series of basins to remove sediment and then returned to the aquifer downgradient of the dewatering system using a rapid infiltration basin. If *Alternative 2B – KDRPP South Pumping Plant* is selected, Reclamation would complete a hydrogeologic study to design the dewatering system and determine the effects on groundwater levels, groundwater wells, and river flow. Reclamation does not, however, expect a decrease in the overall amount of groundwater in the aquifer because the water would be returned to the system. The dewatering system would include a water treatment

method to remove suspended solids before discharge, so that the quality of groundwater (and indirectly surface water) would not be affected.

Construction activities that could affect groundwater quality are the same as those discussed above for *Alternative 2A – KDRPP East Shore Pumping Plant*.

Reclamation would implement BMPs to prevent and minimize potential for spills, and groundwater quality impacts are unlikely.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.5.4.1).Operation

KDRPP South Pumping Plant Facilities
Operation impacts on groundwater would be similar to those described for *Alternative 2A - KDRPP East Shore Pumping Plant.* Reclamation would operate KDRPP the same regardless of the location of facilities.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.5.4.2).

4.5.6 Alternative 3A – KKC North Tunnel Alignment

4.5.6.1 Construction

KKC North Tunnel Alignment Facilities
Construction of *Alternative 3A – KKC North Tunnel Alignment* would involve dewatering to lower groundwater levels for the portion of the pipeline constructed within the Yakima River valley east of I-90 for an estimated 1-year construction period. This would be required for either Option A or Option B for the pipeline. Reclamation and Ecology developed a groundwater flow model to evaluate the decrease in groundwater levels and pumping rates needed for construction (Reclamation and Ecology, 2014h). Groundwater levels would need to be decreased by 30 to 40 feet with a pumping dewatering rate of up to 7,300 gallons per minute (gpm). Dewatering would be accomplished using wells and pumps. The discharge water from dewatering would be routed to a settling basin to remove suspended solids and then returned to the aquifer using a rapid infiltration basin.

Lowering of groundwater in the immediate vicinity of the pipeline would result in lowering of water levels in the wetlands southeast of the reservoir (essentially drying out the water supply for the wetlands) for a 1-year period. Impacts on this wetland are described in Section 4.7.6. No reduction in groundwater levels downstream or outside of the immediate area of dewatering are expected and groundwater discharge to the Yakima River would not decrease because the dewatering water would be infiltrated back into the aquifer near the source and would resume the same groundwater migration paths. There may be a minor decrease in groundwater levels in the two groundwater wells located southeast and within 1 mile of the construction dewatering area, but impacts should not be significant because groundwater modeling indicates that the drawdown of the aquifer in this area would be minor (less than 5 feet) and the well screened intervals are much deeper.

Construction of the tunnel using the TBM would not require dewatering or other activities that would affect groundwater; therefore, no changes in groundwater contributions to streams, springs, wetlands, or nearby wells are anticipated.

Construction activities that could affect groundwater quality are the same as those discussed above for *Alternative 2A – KDRPP East Shore Pumping Plant*. Reclamation would implement BMPs to prevent and minimize potential for spills, and groundwater quality impacts are unlikely.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.5.4.1).

4.5.6.2 Operation

KKC North Tunnel Alignment Facilities
Operation of KKC is not anticipated to affect groundwater. Only minor changes in reservoir surface levels would occur as a result of KKC implementation; therefore, the groundwater levels in wells located around the reservoir would not be affected. No dewatering is required during operations and the proposed tunnel would not interact with groundwater or change groundwater migration patterns. The tunnel is not expected to change groundwater migration patterns in the long-term. The tunnel backfill material would be of coarse granular material similar to the native material in the shallow aquifer, and collars or another form of an impermeable barrier would be placed within the backfill around the pipeline to prevent preferential groundwater flow along the alignment. In addition, the tunnel would be lined and watertight to prevent leakage; thus, no interaction with groundwater would be anticipated.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.5.4.2).

4.5.7 Alternative 3B – KKC South Tunnel Alignment

4.5.7.1 Construction

KKC South Tunnel Alignment Facilities
Although the location of the KKC tunnel and associated portals and shafts would differ from *Alternative 3A – KKC North Tunnel Alignment*, the groundwater aquifer location and conditions are the same for both alignments (see Section 3.5). As a result, construction-

related impacts on groundwater for *Alternative 3B – KKC South Tunnel Alignment* would be the same as those described for construction of *Alternative 3A – KKC North Tunnel Alignment* (Section 4.5.6.1).

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.5.4.1).

4.5.7.2 Operation

KKC South Tunnel Alignment Facilities

Operation impacts on groundwater would be similar to those described for *Alternative 3A - KKC North Tunnel Alignment.* Reclamation would operate KKC the same regardless of the tunnel alignment.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.5.4.2).

4.5.8 Alternative 4 – Combined KDRPP and KKC

4.5.8.1 Construction

KDRPP and KKC Facilities

Kachess and Keechelus Reservoirs are located in bedrock valleys filled with alluvial sediments. There is no groundwater hydraulic connection between the reservoirs, and there would not be an additive effect to groundwater from construction of KDRPP and KKC at the same time. Therefore, construction effects to groundwater for the combined KDRPP and KKC would be the same as those for *Alternative 2A – KDRPP East Shore Pumping Plant* and *Alternative 3A – KKC North Tunnel Alignment*.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.5.4.1).

4.5.8.2 Operation

KDRPP and KKC Facilities

Operation of the combined KDRPP and KKC would result in impacts on groundwater similar to those described for *Alternative 2A – KDRPP East Shore Pumping Plant*. However, as described in Section 4.3.8, the combined KDRPP and KKC would lower the Kachess Reservoir pool below elevation 2,220 for 22 fewer days per year than *Alternative 2A – East Shore Pumping Plant*. This means that Alternative 4 – Combined KDRPP and KKC could reduce the duration of operation effects on groundwater levels, when compared to *Alternative 2A – East Shore Pumping Plant*. However, *Alternative 4 – Combined KDRPP and KKC* would still have the potential to lower groundwater levels and thus water supply to nearby wetlands, springs, streams, and wells. The potential impacts on wells would be mitigated using the methods described in Section 4.5.9.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.5.4.2).

4.5.9 Mitigation Measures

Reclamation would implement the following measures to minimize or mitigate potential impacts on groundwater associated with the action alternatives:

- During construction, Reclamation would prevent or minimize potential adverse effects to groundwater quality from inadvertent spills through use of construction BMPs, such as good housekeeping; proper storage of hazardous materials and petroleum products; and implementation of a Spill Prevention, Control, and Countermeasures Plan.
- Reclamation would monitor wells near Kachess Reservoir to determine if water levels are lowered by additional reservoir drawdown due to the Proposed Action. If well water levels are adversely impacted, Reclamation would develop appropriate mitigation strategies in cooperation with the property owners and Ecology.

4.6 Fish

4.6.1 Methods and Impact Indicators

Methods. The assessment of impacts on fish is based on a review of previous studies and planning efforts in the upper Yakima basin, as well as fisheries and habitat management data from Tribal, Federal and State wildlife managers. The assessment also considered observations from regional biologists and peer-reviewed literature from other regions. Quantitative changes in flow and pool elevations are based on hydrologic modeling using data from 1925 to 2009, as described in Section 4.3, Water Resources.

Impact Indicators. Impact indicators for fish in all habitats of concern (i.e., reservoir, mainstem, and tributary habitats) are described in Table 4-31. The basis for comparison for all criteria is *Alternative 1 – No Action*.

Potential impacts would originate from construction activities, changes in flow regulation, changes in reservoir operations, and implementation of BTE habitat and fish passage improvements at Gold and Cold creeks.

The severity of an impact is influenced by its duration. Short-term impacts are not expected to persist after the construction activities causing disturbance have ceased. Long-term impacts would continue after construction has ceased or are associated with operational activities that would continue for longer periods of time.

Table 4-31. Impact Indicators and Significance Criteria for Fish

Impact Indicator	Significance Criteria
Water temperature	Change in water temperatures such that the affected water body cannot support existing native fish species is considered a significant negative impact. Change in water temperatures that improves conditions for native fish species is considered a beneficial impact.
Turbidity	Substantial alteration of riparian vegetation, change in shoreline stability, mobilization of aquatic sediments that severely limits or eliminates habitat to support native fish species is considered a significant negative impact.
Nutrients	Change in nutrient levels that substantially reduces native fish populations is considered a significant negative impact. Change in nutrient levels that substantially improves conditions for native fish populations is considered a beneficial impact.
Food-based prey	Alteration of hydraulic residence time and change in frequency and magnitude of reservoir drawdowns that result in beneficial or adverse effects in the production of food-based prey is considered a beneficial impact. Modifications in residence time that reduce the availability of food-based prey are considered negative impacts, and conditions that improve conditions for food-based prey are considered beneficial impacts.
Habitat complexity	Changes in habitat complexity that substantially limit or eliminate habitat features used by many native species at different life history stages (e.g., incubation, rearing, or spawning) are considered significant negative impacts; these changes may be a result of altering riparian vegetation, inwater structures, or other habitat features. Changes that improve habitat complexity are considered beneficial impacts.

Impact Indicator	Significance Criteria
Connectivity within reservoir habitats	Lowering of reservoir level to the point that connectivity between Kachess Reservoir lake basins restricts fish passage (elevation 2,220) is a significant negative impact when the frequency of annual occurrence of passage impediments increases by greater than 5 percent and when the average duration of passage impediments increases annually by greater than 5 days. Operations that improve access between Kachess Reservoir lake basins is considered a beneficial impact when the frequency of annual occurrence of passage impediments decreases by greater than 5 percent or the average duration of passage impediments decreases annually by greater than 5 days.
Connectivity between tributary and reservoir habitats	Lowering of Kachess or Keechelus reservoir levels to the point that connectivity between the reservoir and tributary habitats is reduced and impedes fish passage (elevation 2,226) is a significant negative impact when the frequency of annual occurrence of passage impediments increases by greater than 5 percent or the average duration of passage impediments increases annually by greater than 5 days. Changes that improve access between reservoir and tributary habitat are considered a beneficial impact when the frequency of annual occurrence of passage impediments decreases by greater than 5 percent or the average duration of passage impediments decreases annually by greater than 5 days.
River flow	Changes to river flows that are not compliant with instream flow requirements are a negative impact. Changes to river flows that more closely resemble natural flows or changes that result in compliance with instream flow requirements are considered beneficial impacts.
Transmission of disease or invasive species	Transmission of a disease or invasive species as a result of new connections between water bodies that are currently isolated is considered a negative impact.
Disturbance	Increase in noise levels or vibrations that cause avoidance behavior in fish is considered a negative impact.
Entrainment	Increased rate of entrainment of resident fishes other than salmon and trout with small larval juveniles from reservoir habitats into downstream habitats is considered a negative impact.

4.6.2 Summary of Impacts

The effects of each alternative on the specified impact indicators is described below and summarized in Table 4-32.

Water temperature. Under *Alternative 1 – No Action*, current operations would continue. Temperatures would fluctuate over time as a result of climate change patterns, which could result in higher water temperatures over time. Reclamation's ability to respond to these increases would be limited under *Alternative 1 – No Action*, which could result in long-term negative impacts on fish. The potential significance of the impact is uncertain. Under *Alternatives 2A*, *2B*, and *4*, reductions in Kachess Reservoir minimum pool elevation may increase surface heating during the summer months, resulting in an increase in water temperatures within the reservoir. Under *Alternative 4*, Keechelus Reservoir pool elevations would be lower than existing conditions (Figure 4-7, Surface Water Resources) following drought years, potentially resulting in more surface heating during the summer months as the reservoir pool level recovers to nondrought conditions. Increases in reservoir water temperatures could result in negative impacts on salmonids.

Turbidity. *Alternative 1 – No Action* is not expected to cause turbidity impacts. Construction activities associated with all the action alternatives could temporarily increase turbidity levels, resulting in negative impacts on fish. Additionally, reduction in Kachess Reservoir minimum pool elevation (*Alternatives 2A*, *2B*, and *4*) would expose the lower reservoir bed to wave action and thus increase turbidity. It is not expected that these impacts would reach a level of significance, because the impacts would be localized and fish would be able to avoid the increased turbidity.

Nutrients. Under *Alternative 1 – No Action*, nutrient levels in the primary study area are not expected to change. The conveyance of water under *Alternatives 3A*, *3B*, and *4* may cause small nutrient transfer from Keechelus to Kachess Reservoir, but no significant beneficial or negative fish impacts are expected because both reservoirs are nutrient limited and have generally unproductive fish habitats.

Food-based prey. Under *Alternative 1 – No Action*, the influence of climate change on hydraulic residence time and reservoir elevations would have an unknown impact on food-based prey. Reclamation's ability to respond to these changes, should they occur, is limited under *Alternative 1 – No Action*. Under the action alternatives, decreased hydraulic residence time and lower minimum reservoir elevation in Kachess Reservoir would decrease the availability of prey. Under *Alternatives 2A*, *2B*, and *4*, decreased hydraulic residence time in Keechelus Reservoir would reduce the availability of food-based prey. However, under *Alternatives 3A* and *3B*, smaller fluctuations in reservoir level and increased hydraulic residence times during drought years could have a positive impact on the availability of aquatic prey in Keechelus Reservoir.

Habitat complexity. Under *Alternative 1 – No Action*, climate change may reduce reservoir levels and decrease vegetation, resulting in negative impacts on habitat complexity. Under *Alternatives 2A*, *2B*, and *4*, shoreline vegetation would be reduced by construction of new pumping facilities and roads adjacent to Kachess Reservoir, greater fluctuations in Kachess Reservoir levels, reductions in Kachess Reservoir minimum elevation, and lower reservoir levels in Keechelus Reservoir following drought years. *Alternatives 3A* and *3B* could have positive impacts on habitat complexity because smaller fluctuations in reservoir level would increase shoreline vegetation and habitat complexity within Keechelus Reservoir.

Connectivity within reservoir habitats. Under *Alternative 1 – No Action*, lower reservoir levels due to climate change could have a negative impact on connectivity between the two historical lake basins of Kachess Reservoir. Under *Alternatives 2A*, *2B*, and *4*, the reduction in Kachess Reservoir operating level (up to 80 feet) would also have a negative impact on within-reservoir habitat connectivity.

Connectivity between tributary and reservoir habitats. Under *Alternative 1 – No Action*, climate change may reduce reservoir levels and decrease access between reservoir and tributary fish habitats.

Under *Alternatives 2A*, *2B*, and *4*, the reduction in Kachess Reservoir operating level (up to 80 feet) would also have a negative impact on fish passage and connectivity between reservoir and tributary habitats.

For Keechelus Reservoir, *Alternatives 2A* and *2B* would increase the frequency and duration of impeded fish passage between reservoir and tributary habitats, resulting in a negative impact. However, under *Alternatives 3A* and *3B*, decreases in the frequency and duration of impeded fish passage would represent a beneficial impact on habitat connectivity between reservoir and tributary habitats. The BTE actions at Gold and Cold creeks would also have positive impacts by increasing habitat connectivity between reservoir and tributary habitats in Keechelus Reservoir.

River flow. *Alternative 1 – No Action* could have a negative impact because climate change may reduce operational flexibility to meet instream flow requirements. Under *Alternatives 3A*, *3B*, and *4*, summer instream flows in the Keechelus Reach of the Yakima River would be met most years and could significantly increase the productivity and abundance of spring Chinook in that reach. Summer instream flows in the Kachess River would not improve under any of the action alternatives.

Transmission of disease or invasive species. Under *Alternative 1 – No Action*, no changes in transmission of disease or invasive species are expected. Under *Alternatives 3A*, *3B*, and *4*, the potential transmission of diseases or invasive species via the conveyance of water from Keechelus to Kachess could have a negative impact on fish.

Disturbance. Under *Alternative 1 – No Action*, no noise-based disturbance is anticipated. Under all action alternatives, increased noise levels during construction could have a negative impact on fish.

Entrainment. Under *Alternative 1 – No Action*, the entrainment risk to fish is not expected to change. Under *Alternatives 2A*, *2B*, and *4*, there is an increased risk of entraining resident fishes (other than salmon and trout) with small larval juvenile stages in the new intake in Kachess Reservoir.

For fish impact indicators, the most significant effects would be related to project operations (nonconstruction impacts) associated with KDRPP (*Alternatives 2A* and *2B*), KKC (*Alternatives 3A* and *3B*), and the combination of KDRPP and KKC (*Alternative 4*). The operational effects of *Alternatives 2A* and *2B* would be the same as would those of *Alternatives 3A* and *3B*. Table 4-32 summarizes the expected effects resulting from operation of the different alternatives. Table 4-33 summarizes the potentially significant effects by impact indicator. The location where project effects would occur is identified in each colored box: yellow boxes represent potentially significant negative effects; and green boxes represent potentially significant beneficial effects. Grey boxes represent effects that are expected to be equivalent to *Alternative 1 – No Action*.

Table 4-32. Summary of Impacts on Fish under Proposed Alternatives

Impact Indicator	No Action	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Water temperature	N – Climate change may result in increased reservoir and river temperatures.	N – Reduction in Kachess Reservoir minimum pool elevation may increase water temperatures in Kachess Reservoir.	Same as *Alternative 2A.*	No change	No change	N – Reduction in Kachess Reservoir minimum pool elevation may increase water temperatures in Kachess Reservoir. N – Following drought years, reductions in Keechelus Reservoir pool elevation may increase water temperatures in Keechelus Reservoir
Turbidity	N – Construction related to I-90 improvements may increase turbidity within Keechelus Reservoir.	N – Temporary increases in turbidity would occur during construction activities. N – Reduction in Kachess Reservoir minimum pool elevation would expose the lower reservoir bed to wave action and increase turbidity.	Same as *Alternative 2A.*	N – Temporary increases in turbidity would occur during construction activities.	Same as *Alternative 3A.*	N – Temporary increases in turbidity would occur during construction activities. N – Reduction in Kachess Reservoir minimum pool elevation would expose the lower reservoir bed to wave action and increase turbidity.

Impact Indicator	No Action	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Nutrients	No change.	No change.	No change.	No change.	No change.	No change.
Food-based prey	U-Climate change may influence hydraulic residence time and reduce reservoir elevations, changing prey availability.	N – Decreased hydraulic residence time and lower minimum reservoir elevation would reduce available prey in Kachess Reservoir. N – Decreased hydraulic residence time and lower reservoir levels after drought years would reduce available prey in Keechelus Reservoir.	Same as *Alternative 2A*.	N – Decreased hydraulic residence time and lower reservoir levels would reduce available prey in Kachess Reservoir. B – Smaller fluctuations in reservoir level and increased hydraulic residence time during drought years would increase available food prey within Keechelus Reservoir.	Same as *Alternative 3A.*	N – Decreased hydraulic residence time and lower reservoir elevations would reduce available prey in Kachess Reservoir. N – Reduced hydraulic residence times would decrease available zooplankton prey within Keechelus Reservoir.

Impact Indicator	No Action	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Habitat complexity	N – Climate change may reduce reservoir levels and decrease vegetation that contributes to habitat complexity.	N – Construction of new pumping facilities and roads would reduce shoreline vegetation adjacent to Kachess Reservoir. N – Reduction in Kachess Reservoir minimum elevation would reduce shoreline vegetation and habitat complexity. N – Lower reservoir levels after drought years would reduce shoreline vegetation and habitat complexity within Keechelus Reservoir.	N – Construction of new pumping facilities and roads would reduce shoreline vegetation adjacent to Kachess Reservoir. However, the footprint of Alternative 2B is smaller than Alternative 2A. N – Reduction in Kachess Reservoir minimum elevation would reduce shoreline vegetation and habitat complexity. N – Lower reservoir levels after drought years would reduce shoreline vegetation and habitat complexity within Keechelus Reservoir.	N – Greater fluctuations in reservoir level would reduce shoreline vegetation and habitat complexity within Kachess Reservoir. B – Smaller fluctuations in reservoir level would increase shoreline vegetation and habitat complexity within Keechelus Reservoir.	Same as *Alternative 3A.*	N – Construction of new pumping facilities and roads would reduce shoreline vegetation adjacent to Kachess Reservoir. N – Reduction in Kachess Reservoir minimum pool elevation would reduce shoreline vegetation and habitat complexity in Kachess Reservoir. N – Lower reservoir elevations following drought years would reduce shoreline vegetation and habitat complexity in Keechelus Reservoir.

Impact Indicator	No Action	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Connectivity within reservoir habitats	N – Climate change may reduce reservoir levels and decrease habitat connectivity between historical lake basins within Kachess Reservoir.	N – Reduction in Kachess Reservoir minimum pool elevation would reduce connectivity between reservoir habitats.	Same as *Alternative 2A.*	No change.	No change.	N – Reduction in Kachess Reservoir minimum pool elevation would reduce connectivity between reservoir habitats.

Impact Indicator	No Action	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Connectivity between tributary and reservoir habitats	N – Climate change may reduce reservoir levels and decrease access between reservoir and tributary habitats in Kachess and Keechelus reservoirs.	N – Reduction in Kachess Reservoir minimum pool elevation would reduce connectivity between reservoir and tributary habitats. N – Lower reservoir levels after drought years would reduce connectivity between reservoir and tributary habitats in Keechelus Reservoir. B – Bull trout enhancement projects would increase habitat connectivity between reservoir and tributary habitat in Keechelus Reservoir.	Same as *Alternative 2A.*	N – Lower reservoir levels would reduce connectivity between reservoir and tributary habitats in Kachess Reservoir. B – Reduced frequency and duration of passage impediments would increase connectivity between reservoir and tributary habitats in Keechelus Reservoir. B – Bull trout enhancement projects would increase habitat connectivity between reservoir and tributary habitat in Keechelus Reservoir.	Same as *Alternative 3A.*	N – Reduction in Kachess Reservoir minimum pool elevation would reduce connectivity between reservoir and tributary habitats in Kachess Reservoir. B – Bull trout enhancement projects would increase habitat connectivity between reservoir and tributary habitat in Keechelus Reservoir.

Impact Indicator	No Action	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
River flow		No change.	No change.	B – Summer instream flows in the Yakima River (500 CFS target in Keechelus Reach) would be met most years and would increase salmon production and resident fish habitat in the Keechelus Reach.	Same as *Alternative 3A.*	B – Summer instream flows in the Yakima River would be met most years (500 CFS target in Keechelus Reach) and would increase salmon production and resident fish habitat in the Keechelus Reach.
Transmission of disease or invasive species		No change.	No change.	N – The conveyance of water from Keechelus to Kachess reservoir would increase the risk of transmitting diseases and exotic species to Kachess Reservoir.	Same as *Alternative 3A.*	N – The conveyance of water from Keechelus to Kachess reservoir would increase the risk of transmitting diseases and exotic species to Kachess Reservoir.

Impact Indicator	No Action	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Disturbance	N – Construction related to I-90 improvements may disturb fish within Keechelus Reservoir.	N – During construction of project facilities, increased noise levels may disturb fish within Kachess Reservoir. Blasting may be required so noise levels could be significant.	N – During construction of project facilities, increased noise levels may disturb fish within Kachess Reservoir. The use of a tunnel boring machine would reduce disturbances caused by sound compared to *2A.*	N – During construction of project facilities, increased noise levels may disturb fish in Kachess Reservoir and the Yakima River	Same as *Alternative 3A*.	N – During construction of project facilities, increased noise levels may disturb fish in Kachess Reservoir and the Yakima River.
Entrainment	No change.	N – Increased risk of entraining resident fishes (other than salmon and trout) with small larval juvenile stages in new intake in Kachess Reservoir.	Same as *Alternative 2A.*	No change.	No change.	N – Increased risk of entraining resident fishes (other than salmon and trout) with small larval juvenile stages in new intake in Kachess Reservoir.

Notes:

“N” denotes a negative impact

“B” denotes a beneficial impact

Table 4-33. Summary of Significant Operational Effects on Fish

Impact Indicator	No Action	Alternative 2A	Alternative 2B	Alternative 3A	Alternative 3B	Alternative 4
Water temperature		Kachess Reservoir	Kachess Reservoir			Kachess Reservoir and Keechelus Reservoir
Turbidity						
Nutrients						
Food-based prey		Kachess Reservoir	Kachess Reservoir	Kachess Reservoir	Kachess Reservoir	Kachess Reservoir
Habitat complexity		Kachess and Keechelus reservoirs	Kachess and Keechelus reservoirs	Kachess Reservoir Keechelus Reservoir	Kachess Reservoir Keechelus Reservoir	Kachess and Keechelus reservoirs
Connectivity within reservoir habitats		Kachess Reservoir	Kachess Reservoir			Kachess Reservoir
Connectivity between tributary and reservoir habitats		Kachess and Keechelus reservoirs	Kachess and Keechelus reservoirs	Keechelus Reservoir	Keechelus Reservoir	Kachess Reservoir
River flow				Keechelus Reach – Yakima River	Keechelus Reach – Yakima River	Keechelus Reach – Yakima River
Transmission of disease or invasive species				Kachess Reservoir	Kachess Reservoir	Kachess Reservoir
Disturbance						
Entrainment		Kachess Reservoir	Kachess Reservoir			Kachess Reservoir

Yellow=potentially significant negative impacts
Green=potentially beneficial impacts
Gray=no change from the *Alternative 1 – No Action*

4.6.3 Alternative 1 – No Action Alternative

4.6.3.1 Construction

Under *Alternative 1 – No Action,* WSDOT proposes to improve I-90 adjacent to Keechelus Reservoir (WSDOT, 2008). Construction of these improvements would cause temporary impacts on the natural environment, primarily from disturbed vegetation and increased turbidity. Reduction and disturbance of vegetation and sediments adjacent to Keechelus Reservoir may result in reduced habitat complexity or increased turbidity for fish in the reservoir and some tributaries. Temporary impacts would be limited to the period of construction and would be mitigated through construction BMPs to control erosion and restore disturbed areas. Additionally, construction and fill associated with the construction of a new roadbed may cause permanent loss of terrestrial, riparian, and aquatic habitat, including forest, wetlands, streams, and deep-water areas of Keechelus Reservoir. However, because one of the purposes of the I-90 project is to improve ecological connectivity along the highway corridor, significant long-term benefits to fish species in Keechelus Reservoir and tributaries are expected. Proposed improvements would replace narrow bridges and culverts along I-90 with longer bridges and larger culverts, which would allow natural stream channel movement and improved fish passage. These activities would improve habitat connectivity for fish between Keechelus Reservoir and its tributaries, especially Gold Creek.

4.6.3.2 Operation

Kachess Reservoir

Under *Alternative 1 – No Action*, reservoir management would be similar to that under existing conditions. Peak flows from the reservoir would occur during the summer to support irrigation demands downstream in the Yakima basin. Reservoir elevations would fluctuate within the existing range described in Section 4.3. In the near term, Kachess Reservoir habitat would continue to support resident fish species. These species are the basis for popular fisheries, particularly for anglers targeting kokanee and cutthroat trout (WDFW, 2014b). Under *Alternative 1 – No Action*, reservoir operations would continue to cause seasonal passage issues at tributaries such as Box Canyon Creek and Kachess River. During periods when the reservoir is at lower elevations, seasonal fish barriers form where the river and creek cross the dewatered portion of the reservoir bed. These unconsolidated reaches are braided and too shallow for fish to pass (e.g., Reiss et al., 2012).

Kachess Reservoir would remain unproductive, with habitats reflecting existing annual reservoir fluctuations and hydraulic residence times. The food chain would be based on zooplankton and other prey would remain scarce (Mongillo and Faulconer, 1982). The vegetation communities adjacent to the reservoir would continue to be limited by existing fluctuations of pool elevations (e.g., Busch and Smith, 1995) resulting in diminished shallow-water habitat complexity.

Future climate change is expected to alter reservoir habitats, as described in Sections 3.12 and 4.12. The Adverse climate change scenario (see Section 3.12) predicts reduced snowpack in the headwaters above Keechelus and Kachess reservoirs. Also, higher air temperatures would cause snowpack to melt earlier than under current conditions (Reclamation and Ecology, 2011a). Other studies have shown that the Yakima River basin is likely to experience a 12 percent decrease in snowmelt volume given a 1°C rise in air temperature, and a 27 percent decrease in snowmelt volume given a 2°C rise (Vano et al., 2010).

Under *Alternative 1 – No Action*, climate change is expected to change the periodicity of runoff and reduce the net amount of runoff available to refill the reservoir. Based on hydrologic modeling results (Figure 3-27 in Section 3.12), changes in runoff into Keechelus and Kachess reservoirs due to climate change are expected to be significant. For the scenario modeled as part of the Yakima River Basin Study, the average annual change in reservoir inflow decreases by 20 or 21 percent compared to the existing or historically based scenario (Section 3.12.1.3). Spring runoff is expected to decrease by an average of 24 percent, and summer runoff is expected to decrease by 51 or 61 percent. Fall and winter runoff is expected to increase by an amount ranging from 11 to 13 percent of existing runoff.

The shifts in runoff quantity and timing shown by the model results would pose significant risk to water supply. Although fall and winter inflow would increase, the reservoirs may not be able to refill completely before spring, when releases to meet needs during the high-demand and lower-inflow period of summer are expected to be higher, and possibly earlier, than under historical conditions. Additionally, a decrease in spring and summer flow would cause water stored in Keechelus and Kachess reservoirs to be depleted at a faster rate to meet demand. The combined effects would likely cause a decrease in overall supply during the high-demand period. Simulated existing Keechelus and Kachess reservoir water surface elevations under the Baseline (historical) and Adverse climate scenarios are shown in Figures 3-26 and 3-27 in Section 3.12.

On average, water levels at Kachess Reservoir are predicted to be 13 feet lower, with a monthly average difference under the Adverse climate change scenario ranging from 8 to 18 feet lower. The decrease in refill potential would reduce Reclamation's ability to maintain predictable reservoir elevations when balanced against irrigation needs, and could result in increased water temperatures, reduced connectivity within reservoir habitats, reduced connectivity between reservoir and tributary habitats, decreased reservoir elevations, and reductions in habitat complexity.

Interactions between operational and climate-driven changes to reservoir and tributary habitats upstream of Kachess Dam are difficult to predict, but some general patterns are expected. Increasing water temperature may decrease the suitability of reservoir and tributary habitats for some fish species (Eaton and Scheller, 1996; Schindler, 2001; Mantua et al., 2010). Altered reservoir levels may change the hydraulic residence time of the reservoir and potentially influence zooplankton abundance. Lower pool elevations or more variable reservoir fluctuations, resulting from an inability to refill, could reduce diversity of benthic organisms that provide food for fish (Fisher and LaVoy, 1972) or reduce shoreline vegetation that provides cover and habitat complexity for fish (Braatne et al., 2007). The inability to refill the reservoir may also contribute to or worsen passage issues between tributary and reservoir habitats, thereby further limiting spawning and rearing opportunities for resident species that migrate between the two habitat types (Reiss et al., 2012).

Under *Alternative 1 – No Action*, Reclamation would not provide additional funding to improve tributary passage, reduce tributary dewatering events, expand available tributary habitat, or improve the reservoir prey base (Section 4.6.9). Passage barriers would continue to be a problem for resident fish and would worsen with climate change.

Potential changes to water temperature, prey availability, habitat complexity, and connectivity could result in substantial reduction or elimination of reservoir habitat. Although the extent of impact is difficult to predict, it is possible that these changes could cause significant negative impacts.

Kachess River

Under *Alternative 1 – No Action*, flows within the Kachess River below Kachess Dam would be similar to existing conditions. Flows in the Kachess River differ seasonally from the natural streamflow regime. From October to March, flow is reduced and less variable; from April to June, flow is reduced; and from July to September, flow is greatly increased especially during mini flip-flop (Section 3.3). This flow regime and the short length of the reach reduce the habitat value of the reach relative to others in the basin. The Kachess River is a “Lower Priority” instream flow reach and for which no flow objectives are identified in the Integrated Plan (Reclamation and Ecology, 2012). Because habitat functions in the reach are already significantly impaired by baseline operations, changes occurring under *Alternative 1-No Action* are unlikely to improve conditions for fish.

Keechelus Reservoir

Under *Alternative 1 – No Action*, Reclamation would manage the reservoir similar to existing conditions. Peak flow releases from the reservoir occur during the summer to support irrigation demands downstream in the Yakima basin. Impacts on salmonids and other fishes under *Alternative 1 – No Action* would be similar to those of existing conditions. Reservoir elevations would fluctuate within the existing range, as described in Section 4.3. In the near term, Keechelus Reservoir would continue to provide habitat similar to existing conditions to support resident fish species. Keechelus Reservoir receives light fishing pressure but provides anglers with the opportunity to catch kokanee, rainbow trout, cutthroat trout, and burbot (WDFW, 2014c).

Reservoir operations would continue to result in seasonal passage issues at tributaries, such as Gold Creek and Cold Creek. During periods when the reservoir is at lower elevations, seasonal fish barriers form where the creeks cross the dewatered portion of the reservoir bed. These unconsolidated reaches are braided and may become too shallow for fish to pass (Reiss et al., 2012).

Keechelus Reservoir would remain unproductive, with habitats reflecting existing annual reservoir fluctuations and hydraulic residence times. The food chain would be based on zooplankton, and other prey would remain scarce (Mongillo and Faulconer, 1982). The vegetation communities adjacent to the reservoir would continue to be limited by fluctuations in existing pool elevations (e.g., Busch and Smith, 1995), resulting in diminished complexity of shallow-water habitat.

In the future, climate change is expected to alter habitat conditions in Keechelus Reservoir. On average, the existing Keechelus Reservoir is predicted to be 12 feet lower, with a monthly average difference under the Adverse climate change scenario ranging from 1 to 22 feet lower. Simulated existing Keechelus and Kachess reservoir water surface elevations under the Baseline (historical) and Adverse climate scenarios are shown in Figures 3-26 and 3-27 in Section 3.12.

The decrease in refill potential would reduce Reclamation's ability to maintain predictable reservoir elevations when balanced against irrigation needs. In addition, increased temperatures may act directly on habitats independently or through interactions with Reclamation operations. It is anticipated that the collective impact would be increased water temperatures, reduced stability of reservoir elevations, reduced reservoir habitat complexity, and reduced connectivity between tributary and reservoir habitats.

Climate-driven changes on reservoir and tributary habitats upstream of Keechelus Dam are difficult to predict, but the general patterns are expected to be similar to those for Kachess Reservoir, as described in Section 4.6.3.2.

Under *Alternative 1 – No Action*, no actions to improve tributary passage, reduce tributary dewatering events, expand available tributary habitat, or improve the reservoir prey base would occur (Section 4.6.9). Habitat conditions would continue to be a problem for resident fish and would worsen with climate change. The potential significance of these impacts is difficult to predict; however, incremental reductions in habitat quality could, over the long term, result in losses of fish populations within the reservoir.

Yakima River

Under *Alternative 1 – No Action*, Reclamation would manage flows in the Yakima River similar to existing conditions. Peak flows from the reservoirs would occur during the summer to support irrigation demands downstream in the Yakima basin. Climate change would adversely affect flows and habitat conditions.

Keechelus Reach

Target flows in the Keechelus Reach would be met between 20 and 40 percent less frequently under the Adverse climate change scenario, except during July and August, when the ramp down to 500 cfs would be easier because less water would be available in, and delivered from, Keechelus Reservoir.

Under *Alternative 1 – No Action*, flows within the Keechelus Reach would remain at undesirably high levels from July through early September, when juvenile Chinook and steelhead (and potentially coho if reestablished) are rearing in this reach (Table 4-34). Juvenile salmon seek protection against high-velocity flows to avoid being pushed downstream into less desirable habitat and to minimize energy expenditures. High summer flows reduce the amount of suitable rearing habitat for these same species. The negative effects on rearing juvenile salmonids from high summer flow conditions in this reach occur during all water years, but are most significant in wet years. Flows in summer during a wet year such as 2002 average about 1,000 cfs (Reclamation and Ecology, 2011c). The summer target is 500 cfs. Under baseline conditions represented by *Alternative - No Action*, this target is only attained 1 percent of the time; 99 percent of the time and especially during wet years, flows are above target. These high-velocity flows reduce suitable habitat for salmonids.

Table 4-34. Percent Attainment of Seasonal Instream Flow Targets, Keechelus Reach of the Yakima River

Flow Criterion	Winter	Spring	Summer – July	Summer – August	Fall
Target (cfs)	≥100	≥100	Reduce to 500	Reduce to 120	≥100
Alternative 1					
Attainment[1]	67.6	82.8	1.0	11.8	68.2
Alternative 2A					
Attainment[1]	71.3	85.0	3.7	12.7	72.3
Change[2] (%)	3.7	2.2	2.7	0.9	4.1
Alternative 3A					
Attainment[1]	65.7	79.9	99.1	100.0	66.5
Change[2] (%)	-1.9	-2.9	98.1	88.2	-1.7
Alternative 4					
Attainment[1]	69.1	81.3	93.8	96.1	70.1
Change[2] (%)	1.5	-1.5	92.8	84.3	1.9

Note: Data based on 1925 to 2009 period of record

[1]Percent of years instream flow target would be met for period of record

[2]Change relative to *Alternative 1 – No Action*

Under *Alternative 1 – No Action*, flows during winter would remain lower than recommended (Reclamation and Ecology, 2011c). Lower flows reduce available rearing and overwintering habitat throughout the fall and winter, and, in dry years, into early spring. Coho and sockeye are less likely to reestablish if flow requirements are unmet, and spring Chinook and steelhead populations could decline.

Easton Reach
Under *Alternative 1 – No Action*, Reclamation would have limited flexibility to meet instream flow objectives in the Easton Reach. These objectives include increasing spawning and rearing habitat and improving outmigration conditions through adding flow during the fall and winter (Reclamation and Ecology, 2011c). Currently, instream flow targets are not always met (Table 4-35). The Adverse climate change scenario shows that the winter and spring target flows in the Easton Reach are met 10 to 20 percent less frequently, and the fall flows are met 41 percent less frequently (see Section 3.12). The frequency at which summer flow targets are met is essentially unchanged. Increasing base flows to 220 cfs in September and October in dry years and to 250 cfs during the rest of the year would benefit spring Chinook and steelhead, which spawn and rear in the Easton Reach. Once coho are firmly reestablished in the upper Yakima River basin, this species would also benefit from increased base flows, especially if increasing base flows reconnects side channel habitat. Side channel habitat would provide access to more variable habitat conditions, accommodating coho spawning needs more readily and providing low-velocity habitat for rearing juveniles of all salmonid species in the Yakima River basin. Adult sockeye salmon, once reestablished, would migrate through the Easton Reach on their way to upper basin lake spawning and rearing habitat. Sockeye would benefit from increased September base flows as they migrate upstream from late June through September (Reclamation and Ecology, 2011c).

Table 4-35. Percentage Attainment of Seasonal Instream Flow Targets, Easton Reach of the Yakima River

Flow Criterion	Winter	Spring	Summer	Fall
Target (cfs)	≥250	≥250	≥250	≥220
Alternative 1				
Attainment[1]	64.3	76.3	72.4	69.5
Alternative 2A				
Attainment[1]	64.7	76.3	66.4	71.0
Change[2] (%)	0.4	0.0	-6.0	1.5
Alternative 3A				
Attainment[1]	64.0	76.2	73.0	69.0
Change[2] (%)	-0.3	-0.1	0.6	-0.5
Alternative 4				
Attainment[1]	64.3	75.4	66.8	70.5
Change[2] (%)	0.0	-0.9	-5.6	1.0

Note: Data based on 1925 to 2009 period of record
[1]Percent of years instream flow target would be met for period of record
[2]Change relative to *Alternative 1 – No Action*

Under *Alternative 1 – No Action*, spring flow pulses would not be available to benefit spring Chinook, coho, and sockeye outmigrants. Flow pulses are expected to improve outmigration success rates, and without increases, these species would continue to decline (Reclamation and Ecology, 2011c).

Snowmelt is critical for refilling reservoirs and meeting irrigation needs, so significant reductions in snowpack would limit Reclamation's flexibility to meet flow requirements for fish. Coho and sockeye are less likely to reestablish if flow requirements are unmet, and spring Chinook and steelhead populations could decline.

Continuation of flows at existing levels in the Yakima River and its reaches could exacerbate conditions that negatively impact instream flow requirements for salmonids. Over time this could cause significant negative impacts.

4.6.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.6.4.1 Construction

KDRPP East Shore Pumping Plant Facilities
Kachess Reservoir
Construction of the *Alternative 2A – East Shore Pumping Plant* facilities is expected to be completed over 3 years. In addition to site preparation, activities would include construction of a reservoir intake and tunnel, pumping plant, pipeline, outlet works, discharge infrastructure, permanent access roads, and a spoils disposal area. These would require the creation of temporary construction facilities, including access roads, staging areas,

construction parking, and a boat launch and construction basin. These construction elements are described in detail in Section 2.4.2.

Construction activities associated with *Alternative 2A – East Shore Pumping Plant* are expected to result in the following negative impacts on fish and habitat within Kachess Reservoir:

- Disturbance of the Kachess Reservoir shoreline associated with site preparation, construction of the pumping plant, and temporary construction facilities could create localized increases in turbidity and reduction in habitat complexity.
- Impacts of erosion and sedimentation from construction of the reservoir intake, spoils disposal, and temporary construction facilities could increase turbidity and reduce shoreline stability.
- Noise and vibration disturbance associated with the construction activities in the reservoir could cause fish to temporarily avoid the construction area.

Construction activities would disturb or remove riparian vegetation adjacent to Kachess Reservoir. Clearing and grubbing would be required for facilities; construction parking; and staging, material storage, and laydown areas. A total of approximately 65 acres would be cleared (9 acres permanently). Permanent reductions in shoreline vegetation would occur within the footprint of the pumping plant, outlet works, and discharge infrastructure, and at the location of permanent access roads. Shoreline vegetation contributes to habitat complexity by providing cover for resident fish and prey species (Tabor and Wurtsbaugh, 1991). The loss of complexity may reduce the productivity for some resident fish species (Sass et al., 2006). Fish that may be disturbed by construction activity would include littoral (shallow-water) species such as mountain whitefish, cutthroat trout, rainbow trout, eastern brook trout, longnose dace, leopard dace, speckled dace, chiselmouth, redside shiner, peamouth, northern pikeminnow, largescale sucker, mountain sucker, threespine stickleback, and sculpins, all of which are present in Kachess Reservoir.

The installation of the intake, disposal of spoils, and use of the temporary boat launch are expected to disturb sediments within the reservoir and potentially increase turbidity levels. Upland construction activities such as site preparation and road construction may also mobilize sediments that would increase turbidity levels within the reservoir. Higher turbidity can reduce the productivity of aquatic ecosystems (Henley et al., 2000) and alter the dynamics of predator-prey relationships among fish species (Gregory and Levings, 1998). Increases in turbidity would be expected during the 3-year construction window but would be limited by the use of BMPs including erosion and sedimentation control measures as well as the deferral of construction until periods of reservoir drawdown, where practicable; the turbidity increases are not expected to cause significant long-term limitations to fish habitat .

Fish species that may be disturbed by construction of the intake include shallow-water species listed above as well as deep-water species such as burbot and pygmy whitefish.

The proposed construction activities associated with the reservoir intake and tunnel would cause additional noise (above background) in adjacent aquatic environments. Fish behavior can be disrupted by underwater noise but reactions vary depending on the frequency and intensity of the sound (Mitson and Knudsen, 2003). For the construction activities proposed for *Alternative 2A – East Shore Pumping Plant*, blasting would generate the most significant increase in noise and vibrations that would cause avoidance behavior or injury. The application of BMPs would reduce some of the unavoidable blasting-related impacts on fish. Increased noise levels would occur during the period of construction and would cease when construction is complete.

Kachess River
Alternative 2A – East Shore Pumping Plant would require construction of a discharge spillway at the headwaters of the Kachess River immediately downstream of the dam. Site preparation and construction of the discharge spillway would disturb shoreline vegetation and sediments and may cause temporary negative habitat complexity and turbidity impacts on fish species in the vicinity of these activities. The types of impacts resulting from shoreline disturbance and turbidity on fish are described above for Kachess Reservoir.

Keechelus Reservoir
Under *Alternative 2A – East Shore Pumping Plant*, no construction activities would occur at Keechelus Reservoir.

Bull Trout Enhancement
Generally, construction would result in short-term negative impacts on fish species within the tributaries. These impacts include increased turbidity, displacement from construction areas, and the temporary loss of riparian habitat in staging and construction areas.

Channel restoration and filling at Gold Creek along with the channel restoration and culvert removal would require inwater work, likely causing increases in turbidity and noise that would temporarily disturb resident fish from the construction areas downstream to the confluence with the reservoir. The timing of all inwater work would be subject to work windows that minimize the disturbance of bull trout and other aquatic and terrestrial species in the project area. Flows may also need to be partially or completely diverted from the existing channels to allow construction access to bed materials and to prevent fish from encountering major construction activities. All inwater work would adhere to Federal, State, and local regulatory requirements.

In addition to inwater work, construction activities may require temporary access roads and heavy equipment operation in the riparian areas (i.e., adjacent to the creek). Erosion and sediment control plans would be implemented to reduce the risk that upland sediments would enter the creek. Disturbance of riparian vegetation would be transient and all disturbed areas would be regraded and revegetated with appropriate native plant species immediately following construction.

Bridge and foundation installation for the Gold Creek USFS bridge replacement would require inwater work, resulting in increased levels of turbidity and noise that would temporarily disturb resident fish in the construction area (USFS, 2011a). Flows may also need to be partially or completely diverted from the existing channel to allow construction access to bed materials and to prevent fish from encountering major construction activities. Fish salvage and removal efforts would be conducted within the immediate project area to reduce the risk of fish injury and mortality during construction. The project would adhere to Federal, State, and local regulatory requirements, including agency protocols for fish salvage and removal.

4.6.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Kachess Reservoir

The Kachess Reservoir outlet works would be lowered by approximately 80 feet, resulting in a lower inactive pool elevation, at elevation 2,110. The new pumping plant would allow access to stored water that is below the current outlet works (elevation 2,192).

Under *Alternative 2A – East Shore Pumping Plant* operations, reservoir pool elevations are predicted to decrease significantly relative to *Alternative 1 – No Action* (Figure 4-3 and Table 4-5 in Section 4.3, Surface Water Resources). The lowered Kachess Reservoir elevation in drought years would cause reductions in food-based prey (benthic invertebrates, zooplankton), habitat complexity, connectivity within reservoir lake basins, and connectivity between reservoir and tributary habitats; it would also cause temperature changes within the reservoir basins.

Lower reservoir levels would result in more frequent and significant separation of the historical Kachess and Little Kachess lake basins within Kachess Reservoir, reducing within-reservoir connectivity for fish species. Kachess Reservoir would be below the level at which the two lake basins become separated (elevation 2,220) at a frequency of 74 percent of the years, an increase of 1 percent from *Alternative 1 –No Action* (Table 4-36). The mean duration would be 165 days per year, an increase of 78 days per year. During drought years and while reservoir elevations remain below elevation 2,200, fish passage between the basins would be reduced, preventing access to spawning and rearing habitats necessary for reproductive success, cover, refugia, and prey.

Table 4-36. Frequency and Duration of Kachess Reservoir below Elevation 2,220

Unit	Alternative 1	Alternative 2A	Change[1]	Alternative 3A	Change[1]	Alternative 4	Change[1]
Frequency (% of years)	72.9	74.1	1.2%	75.3	2.4%	77.6	4.7%
Mean duration, days	87	165	78	92	5	143	56

[1]Change relative to *Alternative 1 – No Action*

The significant reductions in Kachess Reservoir elevation and persistence of lower elevations for longer periods of time (2 to 5 years to refill the reservoir) would likely reduce the abundance of prey, resulting in negative impacts on fish. These impacts would be expected to result in substantial long-term reductions in the availability of food-based prey, and as such are considered potentially significant negative impacts.

The relationship between pool elevation and benthic invertebrate prey abundance has not been evaluated for Kachess Reservoir; however, fluctuations in the water level of aquatic habitats can reduce the diversity and quantity of benthic organisms that provide food for fish (Fisher and LaVoy, 1972). It is expected that when the reservoir elevation is reduced following drought years, the prolonged lower water levels would reduce availability of benthic invertebrates (i.e., prey) in nearshore areas compared to *Alternative 1 – No Action*. The benthic invertebrate community in Kachess Reservoir is already very limited and has been reduced by existing operations (Mongillo and Faulconer, 1982). Further reduction in operational elevations would affect those remaining invertebrate species, such as midges. Decreased availability of benthic invertebrate prey would negatively affect fish species. Fishes potentially affected include all reservoir species: mountain whitefish, cutthroat trout, rainbow trout, eastern brook trout, longnose dace, leopard dace, speckled dace, chiselmouth, redside shiner, peamouth, northern pikeminnow, largescale sucker, mountain sucker, threespine stickleback, sculpins, kokanee, burbot, and pygmy whitefish.

The relationship between zooplankton abundance and hydraulic residence time has not been evaluated for Kachess Reservoir, but the biomass and diversity of zooplankton is typically positively correlated with hydraulic residence time (Obertegger et al., 2007). Therefore, it is expected that reductions in hydraulic residence time would decrease the availability of zooplankton prey for fish species within the reservoir. Over the entire range of years considered in the modeling described in Section 4.3 (1925 to 2009), average hydraulic residence time drops from 686 days under *Alternative 1 – No Action* to 628 days under *Alternative 2A – East Shore Pumping Plant* (8.5 percent; Table 4-37). In drought years, similar declines are expected. The hydraulic residence time for conditions similar to the 1994 drought year would be 235 days under *Alternative 2A – East Shore Pumping Plant* compared to 791 under *Alternative 1 – No Action* (70.0 percent decline). Under conditions similar to 2001, the hydraulic residence time would be 616 days compared to 676 days under the baseline (8.8 percent decline).

Table 4-37. Kachess Reservoir Mean Hydraulic Residence Times in Days

Modeled Year	Alternative 1 – No Action	Alternative 2A	Change[1]	Alternative 3A	Change[1]	Alternative 4	Change[1]
1925-2009							
Annual	686	628	-58	590	-96	528	-158
Annual maximum	947[1]	1,976[2]	1,029	932[3]	-15	769[4]	-178
Annual minimum	391[5]	219[6]	-172	356[7]	-35	212[8]	-179
1994 (Drought Year)	791	235	-556	689	-102	237	-554
2001 (Drought Year)	676	616	-60	541	-135	352	-324

Note: Calculations are based on the total reservoir volume, including active and inactive storage.

[1]Year of highest *Alternative 1* maximum = 1941

[2]Year of highest *Alternative 2A* maximum = 1946

[3]Year of highest *Alternative 3A* maximum = 1941

[4]Year of highest *Alternative 4* maximum = 1964

[5]Year of lowest *Alternative 1* minimum = 1934

[6]Year of lowest *Alternative 2A* minimum = 1945

[7]Year of lowest *Alternative 3A* minimum = 1934

[8]Year of lowest *Alternative 4* minimum = 1931

When hydraulic residence time drops to very short periods, zooplankton populations may not develop adequately to support fish populations. Brook and Woodward (1956) found that the residence time had to be greater than 18 days for significant development of zooplankton. Hayward and Van Den Avyle (1986) observed a residence time of at least 50 to 250 days was sufficient for establishment of plankton populations that reflected the productive potential of a reservoir.

The modeled hydraulic residence times for Kachess Reservoir under *Alternative 2A – East Shore Pumping Plant* appear to be sufficient to support significant zooplankton populations (Brook and Woodward, 1956; Hayward and Van Den Avyle, 1986). However, what remains unclear is the extent to which zooplankton abundance may be incrementally reduced by shorter hydraulic residence times under *Alternative 2A – East Shore Pumping Plant* operations. Reduced zooplankton abundance may limit food resources available to resident fish in Kachess Reservoir.

Because zooplankton is the major basis for fish production in Kachess Reservoir (Mongillo and Faulconer, 1982), a reduction in zooplankton abundance would likely diminish the survival and productivity of fish that feed on zooplankton (Welker et al., 1994; Dettmers et al., 2003) and secondarily on predatory fish that feed on zooplanktivores (McQueen et al., 1986). The impact may be significant because alternative prey is scarce and the existing reservoir ecosystem is based on zooplankton (Mongillo and Faulconer, 1982).

The severity of impact would also be influenced by persistence of drought conditions over time. Droughts that result in losses of zooplankton over multiple years could compound reductions in the abundance and diversity of resident fish species due to loss of prey. All reservoir fish species would likely be affected by a loss of zooplankton prey during drought years. Future restoration of sockeye salmon would also be negatively impacted because juvenile sockeye feed primarily on zooplankton in reservoir habitats.

Following drought periods, lower reservoir levels may also reduce shoreline vegetation (Busch and Smith, 1995) that provides cover and habitat complexity for fish (Tabor and Wurtsbaugh, 1991; Braatne et al., 2007). The loss of nearshore habitat complexity may reduce the productivity of habitat for some resident fish species (Sass et al., 2006). Reduced habitat complexity is expected to affect littoral species such as mountain whitefish, cutthroat trout, rainbow trout, eastern brook trout, longnose dace, leopard dace, speckled dace, chiselmouth, redside shiner, peamouth, northern pikeminnow, largescale sucker, mountain sucker, threespine stickleback, and sculpins.

Lower reservoir levels after drought years may also contribute to increased reservoir temperatures (Furey et al., 2004). Higher air temperatures resulting from climate warming may directly increase temperatures within tributary and reservoir habitats independent of operations (Mantua et al., 2010). Higher water temperature may decrease the suitability of reservoir and tributary habitats for some fish species as temperatures exceed the thermal tolerance of affected species (Eaton and Scheller, 1996; Schindler, 2001; Mantua et al., 2010). The absence of thermally suitable habitat may reduce the survival and productivity of species that are adapted to cooler habitats, such as native salmonids (Mantua et al., 2010). These changes could result in areas where salmonid fish populations would not be supported, and as such, could be considered a significant negative impact. As part of project mitigation (Section 4.4.9.2), Reclamation and Ecology would implement a water quality monitoring program to document changes in water temperature.

Following drought years, the inability to refill the reservoir to baseline levels may also contribute to existing passage issues for resident fish between tributary and reservoir habitats (Ackerman et al., 2002; Reiss et al., 2012). Kachess Reservoir would be below the level at which fish passage into tributary streams is impeded (elevation 2,226) in 89 percent of years, an increase of 1 percent from *Alternative 1 – No Action*. The mean duration would be 164 days per year, an increase of 55 days per year. The increased frequency and duration would have a significant impact on connectivity between tributary and reservoir habitats. Passage barriers resulting from drought years would reduce the availability of tributary habitats for existing resident species as well sockeye and coho that may be introduced in the future. The most significant tributary habitats that may be affected by low reservoir conditions include Kachess River, Box Canyon Creek, Gale Creek, Thetis Creek, and Lodge Creek, which were assessed as potential habitats that could support anadromous salmonids under future restoration scenarios (Reclamation, 2005b). At low reservoir elevations, streamflows in Box Canyon Creek and Kachess River tend to go subsurface or become widely dispersed in braided channels. These conditions create a potential fish-stranding situation and barriers to passage, and would be considered a negative impact. In the absence of appropriate mitigation, these impacts could be significant for migrating resident fish such as trout.

The reduction in minimum reservoir elevation under *Alternative 2A – East Shore Pumping Plant* may also contribute to increased turbidity within Kachess Reservoir. When reservoir levels drop below the existing outflow level, portions of the reservoir bed that have accumulated fine sediments would be exposed to wave action and storm events. It is expected that these sediments would be mobilized and would increase turbidity levels within the reservoir. The impacts of turbidity on fish are described in Section 4.6.4.1. Impacts due to increased turbidity would occur during and after drought years when reservoir levels are below elevation 2,192. Short-term exceedances of State surface water quality standards for turbidity may occur during and immediately following runoff events (see Water Quality Section 4.4.4.2). These impacts would not result in severely limited habitat over the long term, and as such, are not considered significant.

Entrainment risks posed by operation of the new intake are expected to be low for salmonids because fish screens would be installed. Entrainment is still possible, however, and may cause mortality for resident species such as burbot, whose larval stages are small enough to pass through screens (e.g., Jensen et al., 1982; Mansfield et al., 1983; Weisberg et al., 1987), resulting in negative impacts on those species.

Kachess River

In nondrought years, Reclamation would manage reservoir outlet operations much as it does at present. In declared drought years, Reclamation would operate KDRPP and lower the reservoir intake to release more water. The water released from Kachess Reservoir under *Alternative 2A – East Shore Pumping Plant* would support irrigation needs and therefore would not address annual instream flow objectives for the Kachess River downstream from Kachess Dam.

During drought years, average July river flows would increase significantly under *Alternative 2A – East Shore Pumping Plant* (Table 4-7 in Section 4.3.4). Existing summer flows in the Kachess River downstream from Kachess Dam are already higher than the natural flow regime, and additional summer flows during drought years would not benefit fish. The Kachess River is a lesser priority for improving river flow because of other objectives in the Integrated Plan (Reclamation and Ecology, 2012, Section 5.3.2.1). Given that it could contribute to inconsistency with the natural flow regime, this higher flow is considered a negative impact; however, because the Kachess River is a lesser priority for river flow, it is not considered significant.

Keechelus Reservoir

Under *Alternative 2A – East Shore Pumping Plant*, reservoir levels, both minimum and maximum, would generally decrease following drought years. In other years the reservoir level would not change from *Alternative 1 – No Action* (Figure 4-4 in Section 4.3, Surface Water Resources).

The relative pool elevations for conditions under *Alternative 1 – No Action* versus *Alternative 2A – East Shore Pumping Plant* are depicted in Figure 4-4 (Section 4.3, Surface Water Resources) for the period of November 1, 1991 to November 1, 2009. Minimum and maximum pool elevations for *Alternative 2A – East Shore Pumping Plant* tend to be significantly lower from fall 1992 to fall 1994, and from fall 2002 to fall 2003, reflecting refill from drought conditions. Based on these results, it is expected that negative impacts would occur following drought years, when KDRPP operation would reduce Keechelus Reservoir elevations relative to *Alternative 1*.

Decreased post-drought pool elevations could cause impacts including decreases in benthic invertebrate prey, zooplankton prey, habitat complexity, and habitat connectivity between reservoir and tributary habitats, as well as temperature changes within the reservoir.

Under *Alternative 2A – East Shore Pumping Plant*, it is expected that lower reservoir levels and decreases in hydraulic residence time would cause a small reduction in the availability of zooplankton and benthic invertebrate prey for fish species within the Keechelus Reservoir (Table 4-38). As such, the negative impact is not considered significant. The general interactions between reservoir level, hydraulic residence time, and prey abundance are the same as those for Kachess Reservoir, as discussed in Section 4.6.4.2.

Table 4-38. Keechelus Reservoir Mean Hydraulic Residence Times in Days

Modeled Year	Alternative 1 – No Action	Alternative 2A	Change[1]	Alternative 3A	Change[1]	Alternative 4	Change[1]
1925-2009							
Annual	128	125	-3	127	-1	117	-11
Annual maximum	167[1]	167[2]	0	168[3]	1	168[4]	1
Annual minimum	65[5]	57[6]	-8	64[7]	-1	57[8]	-8
1994 (Drought Year)	81	72	-9	102	21	69	-12
2001 (Drought Year)	99	90	-9	122	23	93	-6

Note: Calculations are based available data for the active storage portion of the reservoir.

[1]Year of highest *Alternative 1* maximum = 1962

[2]Year of highest *Alternative 2A* maximum = 1962

[3]Year of highest *Alternative 3A* maximum = 1925

[4]Year of highest *Alternative 4* maximum = 1925

[5]Year of lowest *Alternative 1* minimum = 1930

[6]Year of lowest *Alternative 2A* minimum = 1929

[7]Year of lowest *Alternative 3A* minimum = 1988

[8]Year of lowest *Alternative 4* minimum = 1930

Following drought years, habitat suitability for resident fish may be affected by decreased reservoir levels and reduced shoreline vegetation. These impacts would be the same as those for Kachess Reservoir, as discussed in Section 4.6.4.2. Decreased reservoir levels could result in more surface heating and a minor increase in water temperature during the summer months as the reservoir pool level recovers to nondrought conditions. However, the predicted changes in temperature are expected to be minimal (Section 4.4, Water Quality) and therefore not result in significant impacts on fish. As part of project mitigation (Section 4.4.9.2), a water quality monitoring program would be implemented to document changes in water temperature.

Following drought years, the inability to refill the reservoir to existing levels may also exacerbate existing passage issues for resident fish between tributary and reservoir habitats (Ackerman et al., 2002; Reiss et al., 2012). Keechelus Reservoir would be below the level at which fish passage to tributary streams is impeded (elevation 2,466) in 82 percent of the years, an increase of 1 percent from *Alternative 1 –No Action*. This increased frequency would be matched by a 10-day increase in duration, to a mean of 125 days. Decreased connectivity between the reservoir and tributaries would reduce the availability of tributary habitats for existing resident species as well as for sockeye and coho that may be introduced in the future. The most significant tributary habitats that could be affected by low reservoir conditions include Meadow Creek, Gold Creek, Cold Creek, Mill Creek, Coal Creek, and Townsend Creek, which have been identified as potentially suitable for future salmon restoration (Reclamation, 2005b). These changes would result in reduced connectivity, and are therefore considered a significant negative impact on fish resources.

Yakima River

Keechelus Reach. Under *Alternative 2A – East Shore Pumping Plant,* streamflows would change slightly, as summarized in Table 4-8, Table 4-34, and Appendix E, Figure E-2. However, streamflows in Keechelus Reach under *Alternative 2A – East Shore Pumping Plant* would remain within current operating ranges, with no decrease in most years; therefore, no benefit to instream flow in the Keechelus Reach would occur (Section 4.3.4.2) and no impacts on fish are expected.

Easton Reach. Under *Alternative 2A – East Shore Pumping Plant*, streamflows in Easton Reach would change slightly from *Alternative 1 –No Action,* as summarized in Table 4-9 and illustrated in Appendix E, Figure E-3. Because the slight flow increase during drought years in the Easton Reach and downstream along the Yakima River to Roza Dam would remain within current operating flows experienced in most years, no significant impact on flow conditions would result (Section 4.3.4.2) and no impacts on fish are expected.

Bull Trout Enhancement

The Gold Creek passage and habitat improvements would provide long-term solutions to address threats to bull trout posed by dewatering and seasonal passage barriers within the

Gold Creek tributary. The Gold Creek bridge replacement would improve passage conditions in Gold Creek and restore floodplain and channel-forming processes to a more natural state. These changes would support the goal of increasing abundance through improving connectivity with important spawning and rearing habitats. The improvements are expected to improve habitat connectivity within Gold Creek and between reservoir and tributary habitats.

The Cold Creek passage improvements are expected to improve habitat connectivity within Cold Creek and between reservoir and tributary habitats. Improved habitat connectivity would increase access to rearing and spawning habitats for resident fish. Additionally, improved access to Gold Creek habitats would provide additional spawning and rearing habitat for anadromous species when future passage is provided at Keechelus Dam.

4.6.5 Alternative 2B – KDRPP South Pumping Plant

4.6.5.1 Construction

KDRPP South Pumping Plant Facilities

Kachess Reservoir

Construction of facilities for *Alternative 2B – KDRPP South Pumping Plant* is expected to be completed over 3 years. For most facilities, construction impacts on fish would be similar to those described for *Alternative 2A – East Shore Pumping Plant* (Section 4.6.4.1). The two exceptions are as follows. First, a TBM would be used to construct the intake and tunnel. Second, construction of the south pumping plant would have a smaller footprint because it would be located adjacent to existing project infrastructure, whereas the east shore pumping plant includes development of a new site and additional access roads and site preparation.

Under *Alternative 2B – South Pumping Plant*, construction impacts on fish would be smaller than those under *Alternative 2A – East Shore Pumping Plant*. The use of a TBM would reduce disturbances caused by sound and turbidity (e.g., no blasting and less disturbance of reservoir bed). Additionally, the smaller project footprint would reduce the area of shoreline disturbance and potential for upland erosion. The impacts of noise and turbidity on fish are as described in Section 4.6.4.1 for Kachess River, and would not cause long-term negative impacts.

Kachess River

Under *Alternative 2B – South Pumping Plant*, construction impacts on fish would be the same as those under *Alternative 2A – East Shore Pumping Plant* (Section 4.6.4.1).

Keechelus Reservoir

Under *Alternative 2B – South Pumping Plant*, no construction activities would occur at Keechelus Reservoir. All project facilities would be located downstream from Keechelus Dam. No construction-related impacts would occur.

Bull Trout Enhancement
Construction impacts associated with the BTE improvements would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.6.4.1).

4.6.5.2 Operation

KDRPP South Pumping Plant Facilities
Under *Alternative 2B – South Pumping Plant*, KDRPP operations would be the same as those under *Alternative 2A – East Shore Pumping Plant.* Therefore, impacts on fish would be the same.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.6.4.2).

4.6.6 Alternative 3A – KKC North Tunnel Alignment

4.6.6.1 Construction

KKC North Tunnel Alignment Facilities
Kachess Reservoir
Alternative 3A – KKC North Tunnel Alignment would impact fish in Kachess Reservoir through construction activities related to the following project elements:

- Kachess Lake Road portal and discharge structure could increase turbidity and result in decreased habitat complexity.
- Kachess Reservoir spillway and stilling basin could increase turbidity and result in changes in shoreline structure.

The Kachess Lake Road portal would be constructed on the west shore of Kachess Reservoir near Kachess Lake Road (Figure 2-8). The portal would include an at-grade concrete discharge structure. The discharge structure would connect to Kachess Reservoir through an energy dissipation spillway channel and stilling basin (Figure 2-9). The energy dissipation spillway and stilling basin would likely be constructed during the fall months when the reservoir is (or could be) drawn down to its lowest elevation, thus permitting construction of the outlet in dry or shallow-water conditions. A sheet pile cofferdam and localized dewatering would likely be required to install the outlet structure. Depending upon the geology of the slope below the stilling basin, riprap may also need to be installed on the slope below the stilling basin. The total construction period for *Alternative 3A – KKC North Tunnel Alignment* would be approximately 3 years.

The staging, site preparation, and construction of these project elements would disturb shoreline vegetation and mobilize sediments, which could raise turbidity and decrease habitat complexity. These impacts would be similar to those described for *Alternative 2A – East Shore Pumping Plant* as described in Section 4.6.4.1 and are not expected to be significant.

Potential impacts would be reduced by BMPs, such as following sediment and erosion control plans, performing construction in-the-dry where practicable, and revegetating disturbed areas after construction.

Construction impacts from turbidity would be temporary, ceasing after construction is completed. Permanent loss of shoreline vegetation would occur within the footprint of the portal, discharge structure, spillway, and stilling basin facilities. The total surface area of the permanent facilities (adjacent to Kachess Reservoir) is expected to be approximately 6 acres. The permanent loss of vegetation associated with these facilities is expected to have a small impact on fish within Kachess Reservoir because it would affect less than 1 percent of the total shoreline of the reservoir.

Kachess River
Under *Alternative 3A – KKC North Tunnel Alignment*, no construction activity would occur within the Kachess River.

Keechelus Reservoir
No construction activities are proposed within the Keechelus Reservoir. All construction would be in the area downstream from the dam.

Yakima River
Alternative 3A – KKC North Tunnel Alignment would impact fish in the Yakima River through construction activities related to the following project elements:

- Yakima River diversion fish screens and intake would increase turbidity, increase noise, and result in potential reductions in habitat complexity.
- Yakima River diversion to Keechelus portal conveyance would alter access downstream of Keechelus Dam.

The Yakima River diversion, fish screens, and intake would be constructed behind a temporary cofferdam to maintain flow in the Yakima River during construction. Dewatering would also likely be required to maintain a dry site behind the cofferdam until the foundation slabs and walls were constructed.

Inwater work associated with construction of the diversion is expected to disturb or displace fish in the vicinity of the construction area. Inwater construction would mobilize sediments and increase turbidity levels. The installation of cofferdams and use of heavy equipment may also increase noise above normal levels and could disturb fish. The staging, site preparation, and construction of these upland project elements would disturb a small amount of riparian vegetation, mobilize sediments, and may result in increased turbidity and decreased habitat complexity adjacent to the Yakima River. The impacts of turbidity and loss of habitat complexity on fish are described in Section 4.6.4.1.

Because the majority of construction would occur in areas that are already disturbed, most construction impacts are expected to be temporary and would cease after construction is completed and disturbed areas are restored. The exception would be the Yakima River diversion, which would alter access to the existing rock-lined channel about 500 feet downstream from the end of the existing concrete outlet from Keechelus Dam. This portion of the river has low habitat value because of scouring flows immediately downstream from Keechelus Dam. The new diversion would create a velocity barrier that would limit fish passage during conveyance operations. The diversion is not expected to negatively impact fish because there is currently no fish passage at the Keechelus Dam. The diversion would be designed to accommodate potential future fish passage at Keechelus Dam.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.6.4.1).

4.6.6.2 Operation

KKC North Tunnel Alignment Facilities

Kachess Reservoir

Under *Alternative 3A – KKC North Tunnel Alignment*, Kachess Reservoir elevations would be similar to those of *Alternative 1 – No Action* conditions on average (Figure 4-5, Table 4-12). Operational flexibility would increase with *Alternative 3A – KKC North Tunnel Alignment*, allowing for slightly greater drawdown of Kachess Reservoir during drought years. Under *Alternative 3A – KKC North Tunnel Alignment*, simulated annual maximum reservoir elevations tend to be higher and minimum elevations tend to be lower. In drought years, such as 1994 and 2001, the difference between minimum and maximum elevation would increase. This increase in the annual range between minimum and maximum reservoir elevation would affect existing habitat connectivity between reservoir habitats, impact connectivity between tributary and reservoir habitats, influence the availability of zooplankton and invertebrate prey, and reduce habitat complexity.

Under *Alternative 3A – KKC North Tunnel Alignment*, lower reservoir levels would result in slightly more frequent and longer separation of Kachess and Little Kachess basins within Kachess Reservoir (Table 4-36). The Kachess Reservoir pool level would be below the elevation at which the two lake basins become separated (elevation 2,220) (and at which fish can no longer pass between the two) in 75 percent of years, an increase of 2 percent from *Alternative 1 – No Action*. The mean duration of this condition would be 92 days per year, an increase of 5 days per year relative to *Alternative 1*. Based on these small changes, impacts on within-reservoir habitat connectivity are not expected to be significant for fish species compared to *Alternative 1 – No Action*.

Connectivity between reservoir and tributary habitats is not expected to change significantly under *Alternative 3A – KKC North Tunnel Alignment*. In most years (88 percent), Kachess

Reservoir would be below the level that impedes fish passage to tributary streams (elevation 2,226), representing no change from *Alternative 1 – No Action*. The mean duration of this effect would be 112 days per year, an increase of 3 days per year.

Reductions in Kachess Reservoir elevation and persistence of lower elevations for longer periods of time would likely reduce the abundance of invertebrate prey. The relationship between reservoir levels and invertebrate prey abundance is described in Section 4.6.4.2.

Under *Alternative 3A – KKC North Tunnel Alignment*, hydraulic residence time would decrease for Kachess Reservoir (Table 4-37), likely resulting in somewhat decreased abundance of zooplankton prey. The relationship between hydraulic residence time and zooplankton abundance is described in Section 4.6.4.2. The modeled hydraulic residence times for *Alternative 3A - KKC North Tunnel Alignment* appear to be sufficient to support significant zooplankton populations (Brook and Woodward, 1956; Hayward and Van Den Avyle, 1986). However, what remains unclear is the extent to which zooplankton abundance may be incrementally reduced by shorter hydraulic residence times under KKC operations. Reduced zooplankton abundance may limit food resources available to resident fish in Kachess Reservoir.

Larger fluctuations in reservoir elevations under *Alternative 3A – KKC North Tunnel Alignment* may also reduce shoreline vegetation (Busch and Smith, 1995) that provides cover and habitat complexity for fish. The loss of habitat complexity may reduce the productivity of habitat for some resident fish species as described in Section 4.4.4.2.

The conveyance of 400 cfs from Keechelus Reservoir to refill Kachess Reservoir could result in a small temperature change in some portion of Kachess Reservoir, transfer nutrients to Kachess Reservoir, and potentially introduce disease or invasive species from Keechelus Reservoir to Kachess Reservoir. However, as described in Section 4.4.6, temperature changes are expected to be relatively localized, and would generally result in slightly cooler temperatures in Kachess Reservoir. Therefore, a significant impact on fish is not expected. As part of project mitigation (Section 4.4.9.2), a water quality monitoring program would be implemented to document changes in water temperature.

It is expected that the transfer of significant amounts of water from Keechelus Reservoir to Kachess Reservoir could have a minor effect on the productivity of Kachess Reservoir. Keechelus Reservoir is more productive than Kachess Reservoir based on nutrient levels, primary production, and zooplankton abundance (Mongillo and Faulconer, 1982). However, both reservoirs are oligotrophic (unproductive), so the transfer of nutrients, phytoplankton, or zooplankton is not expected to significantly change the productivity of Kachess Reservoir (from oligotrophic to something more productive) or result in significant impacts on fish in Kachess Reservoir.

The transfer of water from Keechelus Reservoir to Kachess Reservoir could increase the risk that diseases or exotic species established in Keechelus Reservoir are transferred to Kachess Reservoir. The impacts of either disease or exotic species could be significant for resident fish species that have been isolated from other waters of the upper Yakima basin. Diseases and exotic species may reduce the productivity and survival of native fish species (Ellis et al., 2011; Oidtmann et al., 2011). The risk of disease transmission would likely be similar to other situations where anadromous salmon are reintroduced above barriers to passage (Brenkman et al., 2008).

Kachess River
Under *Alternative 3A – KKC North Tunnel Alignment*, instream flow (based on 1925 to 2009 period of record) in the Kachess River downstream from Kachess Dam is predicted to increase in all seasons compared to existing conditions (Table 4-14 in Section 4.3.6), including drought years. Existing summer flows in the Kachess River are already higher than the natural flow regime, and additional summer flows during drought years would not benefit fish. Kachess River is a lesser priority for improving river flow because of other objectives in the Integrated Plan (Reclamation and Ecology, 2012, Section 5.3.2.1).

Keechelus Reservoir
Under *Alternative 3A – KKC North Tunnel Alignment*, no change is predicted in the average Keechelus Reservoir pool elevation (based on the 1925 to 2009 record). However, the average annual maximum reservoir pool elevation is predicted to decrease, and the average annual minimum reservoir pool elevation is predicted to increase (Table 4-13 in Section 4.3.6).

During drought years such as 1994 and 2001, the difference between minimum and maximum reservoir elevations would decrease (Figure 4-6 in Section 4.3, Surface Water Resources). However, pool elevation in Keechelus Reservoir would be below the elevation that restricts fish passage to tributary streams (elevation 2,466) in 71 percent of the years, a decrease of 10 percent from *Alternative 1 – No Action*. The mean duration of this condition would be 100 days per year, a decrease of 15 days per year, resulting in an improvement for fish access to tributary streams. The increase in frequency and duration of fish passage between reservoir and tributary habitats represents a significant benefit to fish by improving access to spawning and rearing habitats and seasonal refugia.

The proposed elevation changes under *Alternative 3A – KKC North Tunnel Alignment* would dampen reservoir fluctuations compared to *Alternative 1 – No Action*. The average fluctuation between maximum and minimum elevation would be reduced from 60.3 feet to 53.2 feet under *Alternative 3A – KKC North Tunnel Alignment*.

Reduced reservoir fluctuations may increase the diversity and abundance of benthic organisms that provide food for fish (Fisher and LaVoy, 1972). An increase in available prey would improve the survival and productivity of resident species. Reduced reservoir fluctuations would also encourage the development of stable riparian vegetation communities more typical of natural lakes (Nilsson and Berggren, 2000). Shoreline vegetation contributes to habitat complexity by providing cover for resident fish and prey species (Tabor and Wurtsbaugh, 1991).

On average the hydraulic residence time is expected to be similar to that under *Alternative 1 – No Action* (Table 4-38). However, during drought years, the hydraulic residence time is expected to increase. Increased hydraulic residence time would increase the abundance of zooplankton, which provides food for resident fish species. The relationship between hydraulic residence time and zooplankton abundance is described in Section 4.6.4.2.

Yakima River

Keechelus Reach. Under *Alternative 3A – KKC North Tunnel Alignment*, instream flow targets would be met significantly more often in summer months than under *Alternative 1 – No Action* (Table 4-34). Meeting the summer flow targets would increase suitable habitat for fish species.

When flows in the Keechelus Reach meet summer flow targets, the productivity of spring Chinook is expected to be similar to that of the Easton Reach. Using data obtained from NMFS, Reclamation calculated the productivity of the Keechelus Reach based on productivity parameters from the Easton Reach. Assuming maximum carrying capacity, the average number of spring Chinook salmon produced in the Keechelus Reach would potentially increase from 169 (under *Alternative 1 – No Action*) to 1,477 during years when summer flows are at the 500 cfs target. Increases in productivity are expected to require at least 10 consecutive years during which summer instream flow targets are met (Hubble, 2014a). The general benefits of improved habitat function associated with summer flow targets in the Keechelus Reach are discussed in Section 4.6.4.2.

During winter and spring, flows are expected to meet the Keechelus Reach instream flow target slightly less often than under *Alternative 1 – No Action* (Table 4-34). During years when flow targets are not met, the availability of salmonid spawning and rearing habitats would decrease; this decrease may reduce the productivity and survival of fish occupying the Keechelus Reach (Reclamation and Ecology, 2011c).

Easton Reach. Under *Alternative 3A – KKC North Tunnel Alignment*, instream flow targets would be met at a frequency similar to that of *Alternative 1 – No Action* (Table 4-35). Based on hydraulic modeling results, average instream flows would be nearly the same as baseline conditions; however, during drought years, flows would be slightly higher (Table 4-16 in Section 4.3.6). The increase in streamflow during drought years would not have a significant effect on overall Yakima River streamflow conditions because the flows would remain within current operating ranges (Section 4.3.6.2) and impacts on fish would be the same as those expected under *Alternative 1 – No Action.*

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.6.4.2).

4.6.7 Alternative 3B – KKC South Tunnel Alignment

4.6.7.1 Construction

KKC South Tunnel Alignment Facilities
Kachess Reservoir
Under *Alternative 3B – KKC South Tunnel Alignment*, construction impacts would be similar to those described for *Alternative 3A – KKC North Tunnel Alignment* (Section 4.6.6.1). The primary difference is the location of the Kachess Reservoir portal and discharge structure. Under *Alternative 3B – KKC South Tunnel Alignment*, a tunnel exit portal and discharge structure would be located at the Kachess Reservoir west shoreline on a USFS-managed parcel located below a residential development (see Figure 2-11). A discharge structure would be constructed at the end of the tunnel at the shoreline. The construction of the portal and discharge structure would cause the same construction-related impacts as described for Alternative 3A.

Kachess River
Under *Alternative 3B – KKC South Tunnel Alignment*, no construction activity would occur within the Kachess River. Therefore, this alternative would have no impact on the Kachess River.

Keechelus Reservoir
Under *Alternative 3B – KKC South Tunnel Alignment*, no construction activities are proposed within the Keechelus Reservoir. All construction would be in the area downstream from the dam. Therefore, this alternative would have no impact on Keechelus Reservoir.

Yakima River
Under *Alternative 3B – KKC South Tunnel Alignment*, construction impacts would be similar to those described in Section 4.6.6.1. One difference is that construction activities related to the I-90 portal would be relatively close to the Yakima River. Sediment mobilized during construction could be conveyed in runoff to the Yakima River, potentially increasing turbidity.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.6.4.1).

4.6.7.2 Operation

KKC South Tunnel Alignment Facilities
Reclamation would operate the KKC the same as described for *Alternative 3A – KKC North Tunnel Alignment* regardless of the tunnel alignment. Operation impacts would be identical

to those described for *Alternative 3A – KKC North Tunnel Alignment,* as described in Section 4.6.6.2.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.6.4.2).

4.6.8 Alternative 4 – Combined KDRPP and KKC Projects

4.6.8.1 Construction

KDRPP and KKC Facilities
Construction impacts would include those described individually for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.6.4.1) and *Alternative 3A – KKC North Tunnel Alignment* (Section 4.6.6.1). Because KDRPP and KKC would occur in different locations, construction-related impacts are not expected to combine to create significantly greater negative impacts. Some of the same water bodies would be affected, but the location and timing of the temporary construction impacts would prevent significant combined impacts on any of those waterbodies.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.6.4.1).

4.6.8.2 Operation

KDRPP and KKC Facilities
Kachess Reservoir
The impacts resulting from *Alternative 4 – Combined KDRPP and KKC* on Kachess Reservoir include those identified for KDRPP and KKC individually. Expected impacts include reductions in benthic invertebrate prey abundance, zooplankton prey abundance, habitat complexity, connectivity within reservoir habitats, and connectivity between reservoir and tributary habitats; an increase in temperature within the reservoir basin; a small increase in nutrient levels within Kachess Reservoir; and increased exposure to exotic species or diseases that may be present in Keechelus Reservoir but not in Kachess Reservoir. The significant negative and positive effects are described in Table 4-33.

Under *Alternative 4 – Combined KDRPP and KKC*, average and minimum reservoir pool elevations are predicted to decrease compared to *Alternative 1 – No Action*, and more significantly during and after drought years (Table 4-19 in Section 4.3). However, water conveyed from Keechelus Reservoir (through KKC) would allow Kachess Reservoir to fill during nondrought years and resume more typical operations than would occur under KDRPP alone (Figure 4-3 and Figure 4-7) (Thomas, 2014b).

Under *Alternative 4 – Combined KDRPP and KKC*, the number of years during which the two lake basins of Kachess Reservoir would become separated (elevation 2,220) would be 5 percent greater under Alternative 4 than under *Alternative 1 – No Action* (78 versus 73 percent), and for an additional 56 days (143 versus 87 days; Table 4-36). The decrease in frequency and duration of fish passage between lake basins would result in a significant negative impact on within reservoir connectivity for fish species and reduce access to spawning and rearing habitats or seasonal refugia. The number of years during which Kachess Reservoir water levels would fall below elevation 2,220 is higher under *Alternative 4 – Combined KDRPP and KKC* (78 percent) than under *Alternative 2A – KDRPP East Shore Pumping Plant* (74 percent) and *Alternative 3A – KKC North Tunnel Alignment* (75 percent). However, the number of days when the reservoir remains below elevation 2,220 (143 days) would be less than that under *Alternative 2A – KDRPP East Shore Pumping Plant* (165 days).

Under *Alternative 4*, access to tributary streams would be impeded (elevation 2,226) in 88 percent of the modeled years, representing no change from *Alternative 1 – No Action*. However, the mean duration would be 153 days, an increase of 44 days. The increased duration of reservoir levels below 2,226 feet would have a significant negative impact on fish passage and on connectivity between reservoir and tributary habitats. For all action alternatives, the frequency of reduced fish passage conditions would be nearly identical (88-89 percent), but under *Alternative 4*, the duration of reduced fish passage would be longer than that expected under *Alternative 3* (112 days) and shorter than that expected under Alternative 2 (164 days).

The significant reductions in Kachess Reservoir elevation during and after drought years, and persistence of lower elevations for longer periods of time would likely reduce the abundance of invertebrate prey. The impact of reservoir fluctuations on invertebrate abundance is described in Section 4.6.4.2.

Under *Alternative 4 – Combined KDRPP and KKC*, hydraulic residence time would decrease compared to *Alternative 1 – No Action* both on average and during drought years (Table 4-37). The decrease in hydraulic residence time would reduce the availability of zooplankton prey. The relationship between hydraulic residence time and zooplankton abundance is described in Section 4.6.4.2.

Similar to *Alternative 2A – KDRPP East Shore Pumping Plant,* the modeled hydraulic residence times for *Alternative 4 – Combined KDRPP and KKC* appear to be sufficient to support significant zooplankton populations (Brook and Woodward, 1956; Hayward and Van Den Avyle, 1986). However, what remains unclear is the extent to which zooplankton abundance may be incrementally reduced by shorter hydraulic residence times under *Alternative 4 – Combined KDRPP and KKC*. Reduced zooplankton abundance may limit food resources available to resident fish in Kachess Reservoir.

Effects of lower reservoir levels include potential reductions in survival and productivity of fish that feed on zooplankton, potential reductions in shoreline vegetation, increased reservoir temperatures, and passage barriers. These impacts are the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* in Section 4.6.4.2.

The conveyance of water through the KKC tunnel from Keechelus Reservoir to Kachess Reservoir could affect fish by increasing exposure to exotic species or to diseases that may be present in Keechelus Reservoir. Impacts on temperature and nutrient levels associated with water conveyance are expected to be minor and insignificant to fish. The impacts of water conveyance are the same as those discussed above for *Alternative 3A – KKC North Tunnel Alignment.*

The new intake (associated with the KDRPP portion of *Alternative 4 – Combined KDRPP and KKC*) may also pose an entrainment risk to resident fish that have small larval juvenile stages (i.e., species other than salmon and trout). This risk is described in Section 4.6.4.2.

Kachess River

Under *Alternative 4 – Combined KDRPP and KKC,* streamflow (based on 1925 to 2009 period of record) in the Kachess River below Kachess Dam is predicted to increase in all seasons compared to *Alternative 1 – No Action* (Table 4-23 in Section 4.3.8). During drought years, summer instream flow is also expected to increase (Table 4-23). Existing summer flows in the Kachess River are already higher than the natural flow regime, and additional summer flows during drought years would not benefit fish. Kachess River is a lesser priority for improving river flow because of other objectives in the Integrated Plan (Reclamation and Ecology, 2012).

Keechelus Reservoir

The impacts resulting from *Alternative 4 – Combined KDRPP and KKC* would include impacts identified for KDRPP and KKC individually. These include reductions in available prey, habitat complexity, and habitat connectivity between reservoir and tributary habitats, as well as temperature changes within the reservoir.

Under *Alternative 4 – Combined KDRPP and KKC*, Keechelus Reservoir average and maximum pool elevations would decrease compared to *Alternative 1 – No Action* (Table 4-21, Figure 4-8 in Section 4.3, Surface Water Resources). These changes would be more significant during and following drought years and would be greater than those expected under *Alternatives 2A – KDRPP East Shore Pumping Plant* and *Alternative 3A – North Tunnel Alignment*. Minimum pool elevations during drought years would remain similar to those under *Alternative 1 – No Action* but would be lower in post-drought years (Table 4-3). This could be a potentially significant negative impact because lower pool elevations following drought years (see years 2003 to 2006 in Figure 4-8 in Section 4.3, Surface Water Resources) may reduce the abundance of benthic invertebrates (i.e., prey).

Impacts of water level fluctuations on benthic invertebrates in Keechelus Reservoir are discussed in Section 4.6.4.2.

Under *Alternative 4 – Combined KDRPP and KKC*, hydraulic residence time would decrease compared to *Alternative 1 – No Action* both on average and during drought years (Table 4-38). *Alternative 4 – Combined KDRPP and KKC* would also result in an average hydraulic residence time (117 days) less than those of *Alternative 2A – KDRPP East Shore Pumping Plant* (125 days) and *Alternative 3A – KKC North Tunnel Alignment* (127 days). The decrease in hydraulic residence time under *Alternative 4 – Combined KDRPP and KKC* could reduce the availability of zooplankton prey. The relationship between hydraulic residence time and zooplankton abundance is described in Section 4.6.4.2.

Under *Alternative 4 – Combined KDRPP and KKC*, a reduction in shoreline vegetation and increase in post-drought temperature would be expected during and following drought years as a result of lower reservoir levels (Section 4.4.8). These negative impacts would be greater than those expected under *Alternatives 2A – KDRPP East Shore Pumping Plant* and *Alternative 3A – North Tunnel Alignment* and may contribute to conditions that reduce habitat complexity and suitability for resident fishes. These impacts are discussed in Section 4.6.4.2.

Under *Alternative 4*, fish passage between Keechelus Reservoir and tributary streams would be impeded (below elevation 2,466) in 74 percent of the modeled years, a decrease of 7 percent from *Alternative 1 – No Action*. The duration of this condition would be 130 days per year, an increase of 15 days per year. Collectively, the beneficial impact of the decrease in frequency and negative impact of increased duration of impeded fish passage are expected to offset one another and not significantly change connectivity between reservoir and tributary habitats compared to *Alternative 1 – No Action*. *Alternative 4* would have tributary connectivity impacts intermediate between the negative fish passage conditions anticipated under *Alternative 2* and beneficial fish passage conditions anticipated under *Alternative 3*.

Yakima River

Keechelus Reach. Under *Alternative 4 – Combined KDRPP and KKC*, summer instream flow targets would be met much more frequently than under existing baseline (Table 4-34), considered a beneficial impact Additionally, average summer flows would also remain low during drought years (Table 4-24, in Section 4.3.8). Under *Alternative 4 – Combined KDRPP and KKC*, July instream flow targets would be met much more often (i.e., during more than 94 to 96 percent of years) than under *Alternative 2A – KDRPP East Shore Pumping Plant* (3.7 percent) but slightly less often than under *Alternative 3A – KKC North Tunnel Alignment* (99.1 percent).

When flows in the Keechelus Reach meet summer flow targets, the productivity of spring Chinook is expected to be similar to that of the Easton Reach. Using data obtained from

NMFS (Hubble, 2014b), Reclamation calculated the productivity of the Keechelus Reach based on productivity parameters from the Easton Reach. Assuming maximum carrying capacity, the average number of spring Chinook salmon produced in the Keechelus Reach would potentially increase from the of 169 (under *Alternative 1 – No Action*) to 1,477 during years when summer flows are at the 500 cfs target. Increases in productivity are expected to require at least 10 consecutive years when summer instream flow targets are met (Hubble, 2014a). The benefits of lower summer flows to fish are further described in Section 4.6.4.2.

During winter, spring, and fall, flows are expected to meet the Keechelus Reach instream flow target for *Alternative 4 – Combined KDRPP and KKC* at nearly the same frequency as operations under *Alternative 1 – No Action* (Table 4-34). The impacts on fish from winter, spring, and fall flows under *Alternative 4 – Combined KDRPP and KKC* are expected to be similar to those of *Alternative 1 – No Action*.

Easton Reach. Under Alternative 4, instream flow targets would be met at a frequency similar to that under *Alternative 1 – No Action* (Table 4-35) for winter, spring, and fall. During summer, the instream target would be met less often. Hydraulic modeling results (based on 1925 to 2009 period of record) show that during drought years, summertime flows would be higher (Table 4-25 in Section 4.3.8.2). The increase in flow caused by operation of KDRPP would be moderated at the diversion for KRD at the head of the Easton Reach. The change in flows would be within current operating ranges and would not have a significant effect on streamflow in the Easton Reach. The impacts on fish species are the same as those described for Easton Reach in Section 4.6.4.2.

Overall, streamflow in the Yakima River in the Easton Reach and in downstream reaches under *Alternatives 2, 3,* and *4* would not cause flows to extend outside of current operational ranges and the alternatives would not significantly affect streamflow conditions (Section 4.3.8.2) or significantly impact fish.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.6.4.2).

4.6.9 Mitigation Measures

4.6.9.1 Construction Mitigation

As part of the project, Reclamation would use BMPs to reduce sediment mobilization and turbidity levels as described in Sections 4.2.9 and 4.4.9. All construction would comply with applicable Federal, State and local regulations. Additionally, temporary construction and staging areas would be regraded and replanted with native vegetation.

4.6.9.2 Operation Mitigation

To mitigate for fish passage issues associated with the lower minimum pool elevation at Kachess Reservoir, Reclamation is evaluating a number of conceptual passage projects. These projects focus on ensuring fish passage between Box Canyon Creek and Kachess Reservoir, and ensuring fish passage between Little Kachess and Kachess basins within Kachess Reservoir. Reclamation would continue to study options with the intention of providing long-term solutions to improving fish passage in the project area.

Reclamation would adaptively manage the existing emergency monitoring and passage program to be responsive to increased passage risk into bull trout spawning tributaries. This effort would include monitoring for new or increased occurrence of barriers to spawning tributaries caused by reservoir drawdown operations. Reclamation would also provide emergency passage for bull trout if permanent facilities are not in place to address passage barriers affected by operations.

Reclamation would construct permanent fish passage structures or habitat modifications to minimize or fully address potential passage barriers that result from operations at the following locations:

- Between Kachess Reservoir and Lower Box Canyon Creek
- Between Kachess Reservoir and Little Kachess basin
- Between Keechelus Reservoir and Gold Creek

Reclamation would also install permanent fish passage facilities where appropriate at other locations identified as part of the emergency monitoring and passage program.

Reclamation would support a study to examine reservoir productivity and food web impacts from future use of Kachess Reservoir inactive storage expected under the action alternatives. Specifically, this study would examine the relationships between operations and the productivity of the reservoir at different levels in the food chain and examine potential effects of greater reservoir fluctuations and changes in hydraulic residence time. Reclamation would also address increased risk of entrainment associated with the new KDRPP and KKC facilities, including installation of screening on all new diversions and pumps.

All mitigation activities would comply with Federal, State, and local regulations as well as ESA consultation requirements with the Service and NMFS.

4.7 Vegetation and Wetlands

4.7.1 Methods and Impact Indicators

Potential impacts on wetlands and other vegetation communities are primarily related to the following:

- Activities associated with the construction of KDRPP and KKC facilities and BTE
- Changes in Keechelus and Kachess reservoir water surface elevations and potential downstream effects on the Kachess River and Keechelus Reach of the Yakima River during project operation

Methods. Construction and operation impacts under each alternative were estimated using existing information gathered from the Service (2013) National Wetland Inventory (NWI) Geographic Information System (GIS) database, observations from an August 2014 field visit, GIS overlays of facility designs, and available literature regarding the BTE (Reclamation and Ecology, 2014b; Natural Systems Design, 2014). Estimated impacts on wetlands are not based on formal wetland delineations or functional assessments; thus, the actual extent of wetlands may vary once on-the-ground studies are conducted. Reclamation would delineate, categorize, and assess functions of all wetlands in the project corridor during the permitting phase for the preferred alternative. Impacts caused by proposed reservoir operations were assessed using preliminary results of KDRPP and KKC hydrologic modeling reported in Section 4.3, and a review of literature regarding effects of water regime changes on reservoir and riparian vegetation composition and productivity (Cooke and Azous, 1997; Walters et al., 1980; Kercher and Zedler, 2004; Vartapetian and Jackson, 1996; Reclamation, 2011; Howard and Wells, 2009; Auble et al., 2007). These sources provide the basis for an evaluation of potential short-term and long-term effects of changes in reservoir water surface elevations on wetland and vegetation communities along Kachess and Keechelus reservoirs, and downstream effects on Kachess River and the Keechelus Reach of the Yakima River.

Impact Indicators. Impact indicators include changes to upland and riparian vegetation and wetlands around the Keechelus and Kachess reservoirs, at proposed facilities, and in the BTE enhancement areas. Negative impacts are defined as the loss of existing upland or riparian vegetation and vegetated wetlands, whether from clearing and grading activities or changes in water surface elevations at the Keechelus and Kachess reservoirs, which decrease the extent, connectivity, or integrity of riparian or upland habitat in the watershed. Beneficial impacts are defined as positive alterations to wetlands and vegetation that increase the extent, connectivity, or integrity of wetlands and riparian and upland vegetation communities.

For the purposes of this analysis, construction impacts are defined as all temporary and permanent impacts that would result in clearing, grading, or other construction-related activities required to build the KKC and KDRPP facilities, to support the permanent footprint of these facilities, and to install BTE elements. Temporary construction impacts are assessed on the basis of the area of wetlands and vegetation communities that would be disturbed for construction-related activities and restored following construction. These impacts are considered more substantial where extensive areas of rare or intact native vegetation communities are present. Impacts are considered minor where areas have been previously disturbed and vegetation has been removed or invasive species are present. Areas of temporarily and permanently lost vegetation as well as regeneration time for forest and shrub cover were estimated. Operation impacts are defined as the impacts of facility and reservoir operations and maintenance activities on wetlands and vegetation once construction is complete.

The significance criteria presented in Table 4-39 were developed based on consideration of context and intensity of the environmental effects as required under NEPA.

Table 4-39. Impact Indicators and Significance Criteria for Vegetation and Wetlands

Impact Indicator	Significance Criteria
Changes to upland and riparian vegetation	Loss of native vegetation that results in a decrease in extent, connectivity, or integrity of riparian or upland habitat in the watershed is a negative impact. Establishment of invasive plant species that results in a decrease in extent, connectivity, or integrity of native riparian and upland habitat in the watershed is a negative impact. Loss of USFS Survey and Manage individual plants or suitable habitat is a negative impact. Loss of State Sensitive individual plants or suitable habitat is a negative impact. Increase in extent, connectivity, or integrity of native riparian and upland habitat is a positive impact.
Changes to wetlands	Loss of wetland acreage or impairment of wetland functions that cannot be mitigated, resulting in a net loss of wetlands in the watershed, is a negative impact. Enhancement, restoration, or increase in extent of wetland habitat is a positive impact.

4.7.2 Summary of Impacts

No significant wetland and vegetation impacts would occur under any of the alternatives. *Alternative 1 – No Action* would result in a net benefit to wetlands and vegetation in the extended study area, associated with proposed mitigation for the I-90 Phase 2A project. Construction activities under *Alternative 2A – KDRPP East Shore Pumping Plant* and *Alternative 2B – KDRPP South Pumping Plant* would likely result in permanent impacts on wetlands; however, the area affected would be small (less than 1 acre), and wetland impacts would be mitigated to result in no net loss of wetlands. *Alternative 2A* would have a larger construction footprint that would disturb more upland vegetation than *Alternative 2B*. However, permanent changes to vegetation under both alternatives would be small relative to the Kachess watershed, approximately 18 acres under *Alternative 2A – KDRPP East Shore Pumping Plant* and 8 acres under *Alternative 2B – KDRPP South Pumping Plant*. Most of this loss of upland vegetation would be second-growth coniferous and deciduous forest, which is the dominant plant community in the primary study area. No known special or unique plant communities or associations would be altered. As a result, no significant impacts on vegetation or wetlands are anticipated as a result of *Alternatives 2A* or *2B*.

Alternative 3A – KKC North Tunnel Alignment and *Alternative 3B – KKC South Tunnel Alignment* are not anticipated to result in significant permanent impacts on wetlands. Construction dewatering activities under Alternative 3A would potentially impact wetlands located south of Keechelus Dam by temporarily altering groundwater discharge to the wetlands. However, since the dewatering activities would be of short-term duration and the wetlands are mainly fed by spring runoff from the Keechelus Reservoir, the project is not likely to result in permanent loss of wetlands at this site. *Alternative 3A* would have a larger construction footprint and disturb more upland vegetation than *Alternative 3B*, but permanent changes to vegetation under both alternatives would be small relative to the combined Kachess and Keechelus watersheds (approximately 4 acres under *Alternative 3A* and 1.5 acres under *Alternative 3B*). Most of this loss of upland vegetation would be second-growth coniferous forest. No known special or unique plant communities or associations would be altered.

Operations under all action alternatives would affect wetland and vegetation assemblages around the Kachess Reservoir. *Alternative 2A*, *Alternative 2B*, and *Alternative 4* would cause prolonged drawdowns of Kachess Reservoir during drought years, which may substantially change the composition of wetland communities around the reservoir and increase the likelihood of invasive species establishment. Downstream effects on the Kachess River and Keechelus Reach of the Yakima River are not anticipated to be significant under any alternative.

The BTE actions would be implemented as part of all the action alternatives and would have a beneficial impact on up to 30 acres of wetlands in the Gold Creek drainage.

Table 4-40. Summary of Impacts for Vegetation and Wetlands

Impact Indicator	Summary of Impact
Changes to upland and riparian vegetation	*Alternatives 2A, 2B*, and *4* would result in prolonged drawdown of Kachess Reservoir, which may result in substantial establishment of invasive species on the reservoir bed during drought years. This impact would not be significant with the implementation of invasive species monitoring and control. *Alternative 3A, 3B* and *4* would have a beneficial impact on riparian vegetation on the Keechelus Reach of the Yakima River due to reestablishment of flows that mimic an unregulated flow regime. Temporary or permanent loss of riparian and upland vegetation would not be significant under any alternative.
Changes to wetlands	*Alternatives 2A, 2B*, and *4* would cause a permanent loss of 0.7 acre of wetland and would be mitigated for to ensure no net loss of wetlands; thus, the impact would not meet significance criteria. *Alternatives 2A, 2B*, and *4* would cause prolonged drawdown of Kachess Reservoir, which may result in changes to wetland hydrology and vegetation communities along the reservoir shoreline during drought years. This impact would not be significant with the implementation of wetland monitoring and appropriate mitigation to ensure no net loss of wetlands.

4.7.3 Alternative 1 – No Action Alternative

Under *Alternative 1 – No Action*, existing wetland and vegetation conditions would remain largely the same. Reservoir levels would continue to fluctuate as currently occurs, and discharges to Kachess River and Keechelus Reach of the Yakima River would continue as currently occurs. Any changes in riparian and upland vegetation would be driven by trends not related to this project. These trends are discussed in Section 3.7, and include USFS's ongoing management of public lands under the Snoqualmie Pass Adaptive Management Area (SPAMA) guidance (USFS, 2011c), which aims to restore late-successional forest conditions to the area.

WSDOT's I-90 Phase 2A project would result in permanent impacts on wetlands, streams, and associated buffers in the project area. WSDOT proposes to implement the *Wetlands and Aquatic Resources Mitigation Plan* (WARM Plan) as compensatory mitigation for wetland and stream impacts. The WARM plan uses a "landscape-level watershed-based approach" emphasizing restoration, protection, and improvement of hydrologic and ecologic connectivity of wetlands and other aquatic resources in the upper Yakima River basin (WSDOT, 2014b; Corps and Ecology, 2014). Mitigation elements would include wetland reestablishment, wetland and stream buffer enhancement, upland preservation, replacement of fish barrier culverts with fish- and wildlife-passable culverts and bridges, and establishment of new culverts in areas of groundwater flow and seepage. Implementation of the WARM Plan would improve wetland and vegetation conditions in the expanded study area. Wetlands and vegetation in the primary study area would remain the same as today as no impacted wetlands in the primary study area would be directly affected by the I-90 Phase 2A project.

4.7.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.7.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Wetlands

Construction of the pumping plant on the east shore of the Kachess Reservoir and the discharge structure south of the existing Kachess Dam would result in temporary and permanent impacts on wetlands if construction activities or facilities are located within or adjacent to wetland boundaries. Direct impacts on wetlands through filling, excavation, or changes to vegetation could change the capacity of a wetland to perform particular functions, such as storing stormwater, filtering pollutants, protecting streambanks and shorelines, and providing habitat to wildlife. Grading and clearing of wetlands or buffers may temporarily affect wetland hydrology, vegetation, and structure. Table 4-41 summarizes the estimated acreage of permanent impacts on wetlands due to construction of the east shore pumping plant facilities.

Table 4-41. Permanent Wetland Impact Area Associated with *Alternative 2A – East Shore Pumping Plant*

Wetland Type	Permanent Impact (acres)
Palustrine, forested wetland	0.2
Palustrine, emergent wetland	0.5
Total Impact Area (acres)	**0.7**

The pumping plant site would likely permanently impact a 0.2-acre forested wetland on the east shore, and the discharge structure south of Kachess Dam would likely permanently impact one 0.5-acre emergent wetland (Figure 3-16). Construction of the intake tunnel and pipeline and use of the soil disposal area would either occur underground or within unvegetated portions of the reservoir bed, and are not anticipated to directly affect vegetated wetlands. The NWI map does not show wetlands in the areas proposed for new access roads.

The proposed transmission line would follow existing road and transmission line rights-of-way to the extent feasible. Except for the Yakima River, the NWI does not show wetlands that adjoin the potential transmission line. Any wetlands that may adjoin the proposed transmission line are unlikely to be extensive in nature given the landscape position of the conceptual alignment. The conceptual alignment spans a confined reach of the Yakima River that does not have extensive floodplains. Other portions of the alignment are in coniferous forest with well-drained soils formed out of glacial outwash (USDA NRCS, 2014). Additional analysis would be conducted as part of Puget Sound Energy's (PSE) route study and environmental analysis.

Reclamation does not anticipate construction of the east shore pumping plant to significantly impact wetlands along the Kachess Reservoir shoreline or other wetlands in the Kachess Reservoir watershed. The pumping plant facilities would permanently impact a total of approximately 0.7 acre of wetlands in the immediate vicinity of the Kachess Reservoir, and potentially permanently impact small areas of wetland along the transmission line route. The estimated 0.7 acres of permanent wetlands impacts associated with pumping plant construction and any additional permanent wetland impacts that might be identified during subsequent surveys of the affected area comprise a fraction of the over 38 acres of palustrine (freshwater) wetlands mapped within the Kachess watershed (Service, 2013; USGS, 2014). Reclamation would implement compensatory mitigation for unavoidable wetland impacts (discussed in Section 4.7.9), resulting in an overall effect of no net loss of wetlands.

Vegetation

Construction of *Alternative 2A – KDRPP East Shore Pumping Plant* would require removal of vegetation. The cleared areas would be necessary to accommodate the east shore pumping plant, permanent access road to the pumping plant, power supply substation, transmission line, permanent maintenance access road to the pumping plant pipeline, a portion of pipeline near the dam, Kachess River discharge (outlet works) on the south side of the Kachess Dam. Table 4-42 identifies the area of temporary and permanent clearing and the dominant vegetation type.

Table 4-42. Vegetation Disturbance Area Associated with *Alternative 2A – East Shore Pumping Plant*

Construction Feature	Permanent Impact (acres)	Temporary Impact (acres)	Habitat/Forest Type
KDRPP facilities (pumping plant and intake facilities and pipeline)	5.5	4.5	Riparian/second growth coniferous forest
Kachess River discharge (outlet) (rectangular channel and stilling basin)	1	1	Riparian/second growth and mature coniferous forest
Power supply substation	1	1	Second growth coniferous forest
Transmission line	8*	0	Second growth coniferous forest
Permanent access roads	2.5	0	Riparian/second growth coniferous forest
Temporary access roads, staging and stockpile areas	0	49.5	Mixed disturbed/second growth/mature coniferous forest
Temporary construction facilities (construction basin and boat launch)	0	1	Riparian
Total Impact Area (acres)	**18**	**57.5**	**75.5 acres**

* Assumes a 25-foot clearing limit within the transmission line right-of-way between I-90 and the pumping plant substation.
Note: Impact areas for BTE are not included in this table due to the conceptual nature of available information. Impact areas for BTE would be further defined during site-specific impact analyses.

Construction would disturb approximately 57.5 acres of vegetation, 18 acres permanently. Most of this acreage consists of stands of second-growth coniferous forest and patches of riparian vegetation near the Kachess River discharge; however, an entire 4.5-acre stand of mature coniferous and deciduous forest located south of the Kachess Dam would be impacted by construction activities, and approximately1.5 acres permanently so. Permanent and temporary impacts for transmission line construction would be further assessed as part of PSE's route study and environmental analysis. To the extent feasible, Reclamation would minimize disturbance to wetlands and vegetation by using existing roads, cleared areas, and dry unvegetated portions of the reservoir bed for staging and access to construction sites. By revegetating temporarily cleared second-growth forest with suitable tree species and using adaptive management techniques to limit competition from invasive species, shrubs and forbs, Reclamation could promote regeneration of these areas to second-growth forest stands comparable to surrounding forest within 40 to 50 years (Burns and Honkala, 1990; Tarleton State University, 2014). Shrub vegetation communities may regenerate in 5 years with implementation of appropriate revegetation and management practices (USFS, 2002). The overall permanent effects of construction on vegetation are not anticipated to be significant because the permanent impacts are small-scale, totaling approximately 18 acres of approximately 40,600 acres of relatively undisturbed forest within the Kachess watershed (USGS, 2014). Thus, the project would have negligible effects on the extent and connectivity, and overall integrity of forested habitat in the immediate Kachess watershed, or in the larger tracts of forest land encompassed by the Okanogan-Wenatchee National Forest.

Indirect, long-term impacts could result from construction activities, such as modification of vegetation, partial shading of wetland vegetation, water quality degradation, and alteration of wetland hydrology sources. The indirect impacts from the temporary and permanent footprint of *Alternative 2A – East Shore Pump Plant* facilities are expected to be localized and limited by the lack of extensive wetlands in the area. Direct and indirect effects of operation of KDRPP are discussed in Section 4.7.4.2, below.

The proposed construction of KDRPP facilities may affect State sensitive species and USFS Survey and Manage plant species if suitable habitat is located in the project areas. The predominant suitable habitat for State sensitive species in the study area ranges from lakeshore and riparian habitat to coniferous forests and rocky cliffs; Survey and Manage species primarily occur in late successional and old-growth forests in Wenatchee National Forest (Appendix D). If populations of USFS Survey and Manage plant species were present in the project area, construction activities could affect them through trampling, removal of individuals, habitat degradation, potential spread and colonization of noxious weeds, or erosion and sedimentation. The overall effect of KDRPP on Survey and Manage Species is anticipated to be low, since disturbance to vegetated areas would be mainly limited to second-growth forest habitat.

Bull Trout Enhancement

Implementation of the BTE actions would address seasonal dewatering issues in Gold Creek which have degraded bull trout habitat (Reclamation and Ecology, 2014b). The BTE would narrow 1.0 to 2.3 miles of Gold Creek to a channel that is 50 to 125 feet wide (pending hydraulic and flooding analyses). The BTE would also utilize wood and rock to restore 1.0 to 2.3 miles of hardened channel along Gold Creek.

The BTE includes actions to fully or partially fill Gold Creek Pond (up to 27 acres) to approximate the historical wetland mosaic at the site of the pond (Natural Systems Design, 2014). The BTE would also fully or partially fill Heli’s Pond and its outlet channel, totaling up to 2 acres, to restore the area to its historical wetland complex and floodplain condition. These actions would result in overall beneficial impacts on wetlands because the alterations would restore highly disturbed wetlands to predevelopment conditions and improve flow regimes in Gold Creek. Conceptual wetland restoration plans would be developed based on the preferred BTE alternatives, which are pending selection and approval (Long, 2014).

Design and implementation of the BTE plan would comply with Federal, State and local regulations to ensure no net loss of wetlands.

The BTE would include construction of a new bridge on NF-4832 to restore the Gold Creek floodplain and enhance connectivity of bull trout habitat within Gold Creek and between the creek and Keechelus Reservoir. The proposed replacement of the Gold Creek USFS bridge is unlikely to result in permanent impacts on wetlands because it would span the floodplain of Gold Creek. Riparian vegetation may be temporarily or permanently affected by clearing, grading, and creation of the new bridge footprint. Disturbed areas would be regraded and revegetated with appropriate native plant species immediately following construction.

Activities at Cold Creek for passage improvements include removing the existing culvert under Iron Horse Trail, installing a bridge, and improving channel conditions between the existing culvert and Keechelus Reservoir to provide passage to bull trout. No wetlands are documented in the vicinity of the Cold Creek passage improvements, and wetlands are unlikely to occur given the landscape position at the site.

Construction activities to complete the Gold Creek and Cold Creek elements of the BTE would require temporary access roads, staging areas, and heavy equipment operation in the riparian areas adjacent to Gold Creek and Cold Creek. Disturbed areas would be regraded and revegetated with appropriate native plant species immediately following construction. Therefore, the overall effects of the BTE on upland and riparian vegetation are anticipated to be negligible. Additional analysis of potential vegetation and wetland impacts will be conducted as the design of these actions progresses.

4.7.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Once construction of the facilities is complete, operation of the facilities under *Alternative 2A – KDRPP East Shore Pumping Plant* would not disturb vegetation or wetlands. The new transmission line would require ongoing vegetation maintenance activities. Ongoing maintenance activities for other facilities are not anticipated to require additional clearing or grading outside the final facility footprints.

Alternative 2A includes an approximately 7,755-foot pipeline that would carry water from the pumping plant to the discharge point below the dam. Most of the length of the pipeline would be buried in the lakebed, with the exception of approximately 500 feet of the east shore pumping plant pipeline that would traverse under upland forest northeast of the proposed Kachess River discharge structure. Over the lifetime of the pipeline, water could leak and percolate into surrounding soil; conversely, water infiltration into the pipe may drain groundwater surrounding the pipe. The potential effects of infiltration and exfiltration to wetlands and vegetation would be greatest where the pipeline intercepts the shallow groundwater table, which drives wetland hydrology and seasonal saturation of soils in vegetated uplands. The preliminary estimate for the maximum allowable infiltration and exfiltration rates is 19 gallons per day per inch-diameter per 1,000 feet of tunnel (Reclamation and Ecology, 2014f). This maximum allowable rate is a conservative estimate; actual infiltration and exfiltration rates would be significantly less since the pipeline would be concrete-lined to minimize leaking. However, as explained in Section 4.5, the tunnel would be isolated from shallow groundwater and therefore potential infiltration and exfiltration are not anticipated to affect wetlands and vegetation.

Operation of *Alternative 2A – KDRPP East Shore Pumping Plant* would change reservoir levels in both Kachess and Keechelus reservoirs. Kachess Reservoir would be drawn down as much as 80 additional feet in drought years (see Section 4.3). Water surface elevations would be lower than current elevations, exposing more of the reservoir bed (i.e., drawdown zones), a condition that would persist over the next 2 to 5 years until the reservoir returns to normal operating levels. At Keechelus Reservoir, peak water surface elevations may drop as much as 10 feet during the growing season, and the water surface elevation would drop by about 15 feet near the onset of the dormant season. However, reservoir pool recovery time is expected to be much faster at Keechelus Reservoir, and new drawdown zones are not anticipated to persist for more than 1 year.

The approximately 48 acres of palustrine wetlands that are inventoried on the Kachess Reservoir shoreline would experience prolonged periods of no inundation during drawdown (drought years and the 2-5 years following a drought). Wetland and shoreline vegetation responses to prolonged reservoir drawdowns are highly variable depending on reservoir substrate and topography, soil moisture availability, prevailing climatological conditions, plant communities in the surrounding shoreline and uplands, and seed bank availability. Prolonged reservoir drawdowns are expected to cause a shift in existing wetland plant communities. Wetland species with high moisture requirements (rushes, sedges, and some willow species) likely would experience some mortality, particularly during a multiyear drawdown. Wetland plant species that favor less inundated or saturated soil conditions may persist and colonize into areas previously occupied by more obligate wetland species. If shallow groundwater or soil moisture become unavailable, the landward edge of wetlands could shift from wetland to upland vegetation communities. Return of the reservoirs to normal operating conditions would likely result in reestablishment of wetland plant assemblages that are comparable to existing conditions.

In terms of nonwetland shoreline and upland vegetation responses, recent studies suggest that newly exposed, bare land created by prolonged reservoir drawdowns acts as a disturbance zone where short-lived species, including invasive and nonnative weeds, are likely to initially colonize (Auble et al., 2007; Reclamation, 2011). Weedy species may become established if invasive species control is not implemented (Reclamation, 2011).

In summary, Reclamation anticipates that prolonged drawdown of reservoir levels under the *Alternative 2A – KDRPP East Shore Pumping Plant*, particularly on the Kachess Reservoir, would cause periodic shifts in wetland vegetation. The impact would not result in significant, permanent loss of shoreline wetlands with proper monitoring and implementation of compensatory mitigation, if necessary, to ensure no net loss of wetlands. The operation of the reservoirs is not anticipated to cause a significant impact on nonwetland vegetation since Reclamation would implement appropriate invasive species control techniques to limit encroachment into native vegetation communities.

The reservoir drawdowns would have variable effects on sensitive species and USFS Survey and Manage plant species if any occur along the shoreline of Kachess Reservoir. Species that favor variable soil moisture conditions likely would adapt to changes in inundation levels, whereas species requiring high levels of moisture may experience mortality during prolonged reservoir drawdowns. Plant species adapted to mesic or drier conditions could potentially colonize on exposed reservoir bed if a population is established nearby; however, invasive species that establish in the new drawdown zones would likely outcompete sensitive and Survey and Manage species.

Alternative 2A – KDRPP East Shore Pumping Plant could have downstream effects on wetlands and riparian vegetation along the Kachess River and Keechelus Reach of the Yakima River. For the Kachess River, the greatest change would occur during a drought year, when flows would increase by 450 to 550 cfs, although releases during drought years would remain within normal operating range under current conditions. Wetlands and riparian vegetation along the Kachess River would likely benefit from increased hydrologic input during higher flows. Flows on the Keechelus Reach of the Yakima River would change slightly from *Alternative 1 – No Action*. The greatest change would be flow rates during drought years, when mean flows would drop from the normal summer operating range of 800 cfs to 480-580 cfs. Flows would increase by 100 cfs following a drought year. Wetlands along the Keechelus Reach may experience slight changes in vegetation due to decreased flows, although lower water availability would not persist. Riparian vegetation may establish at lower elevations during low flows, although it would likely be temporary in nature and return to previous conditions once flows return to more normal conditions. Overall, downstream effects to wetlands and vegetation would likely be negligible since changes in flows are not anticipated to cause prolonged, substantial shifts in wetland and riparian vegetation communities.

Bull Trout Enhancement

Once construction of the BTE actions is complete, the BTE would not impact vegetation or wetlands. The enhancement areas would be operated under adaptive management practices to ensure that the efforts are meeting enhancement objectives. Operation of the BTE would not require additional clearing or grading outside the final restoration footprints.

4.7.5 Alternative 2B – KDRPP South Pumping Plant

4.7.5.1 Construction

KDRPP South Pumping Plant Facilities

Wetlands

Construction of the south pumping plant located south of the Kachess Dam would result in temporary and permanent impacts on wetlands if the facilities are located within or adjacent to wetland boundaries. The pumping plant and facilities would likely permanently impact the same 0.5-acre emergent wetland located south of the dam as *Alternative 2A – KDRPP East Shore Pumping Plant* (Figure 3-16). *Alternative 2B – KDRPP South Pumping Plant* would not affect wetlands and vegetation along the east reservoir shoreline. Construction of the intake tunnel within unvegetated portions of the reservoir bed is not anticipated to directly affect vegetated wetlands.

The transmission line would follow existing road and rights-of-way to the extent feasible. The transmission line would follow the same route from the Easton Substation to north of I-90 as *Alternative 2A – KDRPP East Shore Pumping Plant*, but the route would be shorter overall as it would tie in to the pumping plant south of the Kachess Dam. Since existing transmission line poles would be used to the extent feasible, there would be limited ground disturbance. The potential transmission line route does not traverse any wetlands identified by the NWI. However, a portion of the route is proximate to the left bank of the Kachess River, where wetlands are most likely to occur. PSE would take measures to avoid and minimize impacts on wetlands similar to those described for the *Alternative 2A – KDRPP East Shore Pumping Plant*.

Reclamation does not anticipate *Alternative 2B – South Pumping Plant* would significantly impact wetlands along the Kachess Reservoir shoreline or elsewhere in the Kachess Reservoir watershed. The pumping plant facilities would permanently impact a total of approximately 0.5 acre of wetlands in the immediate vicinity of the Kachess Reservoir, and potentially permanently impact small areas of wetland along the transmission line route. Wetlands permanently impacted by construction activities comprise a fraction of the over 38 acres of palustrine wetlands mapped within the Kachess watershed (Service, 2013; USGS, 2014). Reclamation would implement compensatory mitigation for unavoidable wetland impacts (discussed in Section 4.7.9), resulting in an overall effect of no net loss of wetlands.

Vegetation

Vegetation clearing would be necessary to accommodate the south pumping plant, permanent access road to the pumping plant, power supply substation, transmission line, and the Kachess River discharge channel from the pumping plant. The area to be cleared and graded would total approximately 44.5 acres, 8 acres of which would be permanently impacted (Table 4-43). Nearly all of the vegetation in this area consists of second-growth coniferous and deciduous forest stands, with the exception of the mature coniferous forest stand that would be permanently impacted by the construction of the pumping plant. The overall permanent effects of construction on vegetation are not anticipated to be significant because the permanent effects are small-scale, totaling approximately 8 acres of approximately 40,600 forested acres within the Kachess watershed. Thus, the overall extent, connectivity, and integrity of forested habitat in the watershed is anticipated to remain intact. Permanent and temporary impacts for transmission line construction would be further assessed as part of PSE's route study and environmental analysis.

Table 4-43. Vegetation Disturbance Area Associated with *Alternative 2B – South Pumping Plant*

Construction Feature	Permanent Impact (acres)	Temporary Impact (acres)	Habitat/Forest Type
KDRPP facilities (pumping plant, intake facilities, outlet)	4.5	2.5	Mature coniferous forest
Power supply substation	1	1	Second growth coniferous forest
Transmission line*	2	0	Second growth coniferous forest
Permanent access roads	0.5	0	Riparian/second growth coniferous forest
Temporary access roads, staging and stockpile areas	0	32	Mixed disturbed/second growth/mature coniferous forest
Temporary construction facilities (construction basin and boat launch)	0	1	Riparian
Total Impact Area (acres)	**8**	**36.5**	**44.5 acres**

* Assumes a 25-foot clearing limit within the transmission line right-of-way between I-90 and the pumping plant substation.
Note: Impact areas for BTE are not included in this table due to the conceptual nature of available information. Impact areas for BTE would be further defined during site-specific impact analyses.

The potential effect of construction of *Alternative 2B – KDRPP South Pumping Plant* on State sensitive and USFS Survey and Manage plant species would be less than that of *Alternative 2A – KDRPP East Shore Pumping Plant* because the construction area requiring vegetation clearing would be substantially smaller (44.5 acres versus 75.5 acres). It is unknown at this time whether the Survey and Manage species are present.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.7.4.1).

4.7.5.2 Operation

KDRPP South Pumping Plant Facilities

Operation of the completed *Alternative 2B – KDRPP South Pumping Plant* would be similar to that of *Alternative 2A – KDRPP East Shore Pumping Plant.* No further impacts on wetlands or vegetation are anticipated for ongoing maintenance and monitoring activities.

Impacts on wetlands and vegetation communities along the Keechelus and Kachess reservoirs and downstream effects to the Kachess River and Keechelus Reach of the Yakima River due to the operation of *Alternative 2B – KDRPP South Pumping Plant* would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant*.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.7.4.2).

4.7.6 Alternative 3A – KKC North Tunnel Alignment

4.7.6.1 Construction

KKC North Tunnel Alignment Facilities

Wetlands

Construction of the Yakima River diversion, fish screens, intake, Yakima River-to-Keechelus portal conveyance, and Keechelus tunnel portal shaft under *Alternative 3A –KKC North Tunnel Alignment* is not anticipated to permanently affect wetlands. Both pipeline construction options from the Yakima River intake to the Keechelus portal— Option A (open trench) and Option B (jack tunnel)—would avoid clearing and grading within the wetland mitigation site located east of Keechelus Dam, and would avoid siting structures within the wetland (Figure 3-17). Tunneling under the wetland mitigation site is not anticipated to cause permanent impacts on its hydrology. The mitigation site's primary source of hydrology is surface water discharge from a drain system that collects seepage from the dam, would not be affected by construction. Construction of either Option A or B would require dewatering in the conveyance area. Groundwater discharge would be affected within the wetland mitigation site for a 1-year period during construction for either option (see Section 4.5). Temporary dewatering may cause minor shifts in the wetland vegetation community. However, as groundwater levels are expected to return to preconstruction conditions within a year and groundwater is not the primary source of hydrology to the wetland area, the long-term loss of wetland vegetation or wetland functions is not anticipated.

Tunneling activities to construct the deep underground tunnel to Kachess Reservoir would not disturb wetlands at the surface. The NWI does not show wetlands in the areas proposed for the Kachess Reservoir Lake Road portal and discharge structure. If wetlands are located in this area, they would likely be limited in size due to the steeply sloped and well-drained hillsides in the portal location. To the extent feasible, Reclamation would use existing roads, cleared areas, and upland sites for staging and access to construction areas in order to minimize disturbance to wetlands and vegetation.

Reclamation does not anticipate construction of *Alternative 3A – KKC North Tunnel Alignment* to significantly impact wetlands in the vicinity of Keechelus and Kachess reservoirs, or other wetlands in the Kachess and Keechelus Reservoir watersheds. There would be no permanent impacts on wetlands in the Keechelus Dam area. If wetlands are present near the Kachess Lake Road portal and discharge structure, they would likely be limited in size and extent. Any permanent impacts would comprise a fraction of the 352 acres of palustrine wetlands mapped within the Keechelus Reservoir and 38 acres of wetlands mapped in the Kachess watershed (Service, 2013; USGS, 2014). Reclamation would implement compensatory mitigation for unavoidable wetland impacts (discussed in Section 4.7.9), resulting in an overall effect of no net loss of wetlands.

Vegetation

Although the deep tunnel to the Kachess Reservoir would be at least 150 feet underground and would not disturb any vegetation, minor clearing would be undertaken to construct the Yakima River intake structure, conveyance pipeline (Option A or B), and the Keechelus portal site (Table 4-44). Overall, construction activities would require approximately 12.5 acres of clearing, 4 acres of which would remain unvegetated. Approximately 1.5 acres of coniferous forest would be cleared for the stream diversion system to be constructed on the right bank of the Yakima River while the intake and associated structures are being built. The open-trench construction that would be required for the Yakima River-to-Keechelus portal conveyance alignment Option A would temporarily clear approximately 4 acres of second-growth coniferous forest. The Kachess Lake Road portal and discharge structure would require clearing approximately 5.5 acres of second-growth and mature coniferous forest, 3.5 acres of which would be permanently cleared. Temporary construction corridors would be revegetated upon completion of construction. The overall effects of construction on vegetation are not anticipated to be significant because permanent impacts are small-scale, totaling 3.5 acres of approximately 40,600 forested acres within the Kachess watershed, and 0.5 acre of approximately 34,000 forested acres within the Keechelus watershed. Impacts of this magnitude would result in a negligible decrease in extent and no discernible effect on connectivity or integrity of forested habitat in the watershed.

Table 4-44. Vegetation Disturbance Area Associated with *Alternative 3A – KKC North Tunnel Alignment*

Construction Feature	Permanent Impact (acres)	Temporary Impact (acres)	Habitat/Forest Type
Yakima River Diversion and Intake	0.5	1.5	Riparian/second growth coniferous forest
Yakima River to Keechelus portal conveyance – Option A and Option B	0	4 (Option A) 0 (Option B)	Riparian/ second growth coniferous forest and disturbed land
Keechelus portal	<0.1	0	Second growth coniferous forest
Kachess Lake Road portal, discharge structure, spillway, stilling basin	3.5	2	Second growth coniferous forest
Temporary access roads, staging and stockpile areas	0	1	second growth coniferous forest
Total Impact Area	**4**	**8.5**	**12.5**

Note: Impact areas for BTE are not included in this table due to the conceptual nature of available information. Impact areas for BTE would be further defined during site-specific impact analyses.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.7.4.1).

4.7.6.2 Operations

KKC North Tunnel Alignment Facilities

Operation of the facilities under *Alternative 3A –KKC North Tunnel Alignment* would not cause disturbance to, or otherwise impact vegetation or wetlands. Ongoing monitoring and maintenance activities at the Yakima River intake, pipelines, tunnels, and discharge facilities are not anticipated to require additional clearing or grading outside the final facility footprints.

Alternative 3A includes approximately 1,200 to 1,450 feet of pipeline between the Yakima River diversion and the Keechelus portal and 4 miles of deep tunnel between the Keechelus portal and Kachess Lake Road portal. Maximum allowable rates of pipeline leaking and infiltration are expected to be similar to those described for KDRPP alternatives (*Alternatives 2A* and *2B*). Effects on wetlands and vegetation would most likely occur along the conveyance from the Yakima River intake to the Keechelus portal, which is the shallowest portion of the pipeline alignment. However, exfiltration effects would be negligible since the pipeline would be at least 25 feet below the ground surface for Option A and at least 30 feet below the ground surface for Option B and backfill material would be comparable to native material. The shallow groundwater table that drives wetland hydrology and seasonally saturated soils in upland vegetation communities ranges from 12 to 28 feet bgs in this area (see Section 3.5.4.1). No exfiltration or infiltration effects are anticipated on wetlands and vegetation along the deep tunnel alignment because the depth of the tunnel would be at least 150 feet bgs, and thus isolated from groundwater.

Operation of *Alternative 3A –KKC North Tunnel Alignment* would change reservoir levels in both Kachess and Keechelus reservoirs. On average, the Kachess Reservoir would have a slightly higher maximum water level (average of 2.1 feet) during most years; however, the maximum pool elevation would not exceed the No Action Alternative maximum pool elevation. On average, the reservoir would have a lower minimum water level (average of 0.8 feet) during most years (see Section 4.3, Surface Water Resources). The anticipated timing of reservoir pool refill and drawdown is expected to be nearly identical to existing conditions of the Kachess Reservoir, with peak water surface elevations occurring in June and July.

The higher maximum water level could have slight effects on existing wetland vegetation along the reservoir shoreline that have likely developed at the site because of the reservoir. However, wetland vegetation communities around the Kachess Reservoir are already adapted to seasonal inundation during the growing season. Temporary seasonal increases in water surface elevations in these wetlands are unlikely to cause substantial change in most of the existing vegetation communities, although some woody vegetation, such as alder or black cottonwood trees, may succumb to anaerobic stress. More flood-tolerant species, such as willows and other deciduous wetland shrubs, as well as sedges, rushes, and bulrushes, are most likely to withstand additional inundation and may recruit into areas previously vegetated by less flood-tolerant trees and shrubs. In summary, Reclamation does not anticipate the increased reservoir levels to result in significant changes in wetland communities around the Kachess Reservoir shoreline; although small shifts in wetland vegetation composition may occur, they would not result in substantial loss of wetland acreage.

Under *Alternative 3A – KKC North Tunnel Alignment*, the Keechelus Reservoir would have a slightly lower maximum water level and higher minimum water level during drought years and when Kachess Reservoir is refilling after a drought. Effects of the operation on wetlands and vegetation would be similar to those of KDRPP. However, since there would not be multiyear periods of drawdown when bare ground could be colonized by invasive species, the overall effect on wetlands and vegetation communities is anticipated to be minimal.

In summary, Reclamation does not anticipate the operation of *Alternative 3A – KKC North Tunnel Alignment* to result in significant loss of vegetation around either the Kachess or Keechelus Reservoir shorelines. The higher reservoir levels at Kachess may cause temporary shifts in wetland vegetation but because the maximum pool elevation would not exceed that of *Alternative 1 – No Action*, there would be no substantial change to vegetation communities landward of the reservoir.

Alternative 3A – KKC North Tunnel Alignment would also have the potential for downstream effects on wetlands and riparian vegetation along the Kachess River and Keechelus Reach of the Yakima River. For the Kachess River, the greatest change would occur during a drought year, when flows would increase 189 to 233 cfs; however, these releases during drought years would remain within the normal operating range of current conditions. Wetlands and riparian vegetation along the Kachess River would likely benefit from increased hydrologic input during higher flows. Flows in the Keechelus Reach of the Yakima River would change from *Alternative 1 – No Action*. The greatest change is that peak summer flows would be reduced to 400 cfs in all years. Restoring summertime flows to a regime that mimics unregulated conditions in this reach would likely result in a shift of wetland and riparian vegetation to mesic or upland vegetation assemblages. This change would allow establishment of more woody vegetation along the Keechelus Reach and may allow vegetation to establish at lower elevations along streambanks. Overall, this would be a beneficial impact on vegetation communities as native riparian vegetation is reestablished under more natural river flow regimes.

Operation of *Alternative 3A – KKC North Tunnel Alignment* would likely have variable effects on State sensitive species and USFS Survey and Manage plant species, with the greatest effects seen at the Kachess Reservoir. Species that favor variable inundated conditions likely would adapt to changes in inundation levels at the Kachess Reservoir, whereas species requiring drier conditions may experience mortality during prolonged inundation.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.7.4.2).

4.7.7 Alternative 3B – KKC South Tunnel Alignment

4.7.7.1 Construction

KKC South Tunnel Alignment Facilities
Wetlands
Construction of *Alternative 3B –KKC South Tunnel Alignment* facilities located in the Keechelus Dam area would result in the same type and extent of impacts on wetlands and vegetation as *Alternative 3A –KKC North Tunnel Alignment* (Figure 3-17). The deep tunnel to the Kachess Reservoir would not require surface disturbance of wetlands. The alignment would require tunneling under the large Swamp Lake wetland complex north of I-90. However, because this tunnel segment would be bored through impermeable rock at least 150 feet below the wetland complex, construction activities would be isolated from the groundwater that feeds Swamp Lake. Effects on hydrology due to dewatering for construction in the wetland mitigation site south of the Keechelus Dam would be similar to those described for *Alternative 3A – KKC North Tunnel Alignment.*

The NWI does not show wetlands in the areas proposed for the Kachess Reservoir portal and discharge structure. If wetlands are present, they are likely limited in size and function due to the outlet structure's location on a relatively steep well-drained hillslope. To the extent feasible, Reclamation would use existing roads, cleared areas, and upland sites for staging and access to construction areas in order to minimize disturbance to wetlands and vegetation. Reclamation would implement compensatory mitigation for unavoidable wetland impacts (discussed in Section 4.7.9), resulting in an overall effect of no net loss of wetlands.

Vegetation

Construction of the KKC south tunnel alignment would require clearing approximately 13 acres of vegetation to accommodate the Yakima River intake structure, conveyance tunnel or pipeline (Option A or B) to the Keechelus portal site, conveyance tunnel from the Keechelus portal to the I-90 portal, or conveyance tunnels from the I-90 portals to the Kachess portal and discharge structure (Table 4-45). The Kachess Reservoir portal and discharge structure would require clearing approximately 1 acre of second-growth and mature coniferous forest to accommodate the portal outlet structure, road crossing, and spillway. Of this cleared area, 1.5 acres would be permanently affected by facility footprints. Most of the vegetation in the impact area consists of second-growth coniferous forest and previously disturbed land. The overall permanent effects of construction on vegetation are not anticipated to be significant because permanent effects are small-scale, totaling approximately 1.5 acres of approximately 40,600 forested acres within the Kachess watershed. The deep tunnel to the Kachess Reservoir would not disturb any upland vegetation.

Table 4-45. Vegetation Disturbance Area Associated with *Alternative 3B – KKC South Tunnel Alignment*

Construction Feature	Permanent Impact (acres)	Temporary Impact (acres)	Habitat/Forest Type
Yakima River diversion and intake	0.5	1.5	Riparian/second growth coniferous forest
Yakima River to Keechelus portal conveyance - Option A and Option B	0	4 (Option A) 0 (Option B)	Riparian/ second growth coniferous forest and disturbed land
Keechelus portal	<0.1	0	Second growth coniferous forest
I-90 portal	0	4	Disturbed land
Kachess discharge	0.5	1.5	Riparian/second growth coniferous forest
Permanent access road	0.5	0	Second growth coniferous forest
Temporary access roads, staging & stockpile areas	0	0.5	Second growth coniferous forest
Total Impact Area	**1.5**	**11.5**	**13**

Note: Impact areas for BTE are not included in this table due to the conceptual nature of available information. Impact areas for BTE would be further defined during site-specific impact analyses.

Construction of *Alternative 3B – KKC South Tunnel Alignment* would likely have a lower degree of permanent effect on wetlands and vegetation than *Alternative 3A – KKC North Tunnel Alignment*.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.7.4.1).

4.7.7.2 Operations

KKC South Tunnel Alignment Facilities

Operation of *Alternative 3B – KKC South Tunnel Alignment* would be similar to that of *Alternative 3A – KKC North Tunnel Alignment.* No further impacts on wetlands or vegetation are anticipated for ongoing maintenance and monitoring activities.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.7.4.2).

4.7.8 Alternative 4 – Combined KDRPP and KKC

4.7.8.1 Construction

KDRPP and KKC Facilities

Impacts from facilities and construction activities for both actions would be the same as those described for KDRPP (Section 4.7.4.1) and KKC (Section 4.7.6.1). In combination, construction impacts under *Alternatives 2A* and *3A* would have the greatest permanent impacts on wetlands and vegetation, whereas *Alternatives 2B* and *3B* would have the least permanent impacts on (Table 4-46). Regardless, the overall significance of impacts on wetlands and vegetation would be negligible: wetland impacts would be mitigated, resulting in no net loss of wetlands, and permanent loss of riparian and upland vegetation would be negligible in extent and would not affect overall connectivity or integrity of riparian and forested upland habitat in the Kachess and Keechelus watersheds.

Table 4-46. Summary of Wetland and Vegetation Disturbance Areas under *Alternative 4* Combinations

Alternative Combination	Permanent Wetland (ac)	Permanent Riparian and Upland Vegetation (ac)	Temporary Riparian and Upland Vegetation (ac)
2A + 3A	0.7	22	66
2A + 3B	0.7	19.5	69
2B + 3A	0.5	12	45
2B + 3B	0.5	9.8	48

Note: Impact areas for BTE are not included in this table due to the conceptual nature of available information. Impact areas for BTE would be further defined during site-specific impact analyses.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.7.4.1).

4.7.8.2 Operations

KDRPP and KKC Facilities

Operation of *Alternative 4 – Combined KDRPP and KKC* would change reservoir levels in both Kachess and Keechelus reservoirs. Water elevations at Kachess Reservoir would be similar to those for both KDRPP and KKC, with periods of multiyear reservoir drawdown. As described for KDRPP and KKC, these types of operations would have a range of effects on shoreline wetlands and vegetation, increasing the likelihood of substantial shifts in wetland vegetation on the Kachess Reservoir shoreline and establishment of invasive plant species. Operations on the Keechelus Reservoir would have similar effects on wetlands and vegetation as KKC.

The combined effects of operation of the Kachess Reservoir under *Alternative 4* may affect vegetation communities since the more frequent and pronounced water surface elevation fluctuations may create a disturbance regime that favors establishment of invasive species. This impact would not be significant since Reclamation would implement appropriate invasive species control techniques.

Downstream effects of *Alternative 4 – Combined KDRPP and KKC* would be similar to those of KDRPP for the Kachess River and KKC for the Keechelus Reach of the Yakima River.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.7.4.2).

4.7.9 Mitigation Measures

Prior to construction in areas where any type of construction or temporary disturbance is proposed, Reclamation would conduct on-the-ground wetland surveys using the current wetland delineation and categorization methodologies accepted by Federal, State, and local agencies. Reclamation would design the actions to avoid wetland impacts. If impacts occur, Reclamation would comply with mitigation measures as established in permit conditions from applicable agencies.

Reclamation would work with the Corps and with State and local agencies to develop appropriate methodologies to determine whether the proposed changes in operations at both Kachess and Keechelus reservoirs and implementation of the BTE actions would result in a loss of wetlands that would require permit approval and compensatory mitigation. Mitigation measures, if necessary, would be developed and implemented to meet agency permit conditions for any wetland impacts caused by changes in reservoir operations.

The design of KDRPP and KKC facilities would minimize the need for vegetation removal to the extent feasible. Buildings, access roads, transmission line alignment, and staging areas would be located in areas of previously disturbed vegetation or on the reservoir shoreline to the extent feasible. Reclamation would replant disturbed areas with native vegetation where replanting would not interfere with the function of shoreline protection measures.

Reclamation would coordinate with the USFS to determine if any sensitive or Survey and Manage species were present in construction or reservoir shoreline areas and would take appropriate steps to minimize impacts on those species.

Reclamation would assess the areas where facilities would be installed to determine if there were any invasive species or undesirable vegetation. If present, Reclamation would suppress this vegetation prior to ground disturbance. Reclamation would monitor for infestations of invasive plant species associated with ground disturbances and periods of prolonged drawdowns on the Kachess and Keechelus reservoirs. Reclamation would implement suppression strategies to control invasive plant populations. These strategies could entail mechanical, chemical, and biological controls. Reclamation and Ecology would evaluate strategies to reduce environmental risks associated with such controls and ensure compliance with Federal, State, and local laws and requirements.

4.8 Wildlife

4.8.1 Methods and Impact Indicators

Methods. Reclamation identified potential impacts on wildlife and wildlife habitat by evaluating the habitats and species that would be affected by construction activities or new reservoir operations. Impacts from construction activities include temporary and permanent habitat loss and short-term noise, while impacts from operations result from long-term changes in reservoir pool elevations and downstream effects. After a literature review to catalog the type and amount of wildlife habitat in the primary and extended study areas and the species likely to be present, a field visit was conducted in the primary study area. Its purpose was to ground-truth the literature findings and further characterize wildlife habitat.

Impact Indicators. Wildlife and wildlife habitat impact indicators and criteria for determining impact significance are shown in Table 4-47. Reclamation assessed all criteria relative to *Alternative 1 – No Action*.

Table 4-47. Impact Indicators and Significance Criteria for Wildlife

Impact Indicator	Significance Criteria
Loss of wildlife habitat (forest and wetland)	Loss of ability to support breeding activities of local species
Alteration of shoreline habitat (littoral fringe)	Loss of shoreline habitat's ability to support breeding activities of local species
Disturbance of wildlife species from construction noise or activity	Injury, death, or harassment of wildlife
Disturbance of wildlife species from operational noise and human activity	Injury, death, or harassment of wildlife

The impact indicators for wildlife include habitat removal from construction, long-term habitat alteration from lower reservoir levels, and disturbance from increased noise levels and human activity. To analyze potential habitat loss, Reclamation quantified available suitable habitat in the Kachess and Keechelus watersheds from GIS maps. To analyze changes in wildlife habitat due to lower reservoir levels, Reclamation considered the life history traits of wildlife species likely to use shoreline habitats, the time of year and number of days the reservoir would be drawn down, and the extent of newly exposed area.

To analyze temporary disturbance to wildlife due to construction noise and human activity, Reclamation considered the types of construction activity, decibel levels produced by equipment, duration and intensity of construction, and the distance needed for construction noise to attenuate to ambient noise levels. Using the WSDOT Terrestrial Noise Calculator and standard noise attenuation formulas, Reclamation calculated three zones of impact for construction activity (explained in detail in Section 4.9, Threatened and Endangered

Species). Analysts determined that the following distances would allow construction noise to reach background levels:

- 4,200 feet for pumping plant construction (*Alternatives 2A, 2B,* and *4*)
- 5,450 feet for portal construction (*Alternatives 3A*, *3B*, and *4*)
- 1,650 feet for general construction (all alternatives) including the transmission line construction (*Alternative 2A – KDRPP East Shore Pumping Plant* only)

Figure 4-9 and Figure 4-10 show the zone of impact for wildlife disturbance associated with all of the alternatives.

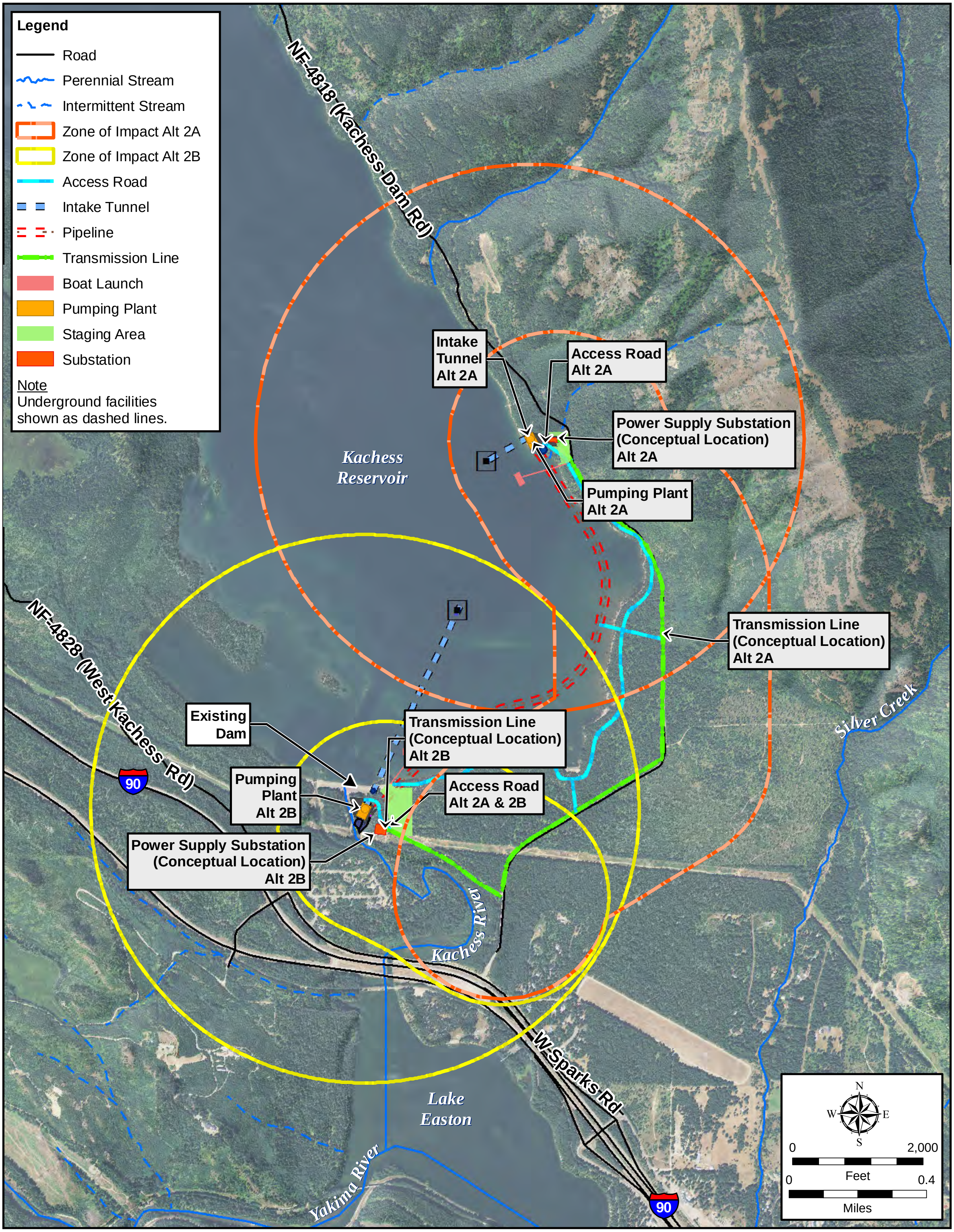

Figure 4-9. Wildlife Impact Zone in the Kachess Reservoir Study Area

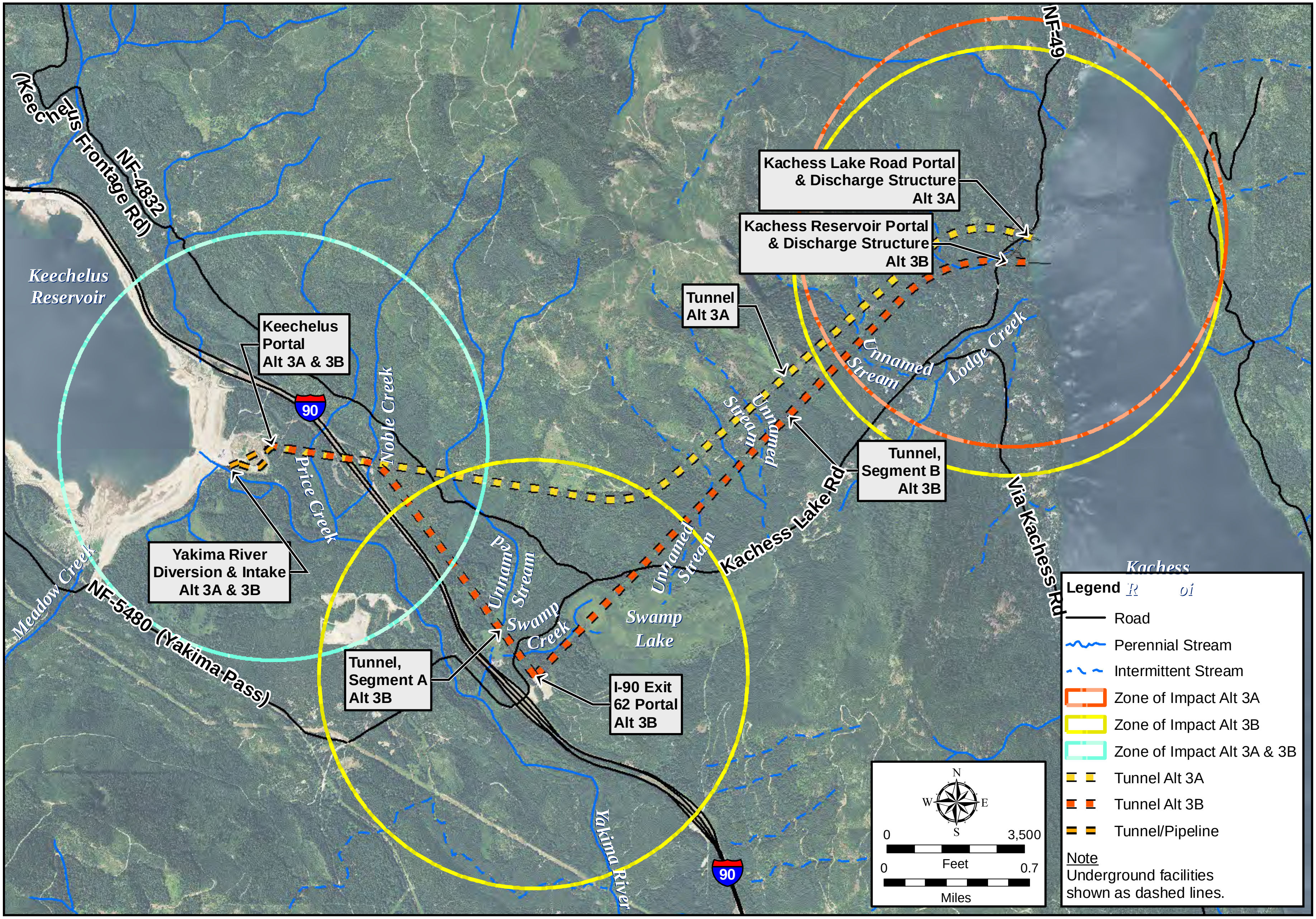

Figure 4-10. Wildlife Impact Zone in the Keechelus Reservoir Study Area

An impact on wildlife habitat would be negative if construction activities or operation of facilities resulted in one of three conditions:

- Direct loss of habitat (e.g., through tree removal, clearing, and grading)
- Injury, death, or harassment of wildlife in the primary study area (e.g., from construction-generated noise
- Habitat degradation (e.g., due to alterations in water levels and erosion)

The significance of a negative impact depends on the degree of expected wildlife habitat loss and alteration by habitat type relative to existing conditions, and the species using the habitat.

4.8.2 Summary of Impacts

Under *Alternative 1 – No Action Alternative*, wildlife conditions would remain similar to existing conditions, but wildlife would benefit from the ongoing wildlife connectivity improvements of the I-90 Phase 2A project. KDRPP and KKC would result in permanent loss of wildlife habitat in the proposed construction areas of each alternative. *Alternative 2A – KDRPP East Shore Pumping Plant* would result in greater habitat loss (18 acres) than Alternative 2B – *KDRPP South Pumping Plant* (9 acres), and *Alternative 3A – KKC North Tunnel Alignment* would result in greater habitat loss (4 acres) than *Alternative 3B – KKC South Tunnel Alignment* (1.5 acres). Combining KDRPP and KKC under *Alternative 4 – Combined KDRPP and KKC* could result in up to 22 acres of habitat loss.

In addition to habitat loss, KDRPP and KKC would disturb wildlife during construction and cause long-term alteration of habitat. All of action alternatives would result in impacts considered significant based on the criteria above, as summarized in Table 4-48.

Table 4-48. Summary of Impacts for Wildlife

Impact Indicator	Summary of Impact
Loss of wildlife habitat (forest and wetland)	*Alternative 2A* would result in greater permanent habitat loss (18 acres) than *Alternative 2B* (8 acres) and greater temporary habitat loss (57.5 acres compared to 36.5 acres). *Alternative 3A* would result in greater permanent habitat loss (4 acres) than *Alternative 3B* (1.5 acres) but lower temporary habitat loss (8.5 acres compared to 11.5 acres). *Alternative 4* would permanently replace approximately 9.5 acres (minimum) to 22 acres (maximum) of forested wildlife habitat and temporarily impact up to 69 acres. Impacts are considered significant under all action alternatives for localized species with small home ranges and not significant for transient species that occupy the larger watershed.
Alteration of shoreline habitat (littoral fringe)	Shoreline vegetation would be altered under *Alternatives 2A, 2B* and *4* by changes in hydrologic conditions. Impacts are not considered significant because permanent loss of wetlands is not expected.
Disturbance of wildlife species in the vicinity from construction noise or activities	*Alternatives 2A, 2B, 3A, 3B*, and *4* could result in direct harm (injury or death) or harassment of wildlife using habitat within or near the construction areas. Impacts are considered significant because direct harm or harassment could result.
Disturbance of wildlife species from increased noise levels and human activity associated with operation	*Alternatives 2A, 2B*, and *4* would create noise, light, and daily human activity near the pumping plant locations. These impacts are not considered significant because no direct harm or harassment of wildlife is expected. *Alternatives 3A* and *3B* would result in daily human activity at the discharge locations; these impacts are not considered significant because relatively low levels of noise are predicted.

The BTE actions would be implemented as part of all the action alternatives and would have both negative and positive effects on wildlife and wildlife habitat. The majority of negative effects are associated with construction, while operations would result in beneficial impacts.

4.8.3 Alternative 1 – No Action Alternative

Under *Alternative 1 – No Action*, Reclamation would continue to manage water supply provided by Kachess and Keechelus reservoirs consistent with current operational practices and constraints. Current trends in wildlife habitat and use in the Kachess and Keechelus basins would continue over the long term. However, wildlife would benefit from the connectivity improvements of the I-90 Phase 2A project (WSDOT, 2008); see Section 3.6 for details. Wildlife species expected to benefit the most include elk, deer, black bear, cougar, and bull trout. Additional species that would benefit include coyote, geese, and other waterfowl.

4.8.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.8.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Construction of the pumping plant, intake tunnel, surge tank, permanent access roads, outlet works and discharge, and transmission line would permanently replace approximately 18 acres of wildlife habitat in second-growth and mature coniferous forest and riparian communities, and 0.7 acre of wetland (Figure 2-1 and Tables 4-41 and 4-42) (see Section 4.7 for a discussion of wetland impacts). Construction would temporarily impact an additional 57.5 acres of forest, but this area would be revegetated with native species after construction is completed. The forest currently provides habitat for wildlife such as songbirds, woodpeckers, small mammals (such as chipmunks and squirrels), and deer (Figure 2-1). The removal of live trees, snags, or shrubs during construction may affect some bird, amphibian, reptile, or small mammal species either through direct loss of nests and young or by removal of potential nesting or foraging habitat. The loss of 18 acres of forest habitat would significantly impact species with small home ranges that overwinter or breed in the primary study area. Species most sensitive to the disturbance include interior forest songbirds (such as chickadees, kinglets, woodpeckers, all of which are protected under the Migratory Bird Treaty Act) and small mammals. The primary study area may also provide foraging habitat and refuge for transient large mammals such as black bear, cougar, and deer. The amount of habitat permanently lost under *Alternative 2A – KDRPP East Shore Pumping Plant* would be insignificant in comparison with the home ranges of these large mammal species. As a result, there would be no significant effect on large mammals due to construction under this alternative.

Wildlife using habitats in the primary study area would also be disturbed or displaced during construction. Noise from excavation, grading, and general construction traffic (e.g., dump trucks, hauling equipment) could disturb wildlife using habitats within 4,200 feet, while noise from construction of the reservoir intake and tunnel, outlet works, Kachess River discharge, and the transmission line could disturb wildlife within 1,650 feet (Figure 4-9). Additional analysis of the transmission line would be conducted as part of PSE's route study and environmental analysis.

Construction noise and increased human activity would cause short-term disturbance to wildlife within these zones during the 3-year construction period. Some individuals may not stay in the vicinity because of the disturbance; background levels of noise are expected outside of these impact zones (as described in detail in Section 4.9). For displaced wildlife, suitable habitat is potentially available nearby but away from areas of construction, although it would come at the cost of increased competition for food and other resources with wildlife already using those habitats.

In summary, impacts associated with construction of *Alternative 2A – KDRPP East Shore Pumping Plant* are expected to be significant because activities would result in permanent loss of wildlife habitat and injury, death, or harassment of nesting wildlife in habitats of the primary study area.

Bull Trout Enhancement

The BTE actions would enhance Gold Creek by modifying the stream channel and filling Gold Creek Pond and Heli's Pond, with the expectation that doing so would reduce summer dewatering events that adversely affect bull trout spawning and rearing (Section 2.4.5 discusses the beneficial effect of BTE for bull trout). The open-water and riparian habitats of the stream and ponds would be impacted by proposed activities. Between 5 acres (partial restoration) and 27 acres (full restoration) of open-water habitat would be lost as a result of the Gold Creek enhancement. An additional 2 acres of open-water habitat would be lost with the filling of Heli's Pond. Wildlife using those habitats during construction would be either lost through direct injury or death or displaced by noise and human activity. Species most likely to be affected include amphibians (if construction occurs during breeding season), waterfowl, and other wetland-dependent species.

Replacement of the Gold Creek USFS Bridge would result in short-term construction disturbance to wildlife species using the open-water and forest habitats in the Gold Creek floodplain. Construction is expected to remove substantial amounts of vegetated habitat within the floodplain. Construction is expected to last approximately 3 years, with activity occurring between April and October. This time interval coincides with the breeding season for many waterfowl species and songbirds; therefore, construction is expected to cause direct loss of nests, young, and foraging habitat, and disturbance due to noise and equipment. The disturbance may drive some individuals away from the vicinity.

The fish passage improvement activities at Cold Creek would require excavation and grading at the existing culvert and approximately 200 feet upstream of the new bridge. Construction impacts associated with this action are similar to those of the Gold Creek USFS bridge replacement. Wildlife using habitats in the vicinity would be disturbed by construction noise and increased human activity, and nesting birds or other breeding wildlife could be impacted. Waterfowl (e.g., mergansers, geese), kingfishers, swallows, and other birds would likely be the most affected. Section 4.9.4 describes impacts on bull trout and steelhead.

Construction impacts from the BTE are expected to be significant because activities would likely result in direct harm to nesting wildlife using the floodplain and riparian areas that would be modified during construction. Additional analysis of potential wildlife impacts will be conducted as the design of these actions progresses.

4.8.4.2 Operation

KDRPP East Shore Pumping Plant Facilities
Under *Alternative 2A – KDRPP East Shore Pumping Plant*, Reclamation would draw down the Kachess Reservoir by 40 to 80 additional feet in drought years. It could take 2 to 5 years after a drought for the reservoir to refill to its previous pool level. Impacts on wildlife habitat caused by operation of the new pumping plant include possible long-term alteration of shoreline vegetation due to changing hydrologic conditions. Under existing conditions, shoreline vegetation shifts periodically in response to the 60-to 80-foot fluctuation in pool level each year. Similar shifts would occur with operation of *Alternative 2A*. However, as discussed in Section 4.7.4, wetland and shoreline vegetation responses to prolonged reservoir drawdowns are highly variable. Reclamation does not anticipate significant permanent loss of wetlands along the shoreline and therefore wildlife habitat would not be substantially affected.

The operation of the proposed pumping plant for *Alternative 2A – KDRPP East Shore Pumping Plant* would not change wildlife habitats in the Kachess Reservoir, but would introduce noise and light that may affect wildlife in the primary study area. Maintenance workers would visit the site on a daily basis and the plant would produce a degree of noise. Birds can be affected by this type of anthropogenic noise because they rely extensively on acoustic communication. Ongoing noise (e.g., from industry or traffic) can reduce species richness, alter population age structure, and change avian predator-prey dynamics (Francis et al., 2009). However, Reclamation expects that noise produced by the pumping plant would be at or near background levels (Section 4.13). Therefore, wildlife impacts associated with operation of *Alternative 2A – KDRPP East Shore Pumping Plant* are not considered significant.

Bull Trout Enhancement
Operation of the new Gold Creek USFS Bridge and the proposed habitat and passage improvements to Gold Creek and Cold Creek are expected to have beneficial impacts for wildlife and wildlife habitat. After construction activities are completed, disturbed areas would be revegetated with native species and the riparian habitats along the stream would be restored to existing conditions. Furthermore, these actions would benefit waterfowl and other water-dependent species because of improved surface water connectivity between the habitats of Gold Creek and Cold Creek corridors and the Keechelus Reservoir.

Beneficial impacts associated with operation of the BTE actions could be significant for localized species with small home ranges or dependent on open-water habitats (such as waterfowl and amphibians).

4.8.5 Alternative 2B – KDRPP South Pumping Plant

4.8.5.1 Construction

KDRPP South Pumping Plant Facilities

The south pumping plant, intake tunnel, power supply, surge tank, permanent access roads, outlet works and discharge, and transmission line would permanently replace approximately 8 acres of wildlife habitat (Table 4-43 in Section 4.7.5). Construction would temporarily impact an additional 36.5 acres of forest, but this area would be revegetated with native species after construction is completed. The new pumping plant would permanently replace approximately 5 acres of multi-storied mature coniferous forest that contains a diverse understory and is contiguous with riparian habitats along the Kachess River. Although a portion of this forest would be affected under *Alternative 2A – KDRPP East Shore Pumping Plant* (for the outlet works and discharge), more vegetation would be cleared under *Alternative 2B – KDRPP South Pumping Plant*. As described above for *Alternative 2A,* impacts on species with small home ranges (e.g., songbirds, chipmunks, frogs, snakes) would be considered significant while impacts on large mammals would not, given availability of suitable habitat in the extended study area. This alternative would impact the same 0.5-acre wetland located south of the dam as *Alternative 2A – KDRPP East Shore Pumping Plant* (as described in Section 4.7.5).

Disturbance of wildlife using habitats in the primary study area would be slightly less under *Alternative 2B* than under *Alternative 2A* because the extent of construction would be approximately 8 acres less than the 18-acre loss expected under *Alternative 2A* (Figure 2-5 and Table 4-43). In addition, construction activities would occur in a smaller area (45 acres of permanent and temporary impact) than *Alternative 2A – KDRPP East Shore Pumping Plant*.

Overall impacts associated with the construction of *Alternative 2B – KDRPP South Pumping Plant* are expected to be slightly less than those for *Alternative 2A – KDRPP East Shore Pumping Plant* because of the reduced area of cleared vegetation. However, potential impacts of *Alternative 2B* are considered significant because habitat would be permanently lost and wildlife in habitats of the primary study area could be injured, killed, or harassed.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.8.4.1).

4.8.5.2 Operation

KDRPP East Shore Pumping Plant Facilities

Operation of the *Alternative 2B – South Pumping Plant* would have the same level of impact on wildlife and wildlife habitat along the shoreline of Kachess Reservoir as *Alternative 2A –*

KDRPP East Shore Pumping Plant. Reclamation would operate KDRPP the same regardless of the location of the facilities.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.8.4.2).

4.8.6 Alternative 3A – KKC North Tunnel Alignment

4.8.6.1 Construction

KKC North Tunnel Alignment Facilities
Construction of the new diversion and intake structure, portals, and discharge structure would cause the permanent loss of approximately 4 acres of wildlife habitat (predominantly second-growth coniferous forest) (Figure 2-6 and Table 4-44). Construction would temporarily impact an additional 8.5 acres of forest, but this area would be revegetated with native species after construction is completed. The removal of live trees, snags, and shrubs during construction may affect certain bird, amphibian, reptile, or small mammal species either through direct loss of nests and young or by removal of potential nesting or foraging habitats. The permanent loss of 4 acres of forest habitat could have substantial impact on species with small home ranges that overwinter or breed in the primary study area. The primary study area may also provide foraging habitat and refuge for transient large mammals such as black bear, cougar, and deer. The amount of permanent habitat lost under *Alternative 3A – KKC North Tunnel Alignment* is insignificant in comparison with the home ranges of these large mammal species. As a result, there would no significant effect on large mammals due to construction under this alternative.

Wildlife using habitats in the primary study area would be disturbed or displaced during construction. Noise from dredging, excavation, grading, tunneling operations, and general construction traffic (e.g., dump trucks, hauling equipment) could disturb wildlife using habitats within 5,450 feet of each portal location and within 1,650 feet of the Kachess River discharge and general construction areas (Figure 4-9). These effects would be present during the 3-year construction period. Some individuals may leave the vicinity because of the disturbance; noise is expected to be at background levels outside of these impact zones (as described in detail in Section 4.9). For displaced wildlife, suitable habitat is potentially available nearby, although it would come at the cost of increased competition for food and other resources with wildlife already using those habitats.

In summary, impacts associated with construction of *Alternative 3A – KKC North Tunnel Alignment* are expected to be significant because activities would result in permanent loss of wildlife habitat and injury, death, or harassment of nesting wildlife using habitats in the primary study area.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.8.4.1).

4.8.6.2 Operation

KKC North Tunnel Alignment Facilities
Operation of *Alternative 3A – KKC North Tunnel Alignment* would have no permanent impacts on wildlife habitat and minimal disturbance-related impacts on wildlife in the primary study area. The alternative would result in minimal changes to vegetation communities along the Keechelus Reservoir shoreline that support littoral wildlife habitat because there would not be multiyear periods of drawdown. Maintenance workers would visit the discharge structure on a daily basis to remove debris, clean, and maintain the facilities, but this minimal level of human activity and noise is not expected to significantly impact wildlife nearby. For the occasional facility repair required, noise would be limited to the immediate vicinity and the predicted decibel levels are unlikely to result in injury, death, or harassment of wildlife.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.8.4.2).

4.8.7 Alternative 3B – KKC South Tunnel Alignment

4.8.7.1 Construction

KKC South Tunnel Alignment Facilities
The Keechelus and I-90 portals and the Kachess Reservoir discharge portal would cause the permanent loss of approximately 1.5 acres of wildlife habitat (Figure 4-9 and Table 4-45). *Alternative 3B – KKC South Tunnel Alignment* would require clearing of additional 11.5 acres of vegetation to accommodate the I-90 Exit 62 portal and the temporary access road, but these areas would be revegetated after construction. As described under *Alternative 3A – KKC North Tunnel Alignment*, direct loss of nests or other breeding wildlife would be considered a significant impact. However, the permanent loss of 1.5 acres of second-growth coniferous forest is not considered a significant impact on wildlife with either small or large home ranges; the area of loss is small and ample similar habitat is available in the primary study area.

Disturbance of wildlife using habitats in the primary study area under *Alternative 3B* would be greater than under *Alternative 3A* because the former would require a third portal to allow tunneling in two directions and construction activity in more locations. Construction would disturb wildlife using habitats within the zone of impact and individuals may leave the vicinity as described under *Alternative 3A – KKC North Tunnel Alignment*.

Overall impacts associated with construction of *Alternative 3B – KKC South Tunnel Alignment* are expected to be slightly greater than those for *Alternative 3A – KKC North Tunnel Alignment* because of the increased area of construction (for the third portal). Impacts are considered significant because wildlife using habitats in the primary study area could be directly harmed. However, long-term loss of wildlife habitat under this alternative is not expected to be significant because of the small area of permanent impact.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.8.4.1).

4.8.7.2 Operation

KKC South Tunnel Alignment Facilities

Operation of *Alternative 3B – KKC South Tunnel Alignment* would have the same level of impacts on wildlife and wildlife habitat as *Alternative 3A – KKC North Tunnel Alignment.* Reclamation operations would be the same regardless of the tunnel alignment.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.8.4.2).

4.8.8 Alternative 4 – Combined KDRPP and KKC

4.8.8.1 Construction

KDRPP and KKC Facilities

Combining KDRPP and KKC would permanently replace approximately 9.5 acres (minimum) to 22 acres (maximum) of wildlife habitat in second-growth and mature coniferous forest (Table 4-46). As with the individual actions, this degree of habitat loss would have significant impact on species with small home ranges that overwinter or breed in the primary study area (such as songbirds, amphibians, reptiles, and small mammals). The combined actions are not expected to have significant impact on transient large mammals (e.g., black bear, cougar, deer) because the loss is insignificant in comparison with their much larger home ranges.

Alternative 4 – Combined KDRPP and KKC would not cause any additional disturbance impacts beyond those discussed for *Alternatives 2* and *3*. If Reclamation constructed KDRPP and KKC simultaneously, wildlife using habitats at multiple sites would be impacted by injury, death, or harassment as described under each individual alternative. This impact is considered significant.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.8.4.1).

4.8.8.2 Operation

KDRPP and KKC Facilities
Combined operation could reduce the drawdown of Kachess Reservoir during drought years and would allow Reclamation to refill Kachess Reservoir more quickly. Therefore, the duration of drawdown-induced impacts on wildlife habitat would be shorter. However, wildlife impacts due to the drawdown would still not be considered significant during drought years (similar to *Alternatives 2* and *3*).

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.8.4.2).

4.8.9 Mitigation Measures

The mitigation measures identified in Section 4.7.9, Vegetation would minimize impacts on wildlife during construction of KDRPP, KKC, and BTE actions. Avoidance and minimization of vegetation removal to the extent possible would reduce impacts on wildlife and wildlife habitats. Areas cleared for construction and temporary access would be replanted where possible. For the BTE, the disturbed streambed and riparian habitats along the stream corridor would be regraded and revegetated.

4.9 Threatened and Endangered Species

This section describes the potential impacts to bull trout, MCR steelhead, and northern spotted owl. As described in Section 3.9.6, wolves, grizzly bear, and Canada lynx may occur in the primary study area on a transient basis; no breeding populations are known to occur in these areas. No suitable habitat for marbled murrelet exists in the primary study area. These species are not likely to be affected by the Proposed Action and are not further discussed.

4.9.1 Methods and Impact Indicators

Methods. Reclamation reviewed Federal and State databases to determine the presence of Endangered Species Act (ESA) listed species likely to be located in the analysis area. Reclamation conducted a literature review to determine the preferred habitat and life cycles of those species and analyze how the additional inundation around the shoreline would affect that habitat. Reclamation evaluated potential noise impacts by comparing expected construction noise levels with the thresholds established by the U.S. Fish and Wildlife Service (Service).

Impact Indicators. Table 4-49 and Table 4-50 show the Federal threatened and endangered species impact indicators and criteria for determining impact significance. The impact indicators for listed bull trout and MCR (Middle Columbia River) steelhead are the same as for fish species in Section 4.6.1. Reclamation assessed all criteria relative to the *Alternative 1 - No Action*.

Table 4-49. Impact Indicators and Significance Criteria for Northern Spotted Owl

Impact Indicator	Significance Criteria
Disturbance of northern spotted owl from construction noise and activities	Noise levels exceeding noise-only injury and noise-only disturbance thresholds established in the biological opinion for the Olympic National Forest Program of Activities would constitute an adverse impact to northern spotted owl. Noise levels exceeding the established noise-only alert and noise-only detectability thresholds would constitute a minor impact to northern spotted owl.
Loss or degradation of habitat that supports northern spotted owl	Any reduction in area or functionality of habitat suitable for supporting northern spotted owl would constitute an adverse impact to northern spotted owl.
Disturbance of northern spotted owl from increased noise levels and human activity associated with project operation	Noise levels exceeding noise-only injury and noise-only disturbance thresholds established in the biological opinion for the Olympic National Forest Program of Activities would constitute and adverse impact to northern spotted owl. Noise levels exceeding the established noise-only alert and noise-only detectability thresholds would constitute a minor impact to northern spotted owl.

The impact indicators for threatened and endangered species are habitat loss and disturbance of the species. Impacts are largely related to vegetation removal, clearing and grading activities, and increased noise and human activity during construction. Impact indicators specific to bull trout and MCR steelhead are the same as those used for fish species in Section 4.6 as summarized in Table 4-31 in Section 4.6.1.

4.9.2 Summary of Impacts

4.9.2.1 Bull Trout and MCR Steelhead

Impacts to bull trout and MCR steel head are similar to those described in Table 4-32 of Section 4.6 Fish and would affect the impact indicators (Table 4-31).

Under *Alternative 1 – No Action*, habitat conditions for bull trout and MCR steelhead would continue similar to existing conditions (Section 3.6). Climate change could exacerbate existing negative bull trout habitat conditions by increasing water temperature and decreasing reservoir residence time. Decreased reservoir levels with climate change would further restrict bull trout access to tributary streams and between the two historical lake basins in Kachess Reservoir. The lack of passage above Kachess and Keechelus dams would continue to limit the opportunity for bull trout populations to migrate between the reservoirs and downstream habitats within the Yakima River basin. The lack of connectivity between reservoir populations reduces access to foraging, rearing and spawning habitats downstream of the reservoirs or interbreeding with other populations to increase the diversity and resiliency of the populations within the reservoirs. Habitat connectivity improvements associated with the I-90 Phase 2A project (see Section 4.4.3, Surface Water Quality) would provide improved conditions for bull trout within Keechelus Reservoir and tributaries. Climate change may limit Reclamation's operational flexibility to meet instream flow requirements for bull trout and MCR steelhead.

Impacts for all the action alternatives would be similar to those described for fish in Table 4-32. All action alternatives would generate construction noise and could cause temporary increases in turbidity that could negatively impact bull trout and MCR steelhead.

Water temperatures within Kachess Reservoir may increase under *Alternatives 2A* and *2B*, which could result in negative impacts on bull trout. Under *Alternatives 2A* and *2B*, reductions in Kachess Reservoir minimum pool elevation may increase surface heating during the summer months increasing water temperatures within the reservoir. Under *Alternative 4*, Keechelus Reservoir pool elevations would be lower than existing conditions (Figure 4-8, Surface Water Resources) following drought years, potentially resulting in more surface heating during the summer months as the reservoir pool level recovers to nondrought conditions.

Habitat connectivity for bull trout between the reservoirs and tributaries and connectivity between Kachess Reservoir lake basins would be affected by all action alternatives. Under *Alternatives 2A*, *2B*, and *4*, the reduction in Kachess Reservoir operating level (up to 80 feet) would have a negative impact on bull trout passage and connectivity between reservoir and tributary habitats and within reservoir lake basins. For Keechelus Reservoir, *Alternative 2A* and *2B* would increase the frequency and duration of impeded fish passage between reservoir and tributary habitats causing negative impacts to bull trout. However, under *Alternative 3A* and *3B*, decreases in the frequency and duration of impeded fish passage would represent a beneficial impact to habitat connectivity between reservoir and tributary habitats for bull trout.

The availability of food-based prey for bull trout would be affected by several of the action alternatives. Under all of the action alternatives, decreased hydraulic residence time and lower minimum reservoir elevation in Kachess Reservoir would decrease the availability of prey. Under *Alternatives 2A, 2B*, and *4*, decreased hydraulic residence time in Keechelus Reservoir would reduce the availability of food-based prey. However, under *Alternatives 3A* and *3B* smaller fluctuations in reservoir level and increased hydraulic residence times during drought years could have a positive impact on the availability of aquatic prey in Keechelus Reservoir.

Under *Alternatives 2A, 2B,* and *4,* reservoir habitat complexity available to bull trout may be impacted by reductions in shoreline vegetation at facility locations along Kachess Reservoir, greater fluctuations in Kachess Reservoir levels, reductions in Kachess Reservoir minimum elevation, and lower reservoir levels in Keechelus Reservoir following drought years. *Alternatives 3A* and *3B* could have positive impacts on habitat complexity because smaller fluctuations in reservoir level would increase shoreline vegetation and habitat complexity within Keechelus Reservoir.

Alternatives 3A, 3B and *4* would improve summer instream flow conditions for MCR steelhead in the Keechelus Reach of the Yakima River potentially resulting in a significant increase in the productivity and abundance of steelhead.

The BTE actions would be implemented as part of all the action alternatives and would have positive impacts by increasing habitat connectivity between reservoir and tributary habitats in Keechelus Reservoir.

4.9.2.2 Northern Spotted Owl

Under *Alternative 1 – No Action*, the I-90 Phase 2A project would cause some loss or degradation of habitat supporting northern spotted owl in the primary study area, but significant property acquisition in potential northern spotted owl habitat included as project mitigation would offset any habitat along the less suitable and fragmented habitat along the I-90 corridor. Therefore, WSDOT anticipates the I-90 Phase 2A project to improve conditions for terrestrial wildlife in the primary study area (WSDOT, 2008).

Construction and operation of facilities under the action alternatives would result in permanent loss of forested habitat that supports northern spotted owl, and increased noise and human activity that would cause adverse and minor impacts to the northern spotted owl. *Alternative 2A* and *Alternative 4* have the potential for the highest loss or degradation of suitable habitat because they involve the highest amount of mature and second-growth forest removal. The BTE actions would have limited benefits to northern spotted owl, primarily related to Gold Creek habitat improvement actions.

None of the action alternatives would be likely to cause injury or direct harm to northern spotted owl from increased noise and human activity. However, all action alternatives have the potential to result in disturbance behaviors in northern spotted owl. In general, those projects with close proximity to northern spotted owl detection areas and occupied nest sites have the highest potential to adversely impact northern spotted owl. *Alternative 2A* has the highest number of project areas in close proximity to occupied habitat and therefore has a higher potential to result in disturbance behaviors. Given the proximity of project areas to occupied habitats under both *Alternatives 2* and *3*, constructing KDRPP or KKC simultaneously (*Alternative 4*) would further increase this potential for eliciting disturbance behaviors in northern spotted owl. Table 4-50 summarizes these impacts to northern spotted owl.

Table 4-50. Summary of Impacts for Northern Spotted Owl

Impact Indicator	Summary of Impact
Loss or degradation of habitat that supports northern spotted owl	All alternatives would have significant adverse impacts on northern spotted owl with the exception of *Alternative 1- No Action*. For *Alternatives 2* and *3*, the amount of vegetation removal within suitable habitat ranges from 12.5 to 75.5 acres with *Alternative 2A* having the largest area of vegetation removal followed by *Alternative 2B, Alternative 3B, Alternative 3A,* and BTE. Between 57 and 88.5 acres of forested habitat would be lost under *Alternative 4.*
Disturbance of northern spotted owl from construction noise and activities	All alternatives would result in increased noise and human activity. No alternatives are expected to result in noise that would result in harm or injury to threatened or endangered terrestrial species; however, noise exceeding the noise-only disturbance threshold may be experienced resulting in significant adverse impacts under all alternatives except *Alternative 1*. *Alternative 2A* has the highest potential for resulting in noise impacts followed by *Alternatives 4*, *Alternative 2B*, BTE, *Alternative 3B*, and *Alternative 3A*.
Disturbance of northern spotted owl from increased noise levels and human activity associated with project operation	*Alternatives 2A* and *2B* would create noise, light, and daily human activity near the pumping plant locations. These impacts are considered minor because noise levels exceeding the noise-only injury and noise-only disturbance thresholds are not expected. *Alternatives 3A* and *3B* would result in daily human activity at the discharge locations; these impacts are considered minor because noise levels exceeding the noise-only injury and noise-only disturbance thresholds are not expected.

4.9.3 Alternative 1 – No Action Alternative

Current trends in threatened and endangered species habitat and use in the Kachess and Keechelus basins would continue over the long term. Conditions would remain similar to the baseline condition; however, threatened and endangered terrestrial species would potentially benefit from the ongoing wildlife connectivity improvement actions of the I-90 Phase 2A project. This would only apply to species such as grizzly bear, gray wolf, and Canada lynx; however, these species overall would be considered extremely rare visitors to the I-90 corridor within the primary study area or extended study area.

4.9.3.1 Bull Trout

Under *Alternative 1 - No Action*, bull trout in Keechelus Reservoir would be exposed to short-term and long-term construction impacts associated with improvements to I-90 described in Section 4.6 Fish. Bull trout may have greater sensitivity to some forms of habitat change or disturbance because of their unique life history. Overall, WSDOT expects the I-90 project to improve habitat connectivity for bull trout between reservoir and tributary habitats.

Under *Alternative 1 - No Action*, Reclamation would operate both Keechelus and Kachess reservoirs in the same manner as existing conditions. The habitat available to bull trout within the reservoirs and tributaries would reflect seasonal water withdrawal and refill patterns where pool elevations are typically highest in late June and early July and lowest in late October and early November. Although bull trout populations have persisted under the existing operations, passage issues between reservoir and tributary habitats occur commonly when reservoirs are drawn down and limit access between tributary spawning and reservoir rearing habitats (Reiss et al., 2012).

Under *Alternative 1 - No Action*, bull trout are expected to continue to be rare in the upper Yakima River and Kachess River (Reiss et al., 2012) because instream flows are too high in summer months.

Because bull trout require clean cool water, future climate change may pose a significant risk to bull trout throughout their existing range (Rieman et al., 2007) and particularly those populations currently isolated within both reservoirs. Climate change would likely affect both Keechelus and Kachess reservoirs by increasing water temperatures (Rieman et al., 2007) and reducing Reclamation’s ability to refill the reservoir following droughts (Mastin, 2008). Increasing water temperatures may decrease the suitability of reservoir and tributary habitats for bull trout, leading to increased population fragmentation and lowered resiliency to other stressors (Rieman et al., 2007). More variable reservoir fluctuations, resulting from an inability to refill, could reduce diversity of aquatic invertebrates (Fisher and LaVoy, 1972) that provide food for juvenile bull trout or other fish species that bull trout prey upon. Additionally, more variable reservoir levels may reduce shoreline vegetation (Braatne et al., 2007) or disconnect existing vegetation from shoreline areas where it provides cover and habitat complexity for fish. The inability to refill the reservoirs after droughts may also make existing passage issues worse between tributary and reservoir habitats, thereby further limiting spawning and rearing opportunities for bull trout that migrate between the two habitat types (Ackerman et al., 2002; Reiss et al., 2012).

Under *Alternative 1 - No Action*, no bull trout enhancement activities would be undertaken and populations in both reservoirs would remain vulnerable to continued declines because of low abundance, lack of genetic diversity, existing passage barriers within tributaries and at reservoir dams, tributary dewatering, availability of prey and other risks (Reiss et al., 2012).

4.9.3.2 MCR Steelhead

Under *Alternative 1 - No Action*, existing operational flow patterns, which differ seasonally from the natural streamflow regime, would continue in the Yakima River. From October to March, flow is reduced and less variable; from April to June, flow is reduced; and from July to September, flow is greatly increased.

Under *Alternative 1 - No Action*, flows within the Keechelus Reach of the Yakima River would remain too high from July through early September when juvenile steelhead would potentially rear in this reach. Juvenile steelhead seek protection against high-velocity flows to avoid being pushed downstream into less desirable habitat and minimize energy expenditures. High summer flows and high water velocities reduce the amount of suitable rearing habitat for steelhead (Reclamation and Ecology, 2011c).

Currently, steelhead production in the Keechelus Reach has not been detected and is assumed to be zero (Hubble, 2014b). Regional biologists believe that high summer flows in July, coinciding with the emergence of hatchling juvenile steelhead, flush the juveniles downstream away from cover or suitable rearing habitat and reduce post-emergent survival to zero. The post-emergent mortality resulting from high summer flows is thought to constrain the production potential of the reach for steelhead (Hubble, 2014b).

Under *Alternative 1 - No Action*, flows within the Keechelus Reach would also remain too low in winter, and flow pulses would be absent in the spring due to runoff being captured by Keechelus Reservoir. Lower winter flows reduce available rearing and overwintering habitat throughout the fall and winter, and into early spring in dry years. Flow pulses in spring mimic natural conditions and are needed to support juvenile outmigration (Reclamation and Ecology, 2011c).

Reclamation would continue to have limited flexibility to meet instream flow targets in the Easton Reach. These targets include increasing spawning and rearing habitat and improving outmigration conditions through adding flow during the fall and winter and adding a spring pulse. Increasing base flows to 220 cfs in September and October in dry years and to 250 cfs during the rest of the year would benefit steelhead, which spawn and rear in the Easton Reach.

Instream flows in the Kachess River below Kachess Dam are expected to remain unsuitable for MCR steelhead. MCR steelhead have not been observed in the Kachess River (Hubble, 2014a).

4.9.3.3 Northern Spotted Owl

Under *Alternative 1 - No Action*, habitat supporting northern spotted owl would generally continue similar to existing conditions. Northern spotted owl would continue to be exposed to background noise that currently typifies the area, including construction associated with the I-90 Phase 2A project. FHWA and WSOT determined that the I-90 Phase 2 project would result in increased noise and human activity potentially resulting in adverse impacts to northern spotted owl (WSDOT, 2008). However, during ESA consultation, the Service determined that there would be no substantial adverse impact on northern spotted owl overall. Operationally, the I-90 Phase 2A project would result in approximately a 5 percent increase in noise over background. However, because northern spotted owls do not currently nest in the vicinity of the I-90 corridor, the Service considered the slight increase over existing noise conditions an insignificant impact on northern spotted owl. The I-90 Phase 2A project would result in some loss of terrestrial habitat; however, the acquisition of 265 acres of suitable owl habitat along the I-90 corridor would offset any habitat along the less suitable and fragmented habitat along the I-90 corridor. Therefore, the I-90 Phase 2A project is expected to improve conditions for terrestrial wildlife in the primary study area.

4.9.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.9.4.1 Construction

KDRPP East Shore Pumping Plant Facilities
Bull Trout
The impacts on bull trout resulting from *Alternative 2A – KDRPP East Shore Pumping Plant* are the same as those described for fish in Section 4.6.4.1. Construction activities would affect habitats in the Kachess Reservoir and Kachess River. Construction-related impacts at Kachess Reservoir would include construction-related disturbance and a temporary change in the functionality of habitat. Specific impacts include the following:

- Removal of shoreline vegetation and disturbance of the Kachess Reservoir shoreline associated with site preparation, construction of the pumping plant, and temporary construction facilities (i.e., access roads, staging areas, and temporary boat launch and construction area). These would have a negative impact on habitat complexity in the reservoir for bull trout and other fish as described in Section 4.6.4.1.
- Impacts of erosion and sedimentation from construction of the reservoir intake, spoils disposal, and temporary construction facilities (i.e., temporary construction roads adjacent to reservoir, a temporary boat launch, and construction basin). These activities would increase turbidity and have a negative impact on bull trout and other fish species as described in Section 4.6.4.1.
- Noise disturbance associated with the construction activities in the reservoir. Increased noise levels may alter bull trout behavior in habitats adjacent to the construction area as described in Section 4.6.4.1.

Within Kachess River, *Alternative 2A – KDRPP East Shore Pumping Plant* would require construction of a discharge spillway at the headwaters of the Kachess River immediately downstream of the dam. Site preparation and construction of the discharge spillway would disturb shoreline vegetation and sediments and may cause temporary negative impacts on bull trout in the vicinity of these activities. Section 4.6.4.1 describes the impacts of shoreline disturbance and turbidity. Bull trout are rarely observed in the Kachess River (Reiss et al., 2012; Hubble, 2014a), so few if any fish would be impacted by construction activities.

Under *Alternative 2A – KDRPP East Shore Pumping Plant*, no construction activities would occur in Keechelus Reservoir.

MCR Steelhead
MCR steelhead are not present in Kachess Reservoir and have not been observed in the Kachess River (Hubble, 2014a). Thus, no MCR steelhead impacts are anticipated from construction activities associated with *Alternative 2A – KDRPP East Shore Pumping Plant*.

Northern Spotted Owl
Construction of *Alternative 2A – KDRPP East Shore Pumping Plant* would result in increased noise and human activity exceeding the noise-only disturbance thresholds and the loss and degradation of habitat that support the northern spotted owl thereby having significant adverse impacts to northern spotted owl.

Noise. Construction would generate increased noise, which has the potential to affect species such as the northern spotted owl. The information presented below provides a baseline for analyzing impacts.

Threshold distances have been established where a target species (in this case the northern spotted owl) elicit a specific response to noise (Service, 2003). Threshold distances used are from a biological opinion for the Olympic National Forest Program of Activities, and may not necessarily apply in all situations, especially since forest practices generally use equipment that differs from construction equipment and includes the use of noise-reducing conservation measures (Service, 2003).

The threshold distances include the following:

- Noise-only detectability threshold (where the noise is detectable to a spotted owl, but the owl does not show a response) – 4 dBA above baseline or ambient noise levels)
- Noise-only alert threshold where the northern spotted owl shows an apparent interest by turning the head or extending the neck – 57 dBA
- Noise-only disturbance threshold where the spotted owl shows avoidance of the noise by hiding, defending itself, moving the wings or body, or postponing a feeding – 70 dBA

- Noise-only injury threshold where the spotted owl is actually injured, which can be defined as an adult being flushed from a nest or the young missing a feeding – 92 dBA

The detectability, alert, and disturbance threshold distances differ as baseline noise differs, but the injury threshold of 92 dBA remains constant.

Construction noise is a point-source noise. Noise from a point source spreads spherically over distance, traveling in all directions equally from the source. The standard reduction for point-source noise is 6 dB per doubling of distance from the source (Service, 2003). An additional 1.5 dB reduction occurs when soft site conditions exist, such as ground cover or normal unpacked earth between the source and the receptor. Dense vegetation can reduce noise levels by 5 dB for every 100 feet of vegetation, up to a maximum of 10 dB. As this project has several work elements in the project area that would be spatially and temporally separated, noise for each of the primary construction activities are discussed separately.

The expected, combined noise level of all construction equipment (e.g., excavator, dozers, cranes and graders) operating together during construction would be 88 dBA at a distance of 50 feet from the source. General construction activities include those necessary to construct temporary and permanent access roads and causeways, pipeline construction from the east shore pumping plant to the outlet works and discharge area at the Kachess River, transmission line construction, concrete batch plant operation, staging and stockpile areas, construction basin and boat launch, and spoils disposal.

In general, soft site conditions exist in areas where construction would occur, which means that noise levels would attenuate at a rate of 7.5 dB less per doubling of distance. An additional 10 dB due to dense vegetation would reduce each calculation further. Anticipated background noise is approximately 40 dB. Spotted owl occurrence in the primary study area is likely because of the presence of suitable nesting and dispersal habitat within the focused portions of the primary study area, and because of documented occurrences of northern spotted owl in the primary study area (USFS, 2014). Construction noise would travel up to 1,650 feet before reaching background noise levels. The closest documented occurrence of an active reproducing pair of spotted owls from general construction activities is approximately 0.28 miles (about 1,500 feet) (USFS, 2014). In addition, several detections have also been noted in the primary study area.

Noise levels associated with general construction activities would not result in harm or injury to northern spotted owls, if present. However, they may elicit disturbance behaviors within 104 feet of construction activities. It is likely that noise associated with general construction activities would result in some level of disturbance, particularly if the activities were to occur during or overlap with the breeding season for northern spotted owl.

Noise generated at the pumping plant construction site would be similar to that observed for other general construction activities. However, pumping plant construction would require the use of confined drill and blasting techniques for a portion of the proposed pumping plant shaft. Blasting would not be required in the upper 150 feet of shaft construction due to presence of unconsolidated materials, but blasting would be required at depths below 150 feet at which point the soil and bedrock interface is reached. Since blasting noise is infrequent and of short duration, impacts from blasting activities are generally assessed using a different metric than more continuous construction noises described above. Other considerations when looking at blasting noise are the size of charges being used, the type of substrate (bedrock typically requires more time and effort than less dense substrates), type of detonation system, directivity, and any use of BMPs to minimize noise propagation through the air. With respect to directivity, blasting that occurs aboveground would act like point-source noise and spread spherically from the source. Where blasting would occur below ground level, as in the case of the pumping plant shaft construction, some directivity occurs, which directs the force of the blast upwards more than horizontally, thereby lessening the noise impacts of the blast. For that reason, noise from blasting within the shaft is more similar to mitigated rock fracturing, which has a noise level of 98 dBA at a distance of 50 feet from the source. This compares to blasting associated with rock slope production which has a noise level of 126 dBA at a distance of 50 feet from the source. Construction noise would travel up to 4,200 feet before reaching background noise levels. As noted above, the closest documented occurrence of an active reproducing pair of spotted owl from access road and causeway construction is about 1,500 feet and several detections have been noted in the analysis area.

Noise levels associated with construction of the pumping plant would not result in harm or injury to northern spotted owls, if present. However, they may elicit disturbance behaviors within 260 feet of construction activities. It is likely that construction noise would result in some level of disturbance during access road construction activities, particularly if they were to occur or overlap with the breeding season for northern spotted owl.

Vegetation Clearing. Vegetation clearing would be necessary to accommodate the east shore pumping plant, permanent access road to the pumping plant, power supply substation, transmission line, permanent maintenance access road to the pumping plant pipeline, a portion of pipeline near the dam, and to accommodate the Kachess River discharge (outlet works) on the south side of the Kachess Dam. Overall, the project would require approximately 75.5 acres of vegetation clearing, most of which is mature conifer forest. In particular, the forested habitat adjacent to the outlet works contains a higher proportion of large, mature conifer trees in comparison to other areas slated for clearing. Table 4-42 in Section 4.7 Vegetation and Wetlands identifies the area of clearing and grading, whether the clearing is permanent, and the dominant vegetation type.

The east shore pumping plant is not located within designated critical habitat for the northern spotted owl. However, a portion of the transmission line and the outlet works construction area would be located within designated critical habitat. Removal of trees in these areas would constitute an adverse impact on designated critical habitat for the northern spotted owl.

Bull Trout Enhancement

Bull Trout and MCR Steelhead

Construction impacts to bull trout would be the same as described for fish in Section 4.6.4. No MCR steelhead are located upstream of Keechelus Dam, so no impacts to that species would occur.

Northern Spotted Owl

Construction activities associated with BTE actions at Gold Creek and Cold Creek would cause increased noise and human activity and removal of vegetation, which could adversely affect northern spotted owl, if present.

Construction activities would require the use of heavy equipment within the floodplain of Gold Creek from the mouth of the creek upstream to Heli's Pond. In general, most construction activities would result in noise levels above background conditions for a distance of 1 mile from the primary study area. Noise levels would not be expected to directly injure or harm northern spotted owls but could result in disturbance behaviors in owls, if they are present. The closest occupied nest sites for northern spotted owl are approximately 2.6 miles southwest of the primary study area, well outside the range of noise impacts. Suitable habitat for northern spotted owl is absent from the primary study area (USFS, 2011a). Therefore, noise would not be expected to result in adverse impacts to northern spotted owl.

Replacement of the existing Forest Service bridge over lower Gold Creek would likely result in the highest level of noise. However, the environmental assessment prepared for that project found that there would be no adverse impact to northern spotted owl (USFS, 2011a).

The BTE actions at Gold Creek would require some limited vegetation clearing within floodplain and riparian habitats. Therefore, some minor impacts to northern spotted owl could be anticipated from habitat alteration. The project would also impact habitat in areas designated as critical habitat for northern spotted owl.

Construction activities necessary to enhance bull trout habitat in Cold Creek would be similar to that described above for Gold Creek. The closest occupied nest site to the Cold Creek project area is approximately 7,500 feet (1.4 miles). Considering the topography of the area and overall distance, adverse impacts to northern spotted owl from increased noise and human activity are not anticipated.

Some vegetation clearing would likely be required to construct temporary access to the construction area. These areas would be restored following construction but may take up to 50 years to reach the maturity of the vegetation to be removed. Removal of habitat containing mature conifers and a multi-layered canopy would be considered an adverse impact to northern spotted owl. These minor impacts would extend until planted vegetation reaches maturity. The Cold Creek project area is largely within habitat not currently designated as critical habitat for northern spotted owl, but temporary roads constructed to access the site would likely be located in areas designated as critical habitat. Vegetation clearing in these areas would likely be considered an adverse impact to critical habitat for northern spotted owl.

The BTE actions would undergo individual environmental review and would be required to meet all local, State, and Federal requirements. As such, adverse impacts to northern spotted owl would be avoided and minimized to the extent practicable.

4.9.4.2 Operation

KDRPP East Shore Pumping Plant Facilities
Bull Trout
Under *Alternative 2A – KDRPP East Shore Pumping Plant*, operations would affect bull trout in Kachess Reservoir, Kachess River, Keechelus Reservoir, and the Yakima River.

Kachess Reservoir. The operation impacts of *Alternative 2A – KDRPP East Shore Pumping Plant* on bull trout are the same as described for fish in Section 4.6.4.2 and include the following:

- Reduction in Kachess Reservoir minimum pool elevation could increase water temperatures, expose the lower reservoir bed to wave action and increase turbidity, reduce shoreline vegetation and habitat complexity, reduce connectivity between reservoir and tributary habitats, and reduce connectivity between reservoir habitats compared to existing conditions.
- Decreased hydraulic residence time and lower minimum reservoir elevation would reduce available zooplankton prey in Kachess Reservoir compared to the baseline. Zooplankton provide the forage base for resident fish species that bull trout prey upon.

Kachess River. Under *Alternative 2A – KDRPP East Shore Pumping Plant,* flows in the Kachess River would be similar to the baseline on average but would increase significantly during summer drought years. Increases in summer instream flow would represent a negative impact on bull trout (Section 4.6.4.2). However, bull trout are rarely observed in the Kachess River (Reiss et al., 2012; Hubble, 2014a) so few if any fish would be affected. Kachess River is a lesser priority for improving river flow because of other objectives in the Integrated Plan (Reclamation and Ecology, 2011c).

Keechelus Reservoir. The operation impacts of *Alternative 2A – KDRPP East Shore Pumping Plant* on bull trout are the same as described for fish in Section 4.6.4.2 and include the following:

- Lower reservoir levels after drought years could reduce shoreline vegetation and habitat complexity, and reduce connectivity between reservoir and tributary habitats compared to existing conditions.
- Decreased hydraulic residence time and lower reservoir levels after drought years could cause a minor decrease in available prey in Keechelus Reservoir compared to existing conditions, but the reduction is not anticipated to be significant.

Yakima River. The operation impacts of *Alternative 2A – KDRPP East Shore Pumping Plant* on bull trout are the same as described for other fish species in Section 4.6.4.2 and include the following:

- Streamflows in the Keechelus Reach would change slightly, as summarized in Table 4-8, Table 4-34, and Appendix E, Figure E-2. However, the streamflow in Keechelus Reach under *Alternative 2A – East Shore Pumping Plant* would remain within current operating ranges with no decrease in most years. As a result, no benefit to instream flow in the Keechelus Reach would occur (Section 4.3.4.2) and no impacts to bull trout or are expected.
- Streamflows in the Easton Reach, would change slightly from *Alternative 1 –No Action*, as summarized in Table 4-9 and illustrated in Appendix E, Figure E-3. The slight flow increase during drought years in the Easton Reach (and downstream along the Yakima River to Roza Dam) would remain within current operating flows experienced in most years. As a result, no significant impact on flow conditions would result (Section 4.3.4.2) and no impacts to bull trout are expected.

Section 4.6.4.2 describes the interactions between instream flow targets and habitat function for resident and anadromous fish in more detail.

MCR Steelhead

Under *Alternative 2A – KDRPP East Shore Pumping Plant*, operations are not expected to affect MCR steelhead within the Yakima River compared to *Alternative 1-No Action* because changes in flows would be minor and within existing operational ranges. The impacts on MCR steelhead habitat are the same as those described for bull trout in the Yakima River in Section 4.9.4.2 and other salmonids described in Section 4.6.4.2.

Northern Spotted Owl

Under *Alternative 2A – KDRPP East Shore Pumping Plant* operations, the disturbance to northern spotted owl caused by increased noise and human activity would be minor as noise levels are anticipated to be at or below the noise-only alert and noise-only detectability thresholds.

The majority of equipment, especially those that have the potential to raise ambient noise levels such as pumps, would be below ground within the pumping plant shaft. Significant adverse impacts to northern spotted owl in relation to noise from pumping plant operations would not be anticipated because noise levels would not exceed the noise-only injury or noise-only disturbance thresholds.

Bull Trout Enhancement

Bull Trout

BTE actions would increase habitat connectivity within Gold Creek and Cold Creek, improve the prey base within Keechelus Reservoir, and directly increase the abundance of bull trout in the reservoir through translocation from other habitats. Section 4.6.4 discusses these positive impacts.

MCR Steelhead

No MCR steelhead are located in Keechelus River or its tributaries at this time. If MCR steelhead establishes in the Keechelus Reservoir after Reclamation and Ecology install fish passage facilities at the dam under the Integrated Plan, MCR steelhead would benefit from the increased habitat connectivity and prey base resulting from the BTE actions.

Northern Spotted Owl

Gold Creek habitat and passage improvements would involve narrowing the existing channel and densely planting riparian and floodplain habitats. Over the long term, vegetation planted in these habitats would mature and potentially result in limited benefits to northern spotted owl by expanding dispersal habitat.

No operation impacts, whether adverse or beneficial to northern spotted owl, would be anticipated from implementation of the Cold Creek enhancements.

4.9.5 Alternative 2B – KDRPP South Pumping Plant

4.9.5.1 Construction

KDRPP South Pumping Plant Facilities

Bull Trout

The impacts on bull trout resulting from *Alternative 2B – KDRPP South Pumping Plant* are the same as described for fish in Section 4.6.5.1. Construction activities would affect habitats in the Kachess Reservoir and Kachess River and overall would be similar to *Alternative 2A – KDRPP East Shore Pumping Plant* described in Section 4.9.4.1.

Alternative 2B – KDRPP South Pumping Plant includes the following activities that would differ from *Alternative 2A – KDRPP East Shore Pumping Plant*, with respect to bull trout impacts:

- *Alternative 2B – KDRPP South Pumping Plant* would use a TBM to construct the intake and tunnel in Kachess Reservoir, resulting in less noise compared to blasting proposed in *Alternative 2A – KDRPP East Shore Pumping Plant*. The use of a TBM would result in less sound disturbance to bull trout in Kachess Reservoir as discussed in Section 4.6.4.1.
- *Alternative 2B – KDRPP South Pumping Plant* would have a smaller construction and infrastructure footprint, resulting in less disturbance of shoreline vegetation and a smaller quantity of sediments mobilized during site preparation and construction. As a result, *Alternative 2B – KDRPP South Pumping Plant* is expected to have less turbidity and smaller negative impact on habitat complexity for bull trout within Kachess Reservoir. Section 4.6.4.1 describes the impacts of construction on turbidity and habitat complexity.

MCR Steelhead
MCR steelhead are not present in Kachess Reservoir and have not been observed in the Kachess River (Hubble, 2014a). Therefore, no MCR steelhead impacts are anticipated from construction activities associated with *Alternative 2B – KDRPP South Pumping Plant*.

Northern Spotted Owl
Noise generated during construction for *Alternative 2B – KDRPP South Pumping Plant* would be similar to that identified above in Section 4.9.4 for *Alternative 2A – KDRPP East Shore Pumping Plant*. The primary difference between the two alternatives would be the distance from construction activities to documented spotted owl nesting and detection locations. In general, the south pumping plant would be located farther away from these areas. The closest documented northern spotted owl nest site to the south pumping plant is approximately 9,000 feet (1.7 miles) northeast. Noise levels would not result in injury to northern spotted owls, if present. However, noise may elicit disturbance behaviors within 260 feet of construction activities. Their presence within this distance is unlikely; therefore, construction of the south pumping plant is not anticipated to cause adverse noise impacts to northern spotted owls.

Vegetation clearing would be necessary to accommodate the south pumping plant, permanent access road to the pumping plant, power supply substation, transmission line, and to accommodate the Kachess River discharge channel from the pumping plant. Overall, the project would require approximately 44.5 acres of vegetation clearing, mostly second-growth and some mature conifer forest. In particular, the forested habitat adjacent to the outlet works contains a higher proportion of large, mature conifer trees in comparison to other areas slated for clearing. Table 4-43 in Section 4.7 Vegetation and Wetlands identifies the area of clearing and grading, whether the clearing is permanent, and the dominant vegetation type.

Alternative 2B would be located almost entirely within designated critical habitat for the northern spotted owl. A portion of the transmission line and the reservoir intake and conveyance tunnel would be located outside of designated critical habitat. Removal of suitable nesting trees in areas designated as critical habitat would be considered a significant adverse impact on northern spotted owl.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.9.4.1).

4.9.5.2 Operation

KDRPP South Pumping Plant Facilities
Bull Trout
The impacts on bull trout resulting from *Alternative 2B – South Pumping Plant* are the same as those described in Section 4.9.4.2.

MCR Steelhead
The impacts on MCR steelhead resulting from *Alternative 2B – South Pumping Plant* are the same as those described in Section 4.9.4.2.

Northern Spotted Owl
Noise impacts associated with operation of the south pumping plant would be similar to that described above for the east shore pumping plant.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.9.4.2).

4.9.6 Alternative 3A – KKC North Tunnel Alignment

4.9.6.1 Construction

KKC North Tunnel Alignment Facilities
Bull Trout
The impacts on bull trout resulting from *Alternative 3A – North Tunnel Alignment* are the same as those described for fish in Section 4.6.6.1. Construction activities would affect habitats in the Kachess Reservoir and Yakima River. Construction-related impacts at Kachess Reservoir would include the following:

- Removal of shoreline vegetation and disturbance of the Kachess Reservoir shoreline associated with site preparation and construction of the Kachess Lake Road portal and discharge structure, and the Kachess Reservoir spillway and stilling basin. These would have a negative impact on habitat complexity for bull trout and other fish in the reservoir. Section 4.6.4.1 describes the impact of reduced fish habitat complexity resulting from the removal of shoreline vegetation.
- Erosion and sedimentation from construction of the Kachess Lake Road portal and discharge structure, and the Kachess Reservoir spillway and stilling basin. These

activities would increase turbidity and have a negative impact on bull trout and other fish species. The impacts of turbidity on bull trout would be the same as described in Section 4.6.4.1.

Under *Alternative 3A - KKC North Tunnel Alignment* the construction-related impacts at the Yakima River would include the following:

- Impacts of erosion and sedimentation from construction of the Yakima River diversion fish screens and intake and Yakima River diversion to Keechelus portal conveyance. These activities would increase turbidity and have a negative impact on bull trout and other fish species. The impacts of turbidity on bull trout would be the same as described in Section 4.6.4.1.
- Noise disturbance associated with the construction activities in the Yakima River. Increased noise levels may alter bull trout behavior in habitats adjacent to the construction area as described in Section 4.6.4.1.
- Displacement of bull trout from habitat within the Yakima River while cofferdams are in place to support the construction of the diversion and installation of fish screens.

Bull trout are rare in the upper reaches of the Yakima River (Reiss et al., 2012). Few if any bull trout are expected to be impacted by construction activities.

MCR Steelhead
Under *Alternative 3A - KKC North Tunnel Alignment*, construction activities would affect MCR steelhead within the Yakima River. The construction impacts on MCR steelhead habitat are the same as those described for bull trout in the Yakima River in Section 4.9.6.1 and other salmonids described in Section 4.6.6.1. Overall, construction activities are expected to have a minimal impact on MCR steelhead because they are rarely observed in the Keechelus Reach (Hubble, 2014b).

Northern Spotted Owl
Construction of *Alternative 3A - KKC North Tunnel Alignment* would result in increased noise and human activity exceeding the noise-only disturbance thresholds and the loss and degradation of habitat that support the northern spotted owl thereby having significant adverse impacts to northern spotted owl.

General construction noise would be similar to that described above in Sections 4.9.4 and 4.9.5. Construction activities would include the construction of the Yakima River diversion and intake, the Keechelus portal, the Kachess Lake Road portal and discharge structure, the Kachess Reservoir spillway and stilling basin, and the conveyance pipeline and tunnel. The closest occupied nest site to general construction activities is approximately 10,000 feet (1.9 miles); therefore, noise levels exceeding the noise-only injury threshold would not be anticipated. Noise levels would still be expected to exceed the noise-only disturbance threshold; therefore, significant adverse impacts to northern spotted owl would still result from increased construction noise and human activity.

Alternative 3A - KKC North Tunnel Alignment would require vibratory pile driving for secant pile and sheet pile installation at the Keechelus portal and some potential confined drilling and blasting at the Keechelus portal as well. These activities would not occur at the same time. Noise generated at the Keechelus portal location would be expected to be approximately 101 dBA at a distance of 50 feet from the source with a 10 dBA noise reduction for vegetation between the source and potential receptors. Since the project is adjacent to I-90, traffic noise also factors into the background noise level. Traffic noise adjacent to construction would be approximately 77 dBA at a distance of 50 feet from the source (WSDOT, 2013; WSDOT, 2014a). The closest occupied northern spotted owl nest site to the Keechelus portal location is approximately 5.3 miles to the northwest. Noise generated from these more highly intensive construction activities would attenuate to traffic noise levels within 1,256 feet of construction, and would attenuate to background levels within 5,450 feet (approximately 1 mile).

Noise levels exceeding the noise-only injury threshold would not be anticipated. Owls would potentially experience noise levels at or exceeding the noise-only disturbance thresholds within approximately 350 feet of construction, if present. Given the project's proximity to I-90, northern spotted owls are unlikely to be present. Therefore, adverse impacts resulting from increased noise and human activity would not be anticipated.

Minor vegetation clearing would be necessary to construct the Yakima River intake structure, conveyance tunnels and pipeline (Option A or B) to the Keechelus portal site, and the Keechelus portal site. The majority of vegetation clearing would be necessary to accommodate construction of the Kachess Lake Road portal site, the temporary Kachess Lake Road construction detour, and the spillway discharge structure at the Kachess Reservoir outlet. Overall, the project would require approximately 12.5 acres of vegetation clearing, most of which is second-growth conifer forest. Table 4-44 in Section 4.7 Vegetation and Wetlands identifies the area of clearing and grading, whether the clearing is permanent, and the dominant vegetation type. The facilities associated with *Alternative 3A - KKC North Tunnel Alignment* would be located almost entirely within designated critical habitat for the northern spotted owl. Removal of suitable nesting trees in areas designated as critical habitat would be considered an adverse impact to northern spotted owl.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.9.4.1).

4.9.6.2 Operation

KKC North Tunnel Alignment Facilities
Bull Trout
Under *Alternative 3A - KKC North Tunnel Alignment*, operations would affect bull trout within habitats including Kachess Reservoir, Kachess River, Keechelus Reservoir, and Yakima River.

Kachess Reservoir. The operation impacts of *Alternative 3A* on bull trout would be the same as described in Section 4.6.6.2 and include the following:

- Decreased hydraulic residence time and lower reservoir levels would reduce available prey in Kachess Reservoir compared to the baseline. Zooplankton provide the forage base for resident fish species that bull trout prey upon.
- Lower reservoir levels and greater fluctuations in reservoir level would reduce shoreline vegetation and habitat complexity within the reservoir compared to the baseline.
- The conveyance of water from Keechelus to Kachess Reservoir could increase the risk of transmitting diseases and exotic species to Kachess Reservoir compared to the baseline.
- The conveyance of water from Keechelus to Kachess Reservoir may cause minor, localized changes in Kachess Reservoir temperature or nutrient levels, but these are not anticipated to cause a significant impact to fish.
- The conveyance of water from Keechelus to Kachess Reservoir may increase the risk of disease transmission or introduction of exotic species from Keechelus to Kachess Reservoir.

Kachess River. The operation impacts of *Alternative 3A - KKC North Tunnel Alignment* on bull trout are the same as described for fish in Section 4.6.6.2. Existing summer flows in the Kachess River are already too high to be suitable for bull trout, and additional summer flows during drought years would not improve habitat conditions. Section 4.9.4.2 describes the negative impact of high flow in the Kachess River.

Keechelus Reservoir. The operation impacts of *Alternative 3A - KKC North Tunnel Alignment* on bull trout are the same as described for fish in Section 4.6.6.2 and include the following:

- Smaller fluctuations in reservoir level and increased hydraulic residence time during drought years would increase available zooplankton and benthic prey within Keechelus Reservoir compared to the baseline. Zooplankton provide the forage base for resident fish species that bull trout prey upon.

- Smaller fluctuations in reservoir level may also increase the stability of shoreline vegetation and increase habitat complexity within Keechelus Reservoir.
- Bull trout passage between reservoir and tributary habits would increase in frequency and duration allowing better access to spawning and rearing habitats and seasonal refugia.

Yakima River. The operation impacts on bull trout are the same as described for other fish species in Section 4.6.6.2 and include the following:

- Summer instream flows in the Keechelus Reach would be met most years. This would increase salmon production and resident fish habitat in the Keechelus Reach compared to the baseline. Section 4.6.6.2 discusses the improvement in habitat connectivity and function. Additionally, bull trout would benefit from increased salmon or steelhead production resulting from improved flows as juvenile salmonids provide a prey source for bull trout in the Yakima River basin (Reiss et al., 2012).
- For the Easton Reach average instream flows would be nearly the same as baseline conditions; however, during drought years, flows would be slightly higher (Table 4-16 in Section 4.3.6). The increase in streamflow during drought years would not have a significant effect on overall Yakima River streamflow conditions because the flows would be within current operating ranges (Section 4.3.6.2) and impacts to fish would be the same as expected under *Alternative 1-No Action*.

MCR Steelhead

Under *Alternative 3A - KKC North Tunnel Alignment*, operations would affect MCR steelhead within the Yakima River. The operation impacts on MCR steelhead habitat are the same as those described for bull trout in the Yakima River in Section 4.9.6.2 and other salmonids described in Section 4.6.6.2.

Reduced summer instream flows and regular attainment of instream flow targets in the Keechelus Reach are expected to significantly improve MCR steelhead productivity over baseline conditions.

When summer instream flow targets are met in the Keechelus Reach, the available habitat is expected to produce a range of up to 610 to 1,010 adult MCR steelhead with an average of 810 adults. Increases in steelhead abundance within the reach are expected to accrue through improved flow conditions as well as natural colonization processes (Hubble, 2014b). Because the productivity of the reach is constrained by high summer flows, it is anticipated that 90 percent of the adults produced would be attributable to keeping summer flows at or below 500 cfs, and 10 percent would be attributable to natural colonization processes. Therefore, summer flow improvements alone are expected to result in an increase of 549 to 909 adult MCR steelhead with an average of 729 adults. With a current assumed baseline of zero steelhead in the Keechelus Reach, achieving the anticipated production levels would require 10 years of meeting the instream flow targets.

Northern Spotted Owl
Under *Alternative 3A - KKC North Tunnel Alignment* operations, the disturbance to northern spotted owl from increased noise and human activity would be minor as noise levels are anticipated to be at or below the noise-only alert and noise-only detectability thresholds. Once completed, the majority of noise generated would be contained underground in the tunnels and conveyance features. During operation, minor impacts to northern spotted owl would occur from increases in noise and human activity at the intake and discharge points for the *Alternative 3A - KKC North Tunnel Alignment* as a result of their proximity to suitable habitat.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for Alternative 2A – KDRPP East Shore Pumping Plant (Section 4.9.4.2).

4.9.7 Alternative 3B – KKC South Tunnel Alignment

4.9.7.1 Construction

KKC South Tunnel Alignment Facilities
Bull Trout
The construction impacts on bull trout are similar to those described for *Alternative 3A -KKC North Tunnel Alignment* in Section 4.9.6.1. *Alternative 3B – KKC South Tunnel Alignment* poses an additional risk of increased turbidity in the Yakima River related to the I-90 portal construction activities described in Section 4.6.7.1.

MCR Steelhead
The construction impacts on MCR steelhead resulting from *Alternative 3B – KKC South Tunnel Alignment* are similar to those described for MCR steelhead in Section 4.9.6.1. *Alternative 3B – KKC South Tunnel Alignment* poses an additional risk of increased turbidity in the Yakima River related to the I-90 portal construction activities described in Section 4.6.7.1.

Northern Spotted Owl
Construction of *Alternative 3B – KKC South Tunnel Alignment* would result in increased noise and human activity exceeding the noise-only disturbance thresholds and the loss and degradation of habitat that support the northern spotted owl thereby having significant adverse impacts to northern spotted owl.

Noise impacts for general construction activities would be similar to those described above in Section 4.9.6.1. The closest occupied nest site to general construction activities would be approximately 2 miles; therefore, noise levels exceeding the noise-only injury threshold would not be anticipated. Noise levels would still be expected to exceed the noise-only disturbance threshold; therefore, significant adverse impacts to northern spotted owl would still result from increased construction noise and human activity.

Alternative 3B – KKC South Tunnel Alignment would also require confined drill and blast techniques as well as vibratory pile driving for secant pile installation at the portal locations, similar to that described above in Section 4.9.6.1. The only difference is that there would be two portal locations where these activities would occur including the Keechelus portal and the I-90 portal. The closest occupied northern spotted owl nest site to these more highly noise intensive construction activities would be approximately 26,000 feet (4.9 miles northeast). Noise levels exceeding the noise-only injury threshold for northern spotted owl would not occur. However, northern spotted owls would experience noise levels exceeding the noise-only disturbance threshold within approximately 350 feet of construction. However, given the project's relative proximity to I-90, northern spotted owls are unlikely to be present. Adverse impacts resulting from increased noise and human activity would not be anticipated.

Minor vegetation clearing would be necessary to accommodate the Yakima River intake structure, conveyance tunnels or pipeline (Option A or B) to the Keechelus portal site, conveyance tunnel from the Keechelus portal to the I-90 portal, or conveyance tunnels from the I-90 portals to the Kachess portal and discharge structure. The majority of vegetation clearing would be to accommodate the permanent operations and maintenance access road to the pipeline and spillway discharge structure at the Kachess Reservoir outlet. This area also includes an approximately 500-foot length of cut-and-cover pipeline extending from the end of the TBM tunnel to the spillway structure. Overall, the project would require approximately 13 acres of vegetation clearing, most of which is second-growth coniferous forest and previously disturbed land. Table 4-45 in Section 4.7 Vegetation and Wetlands identifies the area of clearing and grading, whether the clearing is permanent, and the dominant vegetation type.

Alternative 3B – KKC South Tunnel Alignment would be located almost entirely within designated critical habitat for the northern spotted owl. Removal of suitable nesting trees in areas designated as critical habitat would be considered an adverse impact to northern spotted owl.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.9.4.1).

4.9.7.2 Operation

KKC South Tunnel Alignment Facilities
Bull Trout
The operation impacts on bull trout resulting from *Alternative 3B – KKC South Tunnel Alignment* are the same as those described in Section 4.9.6.2.

MCR Steelhead
The operation impacts on MCR steelhead resulting from *Alternative 3B – KKC South Tunnel Alignment* are the same as those described in Section 4.9.6.2.

Northern Spotted Owl
Under *Alternative 3B – KKC South Tunnel Alignment* operations, the disturbance to northern spotted owl caused by increased noise and human activity would be minor as noise levels are anticipated to be at or below the noise-only alert and noise-only detectability thresholds. Once completed, the majority of noise generated would be contained underground in the tunnels and conveyance features. However, during operation, minor impacts to northern spotted owl would occur from increases in noise and human activity primarily at the intake and discharge points for the *Alternative 3B – KKC South Tunnel Alignment* and from their proximity to suitable habitat.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.9.4.2).

4.9.8 Alternative 4 – Combined KDRPP and KKC

4.9.8.1 Construction

KDRPP and KKC Facilities
Bull Trout
The construction impacts on bull trout resulting from *Alternative 4 – Combined KDRPP and KKC* would be the same as those described for KDRPP (Sections 4.9.4.1 and 4.9.5.1) and KKC (Section 4.9.6.1 and 4.9.7.1). No additional impacts would occur from combined construction.

MCR Steelhead
The construction impacts on MCR steelhead resulting from *Alternative 4 – Combined KDRPP and KKC* would be the same as those described for KDRPP (Sections 4.9.4.1 and 4.9.5.1) and KKC (Section 4.9.6.1 and 4.9.7.1). No additional impacts would occur from combined construction.

Northern Spotted Owl
The range of noise impacts and area of vegetation removal would be greater if Reclamation constructions both KDRPP and KCC. All alternatives have the same relative range of distances for noise to attenuate to below the disturbance threshold for northern spotted owl.

Combined *Alternatives 2A* and *3A* would be in closest proximity to occupied habitat and would therefore have the highest potential for causing disturbance to northern spotted owl. Table 4-51 illustrates this relationship between all possible alternative combinations.

Table 4-51. Summary of Noise Disturbance to Northern Spotted Owl under *Alternative 4* Combinations

Alternative Combination	Range of Distances for Construction Noise to Attenuate to Disturbance Threshold of 70dBA (feet)	Range of Distances to Currently Occupied Habitat (feet)	Disturbance Ranking from Highest (1) to Lowest (4)
2A + 3A	104-350	1,500 – 10,032	1
2A + 3B	104-350	1,500 – 10,560	2
2B + 3A	104-350	9,000 – 10,032	3
2B + 3B	104-350	9,000 – 10,560	4

The area of vegetation clearing would range from 57.8 to 88.5 acres with *Alternative 4 - Combined KDRPP and KKC* and from 12.5 to 75.5 acres of vegetation if either KDRPP or KKC were constructed independently. Table 4-52 below shows the areas of clearing and grading for each combination of alternatives. The combination of *Alternative 3A* and *2B* would require the largest amount of clearing and grading followed by *Alternatives 2A* and *3A*, *2B* and *3B*, and *2B* and *3A*.

Table 4-52. Summary of Vegetation Disturbance Areas under *Alternative 4* Combinations

Alternative Combination	Permanent Riparian and Upland Vegetation (acres)	Temporary Riparian and Upland Vegetation (acres)	Total (acres)
2A + 3A	22	66	88
2A + 3B	19.5	69	88.5
2B + 3A	12	45	57
2B + 3B	9.8	48	57.8

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.9.4.1).

4.9.8.2 Operation

KDRPP and KKC Facilities

Bull Trout

Under *Alternative 4 – Combined KDRPP and KKC*, operations would affect bull trout within habitats including Kachess Reservoir, Kachess River, Keechelus Reservoir, and Yakima River.

Kachess Reservoir. The operation impacts on bull trout of *Alternative 4 – Combined KDRPP and KKC* are the same as described for fish in Section 4.6.8.2 and include the following:

- The reduction in Kachess Reservoir minimum pool elevation would reduce connectivity between reservoir and tributary habitats in Kachess Reservoir and would reduce connectivity between Kachess Reservoir lake basin habitats. During nondrought years, water conveyed from Keechelus Reservoir (through KKC) would allow the Kachess Reservoir to refill, thereby achieving pool elevations more similar to baseline conditions than would occur under *Alternatives 2A* or *2B* alone (Thomas, 2014b).
- Lower minimum pool elevation may increase water temperatures in Kachess Reservoir
- Reduction in Kachess Reservoir minimum pool elevation would reduce shoreline vegetation and habitat complexity in Kachess Reservoir.
- Reduction in Kachess Reservoir minimum pool elevation would expose the lower reservoir bed to wave action and temporarily increase turbidity.
- Decreased hydraulic residence time and lower minimum reservoir levels would reduce available prey in Kachess Reservoir compared to the baseline. Zooplankton provide the forage base for resident fish species that bull trout prey upon. *Alternative 4 – Combined KDRPP and KKC* results in the lowest average hydraulic residence time when compared to KDRPP and KKC alone.
- The conveyance of water from Keechelus to Kachess Reservoir may increase the risk of disease transmission or introduction of exotic species from Keechelus to Kachess Reservoir.
- The conveyance of water from Keechelus to Kachess Reservoir may cause minor, localized changes in Kachess Reservoir temperature or nutrient levels, but these are not anticipated to cause a significant impact to fish.

Kachess River. Under *Alternative 4 – Combined KDRPP and KKC*, average flows in the Kachess River would increase compared to the baseline. Summer flows would increase more significantly during drought years. Increased summer flows would result in negative impacts on bull trout as described in Section 4.9.4.2.

Keechelus Reservoir. The operation impacts of *Alternative 4 – Combined KDRPP and KKC* on bull trout are the same as described for fish in Section 4.6.8.2 and include the following:

- Lower reservoir elevations following drought years could reduce shoreline vegetation and habitat complexity, increase reservoir water temperatures, and reduce benthic invertebrate prey abundance.
- Reduced hydraulic residence times could decrease available zooplankton prey within Keechelus Reservoir. *Alternative 4 – Combined KDRPP and KKC* results in the lowest average hydraulic residence time when compared to *Alternatives 2* and *3*. Zooplankton provide the forage base for resident fish species that bull trout prey upon.

Yakima River. The operation impacts of *Alternative 4 – Combined KDRPP and KKC* on bull trout are the same as described for fish in Section 4.6.8.2 and include the following:

- Under *Alternative 4 – Combined KDRPP and KKC,* summer instream flows in the Keechelus Reach would be met most years, increasing salmon production and resident fish habitat in the Keechelus Reach compared to the baseline. July instream flow targets are met much more often than under *Alternative 2* but slightly less than under *Alternative 3*. The improvement in habitat connectivity and function expected when summer instream flows are met is discussed in Section 4.6.8.2. Additionally, bull trout would benefit from increased salmon or steelhead production resulting from improved flows because juvenile salmonids provide a prey source for bull trout in the Yakima basin (Reiss et al., 2012).
- Under *Alternative 4 – Combined KDRPP and KKC,* instream flow targets in the Easton Reach would be met at a similar frequency to baseline conditions. Predicted flows would be within current operating ranges and would not have a significant effect on streamflow in the Easton Reach (Section 4.3.8.2) or a significant impact on bull trout.

MCR Steelhead

Under *Alternative 4 – Combined KDRPP and KKC,* operations would affect MCR steelhead within the Yakima River. The operation impacts on MCR steelhead habitat are the same as those described for bull trout in the Yakima River in Section 4.9.8.2 and other salmonids described in Section 4.6.8.2.

Similar to KKC, reduced summer instream flows and regular attainment of instream flow targets in the Keechelus Reach are expected to significantly improve MCR steelhead productivity over baseline conditions.

When summer instream flow targets are met in the Keechelus Reach, the available habitat is expected to produce a range of up to 610 to 1,010 adult MCR steelhead with an average of 810 adults. Increases in steelhead abundance within the reach are expected to accrue through improved flow conditions as well as natural colonization processes (Hubble, 2014b). Because the productivity of the reach is constrained by high summer flows, it is anticipated that 90 percent of the adults produced would be attributable to keeping summer flows at or below 500 cfs, and 10 percent would be attributable to natural colonization processes. Therefore, summer flow improvements alone are expected to result in an increase of 549 to 909 adult MCR steelhead with an average of 729 adults. With a current assumed baseline of zero steelhead in the Keechelus Reach, achieving the anticipated production levels would require 10 years of meeting the instream flow targets.

Northern Spotted Owl
All possible combinations of *Alternative 4 – Combined KDRPP and KKC* would result in minor impacts to northern spotted owl as noise levels would be anticipated to be at or below the detectability and alert thresholds for northern spotted owl.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.9.4.2).

4.9.9 Mitigation Measures

Reclamation would implement measures to reduce impacts to listed species caused by KDRPP and KKC. These measures would include both measures to reduce construction impacts and measures to reduce impacts from operation of the projects (see Section 4.6.9).

Reclamation has begun discussions with the Service and NMFS and will complete ESA consultation. Reclamation would implement specific mitigation for listed fish and wildlife species that the agencies require as part of consultation. At a minimum, Reclamation would conduct preconstruction surveys for listed fish and wildlife species prior to construction. Reclamation would implement the conservation measures and recommendations provided by the Service in the Fish and Wildlife Coordination Report (see Section 5.5.2).

4.9.9.1 Bull Trout and MCR Steelhead

Construction
The impacts from construction would be mitigated through adherence to construction windows that reduce exposure of fish to inwater construction impacts and the use of BMPs that reduce sediment mobilization and turbidity levels as described in Sections 4.2.9 and 4.4.9. Additionally, temporary construction and staging areas would be regraded and replanted with native vegetation.

Operation

To mitigate for fish passage issues associated with the lower minimum pool elevation at Kachess Reservoir (*Alternatives 2A, 2B* and *4*), Reclamation has proposed a number of passage projects. These projects focus on (1) ensuring bull trout passage between Box Canyon Creek and Kachess Reservoir, and (2) ensuring bull trout passage between Little Kachess and Kachess basins within the Kachess Reservoir. Section 4.6.9.2 describes these projects.

Reclamation would also conduct general passage improvement activities within Kachess and Keechelus reservoirs under all action alternatives. Reclamation would adaptively manage the emergency monitoring and passage program so that it is responsive to increased passage risk into bull trout spawning tributaries. This would include monitoring for new or increased occurrence of barriers to spawning tributaries caused by reservoir drawdown operations. Reclamation would also provide emergency passage for bull trout if permanent facilities are not in place to address passage barriers affected by operations. Finally, Reclamation would construct permanent fish passage structures or habitat modifications to minimize or fully address potential passage barriers that result from operations.

Reclamation would also support a study to examine reservoir productivity and food web impacts from future use of Kachess Reservoir inactive storage expected under *Alternatives 2A, 2B,* and *4*.

4.9.9.2 Northern Spotted Owl

Construction

To minimize impacts to nesting northern spotted owl, highly intensive construction activities that result in higher levels of noise, such as confined blasting in this case, would be timed to occur outside the nesting season for northern spotted owl (nesting typically occurs from March 1 through September 30). Timing restrictions for construction activities would not be required for *Alternatives 2B, 3A,* or *3B* because no nest sites are within 1 mile of the construction activities.

Operation

Areas temporarily disturbed by vegetation removal would be replanted with similar native trees and shrubs following construction. However, replacement planting would take decades to reach maturity. No impacts would occur to northern spotted owl from operation of the Proposed Action, so no additional mitigation is required.

4.10 Visual Quality

4.10.1 Methods and Impact Indicators

Methods. Reclamation assessed impacts by identifying and describing changes to the visual quality of the landscape. The changes relative to the existing landscape may occur in *visual contrast* introduced by the project elements, and in overall *landscape character*. Elements in a project that have contrast are those that are unlike or in opposition to the forms, lines, colors, and textures that combine in the native landscape to form a visual pattern. The greater the visual contrast introduced by a project element, the greater the adverse impact to the aesthetic quality of the setting. Landscape character refers to the visual and cultural image of a geographic area. It reflects the combination of physical, biological, and cultural attributes that make each landscape identifiable or unique.

This assessment emphasizes the potential relationship between the project and sensitive receptors associated with recreation areas, roadways, and residential development. The most sensitive areas are those that can be viewed by travelers moving to or from recreational activities or along designated scenic corridors. Stationary views from relatively moderate- to high-use recreation areas and residential areas are also considered to be sensitive.

Impact Indicators. Visual impact indicators and criteria for determining impact significance are shown in Table 4-53. Reclamation assessed all criteria relative to *Alternative 1 – No Action*.

Adverse visual impacts are modifications to the environment that substantially contrast with or change the overall landscape character, or detract from the area's visual quality. In the context of reservoir management, adverse visual impacts are changes in pool levels that render the reservoir a less dominant element on the landscape and that result in a shoreline of unnatural appearance, making the area less desirable for recreation.

The USFS manages much of the Federal land in the primary study area, including areas above the current full pool elevation of Kachess and Keechelus reservoirs. Under the USFS Scenery Management System (USDA, 1995), the landscape is composed of diverse landforms, rock forms, and vegetative colors and textures. The potential impacts were evaluated by examining the extent to which the project elements contribute to or conflict with relevant Federal visual management plans, including scenic integrity levels (SILs) and visual quality objectives (VQOs) established in the 1990 *Wenatchee National Forest Plan* and the USFS Scenery Management System (USDA, 1995).

Table 4-53. Impact Indicators and Significance Criteria for Visual Resources

Impact Indicator	Significance Criteria
Introduction of new facilities or modifications to existing facilities	Modifications to the environment having more than a moderate effect, in that they substantially contrast with or interrupt the visual character and integrity of the landscape.
Changes in reservoir inundation and drawdown patterns	Alteration that renders the reservoir a less dominant element on the landscape or results in a shoreline of unnatural appearance, making the area less desirable for recreation.
Changes to instream flows (downstream effects)	Erosion of riverbanks or creation of flow pathways outside the range of existing flows.
Consistency with relevant Federal visual quality management plans	Conflict with SIL/VQO established in the 1990 Wenatchee National Forest Plan and the USFS Scenery Management System (USFS, 1995).

4.10.2 Summary of Impacts

Alternative 1 – No Action would result in visual quality conditions that are the same as those currently experienced. No construction or changes in reservoir levels would occur, and the landscape character would be largely unchanged from baseline conditions. With the influence of the I-90 Phase 2A project on the baseline condition, the primary study area at Keechelus Reservoir would retain an altered landscape character and scenic condition.

During construction, KDRPP and KKC would involve visual quality impacts to local residents and visitors as local views change. None of these short-term impacts would be significant. In the long term, both KDRPP and KKC would involve localized visual quality impacts due to the introduction of new facilities and features on the landscape and due to changes in reservoir pool levels. Under *Alternative 2A – KDRPP East Shore Pumping Plant*, the east shore pumping plant building would substantially contrast with the existing landscape; impacts would be significant. Under all other action alternatives, new facilities and features would only minimally contrast with or detract from the visual quality of the area and existing landscape.

Under both *Alternative 2A – KDRPP East Shore Pumping Plant* and *Alternative 2B – South Pumping Plant*, impacts of Kachess Reservoir drawdowns during drought years would be significant over the long term. The reservoir would appear substantially smaller, rendering it a less dominant element on the landscape. In addition, receding water levels would result in a shoreline of unnatural appearance, making the area less desirable for recreation. There would be no visual quality impacts from downstream effects.

Reservoir pool changes at Keechelus Reservoir under both KDRPP and KKC would preserve the character and dominance of the reservoir on the landscape. Therefore, these changes would not result in significant adverse visual quality changes.

The BTE actions would be implemented as part of all the action alternatives and would have a moderate to high impact on landscape character and quality. However, the overall visual quality impact would not be significant, as the duration of interruption would be limited. Changes to the landscape would be most noticeable to visitors of the Gold Creek Pond Picnic Area. Open-water areas would be reduced, which would alter the visual character. These impacts would not be significant because the landscape would evolve, appearing more natural over time.

Most elements of the Proposed Action would generally be consistent with existing SIL/VQO established by the *1990 Wenatchee National Land and Resource Management Plan* for Kachess and Keechelus Reservoirs while some would represent a substantial change. The elements that represent the most substantial changes to SIL/VQO are the Kachess Reservoir drawdown under *Alternatives 2A*, *2B*, and *4*, and the east shore pumping plant under *Alternative 2A* (and under *Alternative 4* if *Alternative 2A* is selected). Overall, established VQOs of Retention in developed recreation sites, and as viewed from scenic travel corridors, would be retained except during drought years under *Alternative 2A, 2B* and *4*, and the east shore pumping plant viewshed under *Alternative 2A.*

Table 4-54. Summary of Impacts for Visual Resources

Impact Indicator	Summary of Impacts
Introduction of new facilities or modifications to existing facilities	The east shore pumping plant under *Alternative 2A* would have a significant impact because it would substantially contrast with and interrupt the visual character and integrity of the landscape. New facilities under *Alternatives 2B, 3,* and *4* (if *Alternative 2B* is selected) would not substantially contrast with or interrupt the visual character and integrity of the landscape because they would not be visible from recreation sites or scenic travel corridors.
Changes in reservoir inundation and drawdown patterns	Kachess Reservoir drawdowns during drought years under *Alternatives 2* and *4* would have significant impacts due to changes in overall landscape character and desirability from a recreation perspective.
Changes to instream flows (downstream effects)	None of the alternatives would have significant impacts; instream flows would be within the existing flow range.
Consistency with relevant Federal visual quality management plans	Kachess Reservoir drawdowns during drought years under *Alternatives 2A, 2B*, and *4*, and the east shore pumping plant building under *Alternatives 2A* and *4* (if *Alternative 2B* is selected), would not meet the intent of the established SIL/VQO.

4.10.3 Alternative 1 – No Action Alternative

Alternative 1 – No Action visual quality within the primary study areas, including at Kachess and Keechelus reservoirs would remain the same. Kachess Reservoir would remain the dominant element on the landscape, and the landscape would remain as its existing mosaic of natural to slightly altered landscape character and scenic condition. In considering the effects of the I-90 Phase 2A project on the baseline condition, the primary study area at Keechelus Reservoir would retain an altered landscape character and scenic condition. Therefore, *Alternative 1 –No Action* would maintain the existing range of landscape character and scenic integrity conditions within the primary study area.

Visual effects within the extended study area can be assessed only speculatively at this time. Without KKC and KDRPP, no additional would be water available to proratable irrigators during severe drought years. The amount of water available for these irrigators during drought years would continue to depend on the current water supply system, crop demands, climate change, and other factors that influence water availability in the Yakima River basin. Because of uncertainty in these variables and in potential changes in agricultural crops and production, visual quality effects with the basin are unknown; overall, they are likely to be minor.

4.10.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.10.4.1 Construction

KDRPP East Shore Pumping Plant Facilities
Construction of *Alternative 2A – KDRPP East Shore Pumping Plant* would create short-term, localized, and temporary visual impacts for approximately 3 years. Construction activities would be concentrated on the east shore of the southeast portion of Kachess Reservoir, and extend both out into the reservoir (intake construction) and south along the shoreline to the dam (pipeline construction) (Figure 2-2). This portion of the east shore is part of a contiguous segment of undeveloped, forested shoreline that supports a perceived “natural” setting. No developed recreation facilities are present at the site; however, the reservoir is used for recreational boating and provides views of the shoreline. The locations of the pumping plant, intake, pipeline, surge tank, and temporary construction facilities (e.g., concrete batch plant, construction basin and boat launch) would be highly visible from the southeast reservoir and surrounding shorelines. However, there are no developed recreational facilities or residential areas along this portion of the reservoir with views toward the construction area. Portions of the construction areas may be visible from Kachess Dam Road, but intervening trees limit viewpoints.

Those looking at the construction area would notice mechanized equipment, grading and dredging activity, blasting, material movement and stockpiling, barging, construction of pipelines and facilities, and human activity, all of which would detract visually from the setting. Although the temporary construction areas and access roads would be restored post-construction with native vegetation, the appearance of some areas would change from forested to cleared land. Construction of the outlet and discharge structure would have minor visual impacts. Located south of the existing Kachess Dam, this area has no developed public access or viewing points, and views of this area from the reservoir are blocked by the dam and intervening trees, and topography.

Construction of the transmission line from the Easton substation to the pumping plant would create short-term and localized impacts during its 12-month construction period. Construction equipment and activity would be highly visible from roads and crossings along the alignment. However, construction activities would have a limited duration at any one location along the alignment.

Based on limited public viewpoints to construction areas and the temporary nature of construction, *Alternative 2A – KDRPP East Shore Pumping Plant* would have a minor to moderate short-term effect on the visual character and integrity of the landscape.

Bull Trout Enhancement

Construction of BTE actions would create short-term, localized, and temporary visual impacts. Construction activity could disrupt views from recreation areas and I-90, and detract from the overall landscape character at moderate- to high-use recreation areas located at the Gold Creek and Cold Creek sites.

Construction associated with Gold Creek restoration actions and Gold Creek bridge replacement (NF-4832 Bridge) would disrupt visual quality in these areas. Construction activities would be visible from the Gold Creek Pond Recreation Area and from I-90. Temporary access roads, heavy equipment operations in the riparian areas, and staged or stockpiled material would be visible from these areas. In addition, temporary removal of vegetation may open up views to construction areas. Construction activity at Gold Creek would have a moderate to high impact on landscape character and quality for all observers. The greatest effect on views would result from the earthwork involving heavy equipment.

Construction of Cold Creek passage improvements would temporarily interrupt the landscape character and quality along a portion of the John Wayne Pioneer Trail. Construction activity at Cold Creek would have a moderate to high impact on landscape character and quality for all observers. Viewpoints with long-distance views across Keechelus Reservoir to the north would be minimally affected by construction because most construction would occur at the trail or immediately downstream of the trail. Excavation, soil hauling, and other activities would interrupt visual character and quality. However, the overall visual quality impact would be minor, as the duration of interruption to most recreationists would be limited to a short section of trail.

4.10.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Visual impacts from operation of *Alternative 2A – KDRPP East Shore Pumping Plant* relate to changes in reservoir pool elevations, the presence of new facilities on the landscape, and downstream effects.

Reservoir Pool Elevations

This alternative would increase the frequency, magnitude, and duration of lower pool elevations relative to baseline conditions. Reclamation would draw down the Kachess Reservoir by as much as 80 feet below existing low pool conditions in drought years, after which 2 to 5 years would pass before the reservoir refilled to its previous pool level. Kachess Reservoir levels would be lower than those under *Alternative 1 – No Action* in 51 percent of years during drawdown and reservoir refilling, and in those years it would be lower for 314 days out of the year on average. Reservoir levels are simulated to fall below elevation 2,192 (the gravity outlet elevation) for 179 days per year.

Drawdowns in drought years would have major impacts on visual quality as it relates to overall landscape character of the reservoir and desirability from a recreation perspective (refer to Section 4.14 for a discussion of impacts to recreation). Visual impacts in the primary study area would likely vary with location. Given the duration of the effect and the distance the reservoir pool would recede, impacts would be considered significant for some observers, particularly those along areas of the west shore of the reservoir. Viewing opportunities occur primarily at Kachess Campground, at East Kachess Group Site, and along Lake Kachess Road near a community of private cottages. Under proposed maximum drawdown conditions, the distance to the water line from Kachess Campground and from residential areas along the west shore would exceed 1,500 feet, which is a substantial change from the approximately 400-foot distance to the water line associated with the current maximum drawdown. However, in most areas, the reservoir pool would recede approximately 200 additional feet under the maximum drawdown condition.

Additional drawdown during drought years would increase the distance between reservoir-edge recreation facilities (e.g., boat launches) and the water's edge, lengthening the amount of time facilities are stranded, as described in Section 4.14. The changes in visual quality could make the area less desirable for recreation, especially during summer months. Summer reservoir water elevations are most important because the majority of visitation and reservoir viewing occurs during this time.

As described in Section 4.3, during the 2- to 5-year period required for Kachess Reservoir to refill, water levels in Keechelus Reservoir would be reduced by about 15 feet; peak water levels would not be affected. In other years the reservoir level would not change from *Alternative 1 – No Action* conditions. Drawdowns in drought years would likely not meet the USFS' SIL/VQO of high/retention for this area. In areas, the reservoir would appear moderately to heavily altered which is consistent with a SIL/VQO of low/modification (see Section 3.10, Table 3-24). While the reservoir would remain a managed facility within the general setting and context of other managed reservoirs in the primary and extended study area, the decreased reservoir pool under maximum drawdown conditions would be substantial, and could change the visitor perception of natural appearance or the overall dominant element of the reservoir on the landscape. Therefore, this impact would be significant.

New Facilities

Visual impacts from the pumping plant, associated power supply substation, surge tank, and transmission line would likely vary from minor to significant, depending on the observer's location. The pumping plant would be located approximately 3,000 feet north of Kachess Dam along the east shore of the southeast portion of the reservoir (Figure 2-2). Much of the plant would be underground, with the aboveground portion housed in a steel building approximately 150 feet long by 220 feet wide and 65 feet high, akin to a 6-story building and roughly the size of a small warehouse (Figure 2-3). The building would be located on the immediate shoreline where forested landscape conditions predominate (Figure 4-11).

Figure 4-11. Typical Forested Condition on East Shore

The pumping plant building would be highly visible from areas along the south portion of the reservoir. The building would substantially interrupt the form, line, color, and texture of the undeveloped, forested shoreline landscape, resulting in localized changes in visual character at the Kachess Reservoir shoreline. People walking along the reservoir shoreline, boating on the reservoir at this location, or viewing from the opposite (west) shore would notice these changes. Because of the substantial contrast with, and interruption of the visual character and integrity of the landscape, this impact would be significant.

The power supply substation would be located landward of, and largely blocked from view by, the pumping plant building. The low profile of the surge tank (110 feet in diameter, 3 feet above ground) is not likely to be visible from the reservoir. Once complete, the intake and pipeline would be buried (or permanently covered by water) and create no visual quality impacts. The outlet works and discharge structure would be located south of the dam, outside of public view, and would not affect visual quality.

Exterior lighting on the east shore pumping plant building would be limited to security and emergency lighting. To the extent possible, Reclamation would attempt to locate exterior access points and associated security lighting away from the reservoir-side of the building. Pole-mounted lighting proposed for the perimeter of the power substation is not anticipated to be visible from the reservoir given the building’s location behind the east shore pumping plant building. With the use of lighting cutoff options and shields to avoid sky glow and glare, minimal impacts from exterior lighting at night are anticipated.

The transmission line for the pumping plant would extend from the existing Easton Substation east of the reservoir to the new pumping plant primarily follow existing roads and transmission corridors that provide a perceived “altered” setting. Although the transmission line would introduce an artificial form, multiple large transmission lines and roads are already present in this portion of the primary study area. Some of the existing poles would be replaced with taller poles, but this change would not substantially interrupt the visual character and integrity of the landscape. Additional analysis would be conducted as part of PSE’s route study and environmental analysis.

Foreground views from areas most often used by the public, such as campgrounds and boat launches, are managed according to the SIL/VQO of high/retention (management activities in the foreground view provide an unaltered appearance), and middle-ground views are managed according to the moderate/partial retention SIL/VQO (management activities in the middle ground provide a slightly altered appearance). The east shore pumping plant building would present more than a slightly altered landscape appearance. Therefore, *Alternative 2A – KDRPP East Shore Pumping Plant* would not meet the intent of the high/retention and moderate/partial retention SIL/VQO established by the 1990 *Wenatchee National Land and Resource Management Plan* for Kachess Reservoir.

Downstream Effects

Additional releases to the Kachess River would increase the volume of water in the river but the flow rate would remain within the range of existing flows. This effect would have a negligible effect on scenic resources. The Kachess River would continue to meet established high/retention SIL/VQO.

Bull Trout Enhancement

Changes to the landscape resulting from the Gold Creek restoration actions would be most noticeable to visitors of the Gold Creek Pond Picnic Area. The landscape would evolve, appearing more natural over time. Once it matured, the vegetation planted in the restoration areas would present a pleasing visual quality and character. Restoration actions would reduce open-water features at the Gold Creek area, allowing the site to revert to more natural conditions. Between 5 acres (partial restoration) and 27 acres (full restoration) of open water would be lost to the Gold Creek enhancement. An additional 2 acres of open-water habitat would be lost with the filling of artificial Heli's Pond. The visual quality of these open-water areas would be diminished; however, the site would become a small, natural functioning wetland, as it was before recent human intervention. Views from the picnic area would change because the filled pond would no longer reflect the adjacent mountains. However, the mountains would continue to be visible across the restored wetland. Replacing the bridge at NF-4832 would cause few changes to the views of drivers along I-90. The low bridge would be replaced with a wider but similar structure. The restored floodplain would add vegetation to the area.

The Cold Creek fish passage improvements would permanently change the John Wayne Pioneer Trail in Iron Horse State Park. The new 120-foot-long bridge over Cold Creek would be 35 feet lower than the current trail, which would slightly change the viewpoint perspective along that portion of the trail. The trail on either end of the new bridge would be gradually sloped to meet the new elevation. Depending upon viewpoints available along these sections of trail, other viewpoints could be altered. Reconstruction of more natural topography and ground contours downstream of the trail (toward Keechelus Reservoir) would be followed by revegetation with native shrubs and trees. When mature, the vegetation planted in the restoration areas would present a pleasing visual quality and character. Additional analysis of potential visual quality impacts will be developed as the design of these actions progresses. The impacts from the BTE actions are not anticipated to be significant because restoration activities would likely not contrast with, or interrupt the visual character of the landscape.

The BTE actions would be consistent with SILs/VQOs established by the 1990 *Wenatchee National Land and Resource Management Plan* for Keechelus Reservoir. The restoration activities would meet the SIL/VQO of high/retention by improving developed recreation facilities at Gold Creek Day Use Site and along the John Wayne Pioneer Trail with native vegetation and habitat enhancement. The landscape character would be reflective of a natural appearing environment. Foreground and middle-ground views from sensitive viewing locations would be minimally affected by restoration activities and new or altered bridges.

4.10.5 Alternative 2B – KDRPP South Pumping Plant

4.10.5.1 Construction

KDRPP South Pumping Plant Facilities

Construction of *Alternative 2B – KDRPP South Pumping Plant* would create short-term, localized, and temporary visual impacts for approximately 3 years. Construction activities would be concentrated on the south shore of the reservoir. Types of visual quality impacts would be similar to those for *Alternative 2A – KDRPP East Shore Pumping Plant*, although impacts would be less for the south pumping plant since much of the construction would be located south of Kachess Dam (Figure 4-12).

Figure 4-12. South Pumping Plant Location (South of Kachess Dam)

Construction activities south of the dam for the pumping plant, surge tank, and power supply substation would result in removal of vegetation and the presence of construction equipment and activity, with possible degradation in the quality of views. However, elevation differences between the Kachess Dam and the construction areas to the south would block views of most of the construction equipment, materials, and activity at the pumping plant site from the reservoir. The locations of temporary construction facilities (e.g., concrete batch plant, construction basin and boat launch) would be highly visible from the southeast portion of the reservoir. The TBM to be used for construction of the intake and tunnel for this alternative would minimize the visual impact of construction within the reservoir relative to *Alternative 2A – KDRPP East Shore Pumping Plant.* Based on limited number of public viewpoints into construction areas and the temporary nature of construction, *Alternative 2B –*

KDRPP South Pumping Plant would have a minor short-term effect on the visual character and integrity of the landscape.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.10.4.1).

4.10.5.2 Operation

KDRPP South Pumping Plant Facilities
As for *Alternative 2A – KDRPP East Shore Pumping Plant*, visual impacts from operation of the south pumping plant relate to changes in reservoir pool elevations, the presence of new facilities and features on the landscape, and downstream effects.

Reservoir Pool Elevations
Visual quality impacts of reservoir pool elevation changes would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.10.4.2).

New Facilities
The *Alternative 2B – KDRPP South Pumping Plant* would be located in a forested area, south of Kachess Dam, which provides a perceived "altered" visual setting. Once complete, the pumping plant, associated power supply substation, and surge tank would not be visible to recreationists or other observers on the north (reservoir) side, whose view would be blocked by the dam, intervening elevation changes, and vegetation. Impacts would be minor because access to and views of these facilities are limited, and few people would notice the modification. Similar to *Alternative 2A – KDRPP East Shore Pumping Plant*, once complete, the intake would be buried (or covered by water) and create no visual quality impacts. Impacts of exterior lighting on the south pumping plant building and power substation would be similar to those described for *Alternative 2A – KDRPP East Shore Pumping Plant*. With the use of lighting cutoff options and shields to avoid sky glow and glare, minimal impacts from exterior lighting at night are anticipated. Impacts of the transmission line would also be similar to those described for *Alternative 2A – KDRPP East Shore Pumping Plant*.

Alternative 2B – KDRPP South Pumping Plant would be consistent with SILs/VQOs established by the 1990 *Wenatchee National Land and Resource Management Plan* for Kachess Reservoir. The new facilities and features of *Alternative 2B – KDRPP South Pumping Plant* would not be visible from areas most often used by the public. Therefore, foreground and middle-ground views from sensitive viewing locations would not be affected.

Downstream Effects
Visual quality impacts of downstream effects would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.10.4.2).

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.10.4.2).

4.10.6 Alternative 3A – KKC North Tunnel Alignment

4.10.6.1 Construction

KKC North Tunnel Alignment Facilities
Construction of *Alternative 3A – KKC North Tunnel Alignment* located in the Keechelus Dam area includes the Yakima River diversion, fish screens, intake, Yakima River-to-Keechelus portal conveyance, and the Keechelus portal. These facilities would generate limited visual quality impacts. Construction would occur behind the earth-filled dam and is not expected to be visible from I-90. The north tunnel alignment from the Keechelus portal to the Kachess Reservoir would be constructed underground and would not result in impacts at the surface. The only visual quality impacts would occur at the Kachess Lake Road portal.

Construction of the Kachess Lake Road portal and discharge structure and the Kachess Reservoir spillway and stilling basin would create short-term, localized, and temporary visual impacts for approximately 3 years. Construction activities at the Kachess Lake Road portal and discharge structure would take place in a primarily wooded and undeveloped setting.

Figure 4-13. Kachess Lake Road Portal Location – Forested Condition

Construction activities would temporarily disrupt the visual character along Kachess Lake Road, which is used by recreationists and residents. The appearance of the 600-foot-by-250-foot cleared portal area, temporary road reroute, heavy truck traffic, and other construction activities would contrast with and detract from the overall wooded and undeveloped landscape character.

Construction activities associated with the spillway and stilling basin would be located on the west shore of the reservoir. The presence of a temporary sheetpile cofferdam, equipment, and construction activity along this portion of the reservoir would represent a noticeable change in the visual environment, but these activities would not occur in sensitive viewing areas, and would be viewable only from limited areas of the reservoir. Based on the temporary nature of construction, *Alternative 3A – KKC North Tunnel Alignment* would have a minor short-term effect on the visual character and integrity of the landscape.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.10.4.1).

4.10.6.2 Operation

KKC North Tunnel Alignment Facilities
Visual impacts from operation of *Alternative 3A – KKC North Tunnel Alignment* relate to changes in reservoir pool elevations, the presence of new facilities and features on the landscape, and downstream effects.

Reservoir Pool Elevations
The KKC would change reservoir levels in both Keechelus and Kachess reservoirs compared to *Alternative 1 – No Action*. However, *Alternative 3A – KKC North Tunnel Alignment* would have no long-term impacts on visual quality at Kachess Reservoir because operations would not impact reservoir levels outside of existing variability. Keechelus Reservoir would have a slightly lower maximum water level and higher minimum water level during drought years and when Kachess Reservoir is refilling after a drought. This slightly restricted range would be acceptable according to USFS SILs/VQOs of moderate/partial retention and low/modification for the scenic viewsheds in the primary study area. The reservoir would remain a managed facility, like other reservoirs in the area, and the slightly changed reservoir pool levels would not change the visitor perception of natural appearance or the overall dominant element of the reservoir on the landscape.

KKC Facilities
At Keechelus Reservoir, *Alternative 3A – KKC North Tunnel Alignment* facilities located in the Keechelus Dam area would create limited visual quality impacts. Because the area is closed to the public and is not visible from adjacent areas, public views would be largely unaffected. The north tunnel alignment to the Kachess Reservoir would be underground and would not result in impacts at the surface.

The only visual quality impacts would occur at the Kachess Lake Road portal and discharge structure, and the Kachess Reservoir spillway and stilling basin. The portal and discharge structure would be located in a forested area that provides a perceived "natural" though "slightly altered" visual setting, primarily due to the presence of Kachess Lake Road. The Kachess portal would be excavated into the hillside to the northwest of Kachess Lake Road allowing at-grade access to the partially buried structure. The wall of the portal, concrete deck panels and vent stacks would be visible above ground. Reclamation would screen the site from Kachess Lake Road using a berm and trees. Exterior lighting on the portal facility would be limited to security and emergency lighting. With the use of lighting cutoff options and shields to avoid sky glow and glare, minimal impacts from exterior lighting at night are anticipated. With site restoration and screening, Reclamation anticipates the visual impacts of the permanent facilities would be minor.

Alternative 3A – KKC North Tunnel Alignment would introduce a roughly 400-foot long double box culvert, 6 feet wide by 6 feet high culvert under Lake Kachess Road. From there, the water would be routed through a 90-foot long and 20-foot wide energy dissipation spillway channel, into a 60-foot long, 20-foot wide stilling basin located approximately 10 feet below the full pool elevation of the Kachess Reservoir. Water would then flow over a 200-foot long by 30-foot wide riprap pad directly into the Kachess Reservoir (Figure 2-9). The final size, shape, and extent of riprap would be determined based on bed materials, slope and erosion potential. The site would be fenced for security purposes. These features would interrupt the form, line, color, and texture of the shoreline landscape, resulting in minor and localized changes in visual character at the Kachess Reservoir shoreline. People walking along the reservoir shoreline or boating at this location would notice them. The Kachess Lake Road portal and discharge structure as well as the Kachess Reservoir spillway channel, stilling basin, and riprap would not be visible from areas most often used by the public. These effects would not be located in sensitive viewing areas, and would be viewable only from limited areas of the reservoir, so the impacts would not be significant. Where feasible and appropriate, the spillway and stilling basin would be designed to minimize visual impacts. In the short-term, the area disturbed by portal and discharge structure construction would not meet the intent of the established SIL/VQO of high/retention in developed recreation sites, and as viewed from scenic travel corridors; it would likely represent low/modification SIL/VQO. As vegetation in the restored area matures, the area is expected to revert to the previous SIL/VQO.

Downstream Effects

Reclamation would operate the KKC by diverting water downstream of Keechelus Reservoir and conveying water directly to Kachess Reservoir. *Alternative 3A – KKC North Tunnel Alignment* would reduce summer flows in the Keechelus Reach of the Yakima River by 50 percent in the summer, but still well above winter low flow conditions. This change would be noticeable, but the lower flows would create more natural visual conditions over the current artificially high flows. Changes in streamflow would also occur in the Kachess River and Easton Reach of the Yakima River. However, none of the changes would result in visual quality impacts. In the Easton Reach, summertime streamflow would increase during drought years (by 39 to 52 cfs or 4.4 to 8.3 percent), but would remain within the range of existing flow conditions for this reach. Therefore, visual quality impacts due to riverbank erosion or flows outside the range of existing flows would not occur. The Keechelus Reach of the Yakima River would continue to meet established SIL/VQO of high/retention.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.10.4.2).

4.10.7 Alternative 3B – KKC South Tunnel Alignment

4.10.7.1 Construction

KKC South Tunnel Alignment Facilities
Construction of *Alternative 3B – KKC South Tunnel Alignment* facilities located in the Keechelus Dam area would result in the same type and extent of visual quality impacts as *Alternative 3A – KKC North Tunnel Alignment*. The tunnel to the Kachess Reservoir would be underground and would not require surface construction activity except at the I-90 Exit 62 portals and the Kachess Reservoir discharge structure. Impacts at the I-90 Exit 62 portal area would be minor because the site is currently a disturbed landscape, with restricted views from I-90 to the portion of the site proposed for the portals (Figure 4-14). Exterior lighting on the portal facilities would be limited to security and emergency lighting. With the use of lighting cutoff options and shields to avoid sky glow and glare, minimal impacts from exterior lighting at night are anticipated.

Figure 4-14. I-90 Exit 62 Portal Location – Active WSDOT Staging

Construction activities (e.g., truck hauling) would temporarily disrupt the visual character along I-90, a National Scenic Byway (Mountains-to-Sound Greenway). No additional visual quality impacts are anticipated.

Impacts at Kachess Reservoir would be reduced relative to *Alternative 3A – KKC North Tunnel Alignment* (Section 4.10.6.1) because Lake Kachess Road would not need to be rerouted for portal construction. Therefore, there would be fewer temporary disruptions to the visual character of the area. Because access to and views of the construction areas would be limited, few people would notice the construction. Construction impacts at the reservoir shoreline would be similar to those described for *Alternative 3A – KKC North Tunnel Alignment.* Given the limited public viewpoints to construction areas and the temporary nature of construction, *Alternative 3B – KKC South Tunnel Alignment* would have a minor short-term effect on the visual character and integrity of the landscape.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.10.4.1).

4.10.7.2 Operation

KKC South Tunnel Alignment Facilities
Similar to *Alternative 3A – KKC North Tunnel Alignment*, visual impacts from operation of *Alternative 3B – KKC South Tunnel Alignment* relate to changes in reservoir pool elevations, the presence of new facilities and features on the landscape, and downstream effects.

Reservoir Pool Elevations
Visual quality impacts of reservoir pool elevation changes would be the same as described for *Alternative 3A – KKC North Tunnel Alignment* (Section 4.10.6.2).

New Facilities
At Keechelus Reservoir, all of the proposed elements would be the same as *Alternative 3A – KKC North Tunnel Alignment*. The south tunnel alignment to the Kachess Reservoir would be underground and would not result in new facilities or features at the surface, except at the I-90 Exit 62 portals and the Kachess Reservoir portal and discharge structure. Once construction is complete, the site would be restored, and access facilities at the I-90 Exit 62 portals and the Kachess Reservoir portal would constitute the only permanent facilities. With site restoration, Reclamation anticipates the visual impacts of the permanent facilities would be minor.

Impacts at Kachess Reservoir would be similar to *Alternative 3A – KKC North Tunnel Alignment* (Section 4.10.6.2). The Kachess Reservoir portal and discharge structure would be located at the Kachess Reservoir west shoreline on a parcel managed by the USFS south of a residential development, and would not be visible from Kachess Lake Road (Figure 2-11). The portal and discharge structure would be located in a forested area that provides a perceived “natural” though “slightly altered” visual setting, primarily due to the presence of Kachess Lake Road and nearby residential development. A permanent access road from Kachess Lake Road 25 feet wide and 500-feet long would be constructed just north of the portal. The buried, discharge structure pipeline would connect to a 20-foot-wide, 50-foot-long spillway by a 30-foot-long transition structure that would exit into the Kachess Reservoir over a concrete or riprap lined channel.

Alternative 3B – KKC South Tunnel Alignment would result in minor changes in visual character at the Kachess Reservoir shoreline. The Kachess Reservoir portal and discharge structures would interrupt the form, line, color, and texture of the shoreline landscape, presenting a noticeable change in the visual environment. However, these structures would not impair the visual quality or character of Kachess Reservoir because they would not be prominent on the landscape, and would be viewable only from limited areas of the reservoir. Where feasible and appropriate, structures and other proposed facilities would be designed to reduce the visual impacts.

Alternative 3B – KKC South Tunnel Alignment would be consistent with SILs/VQOs established by the 1990 *Wenatchee National Land and Resource Management Plan* for Kachess Reservoir. The Kachess Reservoir portal and discharge structure would not be visible from areas most often used by the public. Therefore, foreground and middle-ground views from sensitive viewing locations would not be affected.

Downstream Effects
Visual quality impacts of downstream effects would be the same as described for *Alternative 3A – KKC North Tunnel Alignment* (Section 4.10.6.2).

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.10.4.2).

4.10.8 Alternative 4 – Combined KDRPP and KKC

4.10.8.1 Construction

KDRPP and KKC Facilities
Impacts from facilities and construction activities for simultaneous development of both KDRPP and KKC would be the same as for *Alternatives 2A* and *2B* (KDRPP) (Sections 4.10.4.1 and 4.10.5.1) and *Alternatives 3A* and *3B* (KKC) (Sections 4.10.6.1 and 4.10.7.1). Combining KDRPP and KKC would not cause any additional construction impacts. If KDRPP and KKC were constructed simultaneously, visual quality impacts at Kachess Reservoir would detract further from the overall landscape character by the presence of construction equipment, activities, materials, and truck trips at multiple construction sites. Based on the temporary nature of construction, *Alternative 4 – Combined KDRPP and KKC*

would have a minor to moderate short-term effect on the visual character and integrity of the landscape.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.10.4.1).

4.10.8.2 Operation

KDRPP and KKC Facilities
Impacts from new facilities would be the same as for *Alternatives 2A* and *2B* (KDRPP) (Sections 4.10.4.2 and 4.10.5.2) and *Alternatives 3A* and *3B* (KKC) (Sections 4.10.6.2 and 4.10.7.2). Visual impacts of KDRPP would depend on which alterative is selected. Combining KDRPP and KKC would not cause any additional operational impacts. Combined operation could reduce the drawdown of Kachess Reservoir during drought years, allowing for a more rapid refilling and a shorter duration of drawdown-induced impacts on visual quality. However, visual quality impacts due to the drawdown would still be considered significant to some observers during drought years (similar to *Alternatives 2A* and *2B*).

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.10.4.2).

4.10.9 Mitigation Measures

Under all action alternatives, Reclamation would restore temporary access and staging areas and replant with native species. Reclamation would coordinate with the USFS on appropriate design and landscaping, including the use of the Cascadian architectural style for the design of facilities where appropriate. Reclamation would also design facilities to blend with the surrounding areas by burying or partially burying new facilities where feasible and appropriate, and by painting visible portions of building exteriors in flat, nonreflective dark earth tone colors.

Under KDRPP *Alternative 2A* and *2B*, Reclamation would design the transmission line alignment to minimize visual quality impacts to the extent feasible.

The significant impacts to visual quality under KDRPP *Alternative 2A* and *2B* due to the increased drawdown of Kachess Reservoir would not be mitigated.

4.11 Air Quality

4.11.1 Methods and Impact Indicators

Methods. The primary study area lies within Kittitas County, which is in attainment for all criteria pollutants listed in the Clean Air Act. Reclamation conducted a semiquantitative evaluation of the construction and operational characteristics of the project and its potential to approach the General Conformity *de minimis* thresholds as specified by the Environmental Protection Agency (EPA) in 40 CFR 93.153. The EPA establishes *de minimis* thresholds for nonattainment and maintenance areas as the emissions levels under which conformity determination is not required for an action. This analysis uses the *de minimis* thresholds as the metric for identifying adverse environmental impacts. The *de minimis* thresholds used for this analysis are 100 tons per year for all criteria pollutants except lead. The *de minimis* threshold for lead is 25 tons per year; however, lead is no longer associated with vehicle and heavy equipment emissions, so is not relevant to the air quality evaluation in this document.

Impact Indicators. The impact indicators for air quality and criteria for determining impact significance are shown in Table 4-55.

Table 4-55. Impact Indicators and Significance Criteria for Air Quality

Impact Indicator	Significance Criteria
Increased vehicle and equipment emissions and level of fugitive dust during construction	Exceedance of EPA General Conformity *de minimis* thresholds.
Exposure of sensitive receptors to substantial pollutant concentrations or odors	Exceedance of EPA General Conformity *de minimis* thresholds

4.11.2 Summary of Impacts

Alternative 1 – No Action would not result in air quality impacts because there would be no construction and no operational generation of emissions above baseline conditions. For *Alternatives 2* through *4*, construction emissions would be moderate over the respective construction periods. With BMPs in place, construction would not result in an exceedance of EPA General Conformity *de minimis* air quality thresholds. No sensitive receptors would be exposed to substantial concentrations of pollutants or odors above EPA General Conformity *de minimis* thresholds. None of the alternatives would generate emissions or fugitive dust once construction is complete (Table 4-56).

The BTE actions would be implemented as part of all the action alternatives and would result in localized generation of emissions and fugitive dust, primarily from heavy equipment and truck trips required for moving fill material as part of the Gold Creek channel narrowing, Gold Creek Pond fill, and Heli's Pond fill. Air quality impacts would not be significant.

Construction activities would be temporary and would not result in emissions that would exceed EPA General Conformity *de minimis* thresholds.

Table 4-56. Summary of Impacts for Air Quality

Impact Indicator	Impact Summary
Increased vehicle and equipment emissions and level of fugitive dust during construction	Construction would result in increased emissions and fugitive dust throughout the 3-year construction period, primarily due to truck hauling of project spoils to the disposal area. Impacts are not considered significant because emissions would be well below EPA General Conformity *de minimis* thresholds. *Alternative 2A – KDRPP East Shore Pumping Plant* would result in the most emissions (highest number of required truck trips), but the impact is not considered significant.
Exposure of sensitive receptors to substantial pollutant concentrations or odors	Due to the relatively low level of emissions and distance between proposed construction sites or key hauling routes and sensitive receptors, emissions and fugitive dust would not have a significant impact on these receptors. For *Alternatives 2A* and *2B*, offsite spoils disposal would increase impacts as haul routes would pass closer to several residences; however, the impact is not considered significant. *Alternative 3A – KKC North Tunnel Alignment* would result in more impact (residences along Kachess Lake Road haul route) than *Alternative 3B – KKC South Tunnel Alignment* (large majority of truck trips would avoid sensitive receptors).

4.11.3 Alternative 1 – No Action Alternative

The projects identified as occurring under *Alternative 1 – No Action*, as described in Section 2.3, include the I-90 Phase 2A project, which would include expanding 2.1 miles of the highway to six lanes. Along with capacity increase, the project would improve level of service (LOS) provided through the corridor, with LOS D not reached until 2041 and LOS E not reached until 2058. Without the project, the I-90 corridor would maintain the current LOS D status until 2025, at which point it would already reach LOS E (28 years earlier than with the project). Improved long-term LOS could reduce vehicular emissions within the I-90 corridor, especially during peak travel times. In addition, vehicular carbon monoxide emission rates would fall by approximately 53 percent over the next 25 years due to the Clean Air Act fuel and engine requirements. WSDOT determined that there would be no permanent adverse impact to air quality caused by the I-90 Phase 2A project (WSDOT, 2008).

Beyond the I-90 expansion, no new emissions or fugitive dust sources are anticipated under *Alternative 1*. Therefore, air quality conditions would not exceed EPA General Conformity *de minimis* thresholds and would remain generally consistent with existing conditions.

4.11.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.11.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Construction emissions and generation of fugitive dust associated with *Alternative 2A – KDRPP East Shore Pumping Plant* would be primarily associated with excavation for the intake tunnel and pumping plant shaft. These activities would require significant excavation, handling, and transport of spoils, all involving extended use of heavy construction equipment and trucks. Construction of other facilities for *Alternative 2A - KDRPP East Shore Pumping Plant*, such as the transmission line, would also require use of heavy equipment and trucks, but emissions associated with these activities would be minimal compared to construction and spoils hauling for the intake tunnel and pumping plant shaft.

Mining and excavation required as part of *Alternative 2A – KDRPP East Shore Pumping Plant* would result in approximately 28,900 truck roundtrips over the life of the project (approximately 49 truck roundtrips during each day of construction, with six trips per hour; as described in Section 4.18.4.1). Truck hauling trips represent the large majority of machinery- and vehicle-derived emissions associated with construction of *Alternative 2A - KDRPP East Shore Pumping Plant*. Reclamation would use one of two spoil disposal areas: (1) an abandoned spillway on the southeast Kachess Reservoir shoreline, located approximately 1 mile south of the proposed pumping plant and 0.6 mile east of the existing Kachess Dam; or (2) an offsite location within approximately 12 miles of the reservoir (no specific offsite location has been identified). With either location, the contractor would transport soils in dump trucks along the east shore of Kachess Reservoir. If Reclamation determines the spillway site is available, the roundtrip haul route would be approximately 3.2 miles per trip, or 30,830 total truck miles per year. The worst-case scenario roundtrip haul route would be 24 miles per trip, or 231,200 total truck miles per year.

Under this worst-case scenario, *Alternative 2A – KDRPP East Shore Pumping Plant* construction activities would result in minor emissions of 12 percent or less of EPA General Conformity *de minimis* thresholds for all relevant criteria pollutants (Table 4-57).

Table 4-57. Emissions from *Alternative 2A – KDRPP East Shore Pumping Plant* Construction Hauling

Criteria Pollutant	Emissions — Worst-Case Scenario (tons/year)	Percent of *De Minimis* Threshold
Carbon monoxide (CO)	1.98	2
Ozone		
NO_x	11.06	11.1
VOC	0.32	0.3
Particulate pollutants		
PM_{10}	0.75	0.8
$PM_{2.5}$	0.73	0.7

In addition to machinery and vehicle-derived emissions, clearing, grading, and truck trips would create fugitive dust. Impacts from windblown particulate matter or fugitive dust would be localized to construction sites and haul routes, all of which are removed from any residential or recreational sensitive receptors. Haul routes are on paved roads, limiting potential for generation of fugitive dust.

The nearest anticipated rural residential or vacation home use is located 0.4 mile south of the proposed spoils disposal area (rural residents and cabins along Silver Trail Road and Silver Trail Lane). Emissions would not impact these sensitive receptors because there would not be substantial concentrations of pollutants.

Construction would occur approximately 8 miles south of Alpine Lakes Wilderness Area, a federally designated Class I area. However, construction emissions would not be expected to affect the area due to the distance, prevailing wind patterns, and the low level of emissions anticipated.

Regular use of heavy equipment and truck trips would be required for *Alternative 2A - KDRPP East Shore Pumping Plant* over the entire 3-year construction period. Emissions and fugitive dust would occur within a localized area surrounding the project, with no anticipated air quality impacts on nearby sensitive receptors. There are no rural residential or recreational uses between the existing Kachess Dam and the proposed east shore pumping plant location (along the southeast and east shorelines of the reservoir), outside of boating and other water recreational activities on Kachess Reservoir. Dispersed recreational users on the reservoir and reservoir shoreline could experience short-term increases in fugitive dust in close proximity to project construction areas; however, recreational users could avoid these areas during construction. Impacts would occur over the 3-year duration of construction, but intermittently over the course of the workday.

Bull Trout Enhancement

Construction of BTE actions would result in localized generation of emissions and fugitive dust, primarily from heavy equipment and truck trips required for moving fill material as part of the Gold Creek channel narrowing, Gold Creek Pond fill, and Heli's Pond fill. Air quality impacts would not be significant. Construction activities would be temporary and would not result in emissions that would exceed EPA General Conformity *de minimis* thresholds.

4.11.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Operation of the pumping plant would cause minor increases in emissions. Electric pumps would be used at the pumping plant. Power supply would come from the regional power grid; therefore, air quality effects are not anticipated in the primary study area. The regional power grid draws from hydropower sources and from some fossil fuel-powered electricity generation facilities, so there may be minor air quality effects at locations where the power is generated. Therefore, no new emissions would be associated with actual pump operations.

Vehicle trips necessary for pumping plant operations and maintenance would result in minor increases in emissions along Kachess Dam Road (NF-4818). However, these increases would not result in air quality impacts because of the low level of emissions and distance to receptors.

Alternative 2A – KDRPP East Shore Pumping Plant would increase the area of Kachess Reservoir shoreline exposed when the reservoir is drawn down (a maximum of an additional 80 vertical feet of shoreline along the entire reservoir). The additional exposed shoreline could increase the amount of windblown dust, but shoreline materials are mostly stable. Therefore, the new reservoir pool is not expected to cause air quality impacts.

Bull Trout Enhancement
BTE actions would not result in operation impacts on air quality because no use of power or regular maintenance would be required after construction is completed.

4.11.5 Alternative 2B – KDRPP South Pumping Plant

4.11.5.1 Construction

KDRPP South Pumping Plant Facilities
Construction impacts would be similar to *Alternative 2A – KDRPP East Shore Pumping Plant* as described in Section 4.11.4.1. *Alternative 2B – South Pumping Plant* would require less overall excavation and affect fewer recreational users than *Alternative 2A – KDRPP East Shore Pumping Plant.* Additionally, construction activities would take place closer to Kachess Dam, and recreational activities are more limited in this area.

Excavation for the intake tunnel and pumping plant shaft would result in approximately 8,800 truck roundtrips over the life of the project (approximately 15 truck roundtrips during each day of construction with two trips per hour, as described in Section 4.17.5.1). This is approximately 30 percent of the total truck trips required for *Alternative 2A – KDRPP East Shore Pumping Plant*.

Reclamation is evaluating the same spoils disposal options for *Alternatives 2A* and *2B*. Under the worst-case option for disposal, spoils would be hauled no farther than 12 miles from the south pumping plant. The large majority of *Alternative 2B – South Pumping Plant* spoils would be excavated and loaded onto trucks from this location. Under the worst-case scenario, construction emissions would be less than 4 percent of EPA General Conformity *de minimis* thresholds for all relevant criteria pollutants (Table 4-58).

Table 4-58. Emissions from *Alternative 2B – South Pumping Plant* Construction Hauling

Criteria Pollutant	Emissions — Worst-Case Scenario (tons/year)	Percent of *De Minimis* Threshold
Carbon monoxide (CO)	0.60	0.6
Ozone		
NO_x	3.37	3.4
VOC	0.10	0.1
Particulate pollutants		
PM_{10}	0.23	0.2
$PM_{2.5}$	0.22	0.2

Fugitive dust from clearing, grading, and truck trips would result in impacts similar to those of *Alternative 2A – KDRPP East Shore Pumping Plant*; however, the fewer truck trips required would reduce emissions. There are no residential or recreational sensitive receptors located in the immediate vicinity of the south pumping plant and surrounding facilities.

Bull Trout Enhancement

Emissions and construction impacts from the BTE would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant.*

4.11.5.2 Operation

KDRPP South Pumping Plant Facilities

Operation impacts would be similar to those described for *Alternative 2A – KDRPP East Shore Pumping Plant* in Section 4.11.4.2.

Bull Trout Enhancement

Operation impacts from the BTE would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.11.4.2).

4.11.6 Alternative 3A – KKC North Tunnel Alignment

4.11.6.1 Construction

KKC North Tunnel Alignment Facilities

Construction emissions and fugitive dust associated with *Alternative 3A – KKC North Tunnel Alignment* would primarily result from transport of spoils from the deep tunnel between the Kachess Lake Road portal and the Keechelus portal, as well as other project excavations. Based upon excavation required for the proposed tunnel, approximately 11,600 truck trips would be required from the Kachess Lake Road portal site to the spoils disposal site, or approximately 18 truck roundtrips during each day of construction (approximately two to three trucks per hour).

Reclamation has identified two primary options for spoils disposal. The first is disposal at an existing quarry near Keechelus Dam and the second is use by WSDOT as fill material for I-90 improvements. Truck emissions could impact existing sensitive receptors along spoils hauling routes. Impacted residences and vacation home properties would include those along Kachess Lake Road between the Kachess Lake Road portal and I-90 Exit 62. Impacts would occur over the 3-year duration of construction, intermittently over the course of the workday.

Under the worst-case scenario for spoils hauling, *Alternative 3A – KKC North Tunnel Alignment* construction emissions would be less than 5 percent of EPA General Conformity *de minimis* thresholds for all relevant criteria pollutants (Table 4-59).

Table 4-59. Emissions from *Alternative 3A – KKC North Tunnel Alignment* Construction Hauling

Criteria Pollutant	Emissions — Worst-Case Scenario (tons/year)	Percent of *De Minimis* Threshold
Carbon monoxide (CO)	0.79	0.8
Ozone		
NO_x	4.44	4.4
VOC	0.13	0.1
Particulate pollutants		
PM_{10}	0.30	0.3
$PM_{2.5}$	0.29	0.3

Generation of fugitive dust from clearing, grading, and truck trips would have minimal impacts on sensitive receptors, assuming BMPs are used during construction. There are no residential or recreational sensitive receptors located in the immediate vicinity of primary facilities (including the Kachess Lake Road Portal), and proposed hauling routes are along paved roads.

Bull Trout Enhancement

Emissions and construction impacts from the BTE would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.11.4.1).

4.11.6.2 Operation

KKC North Tunnel Alignment Facilities

Operation of the Keechelus-to-Kachess Conveyance under *Alternative 3A* would cause minor increases in emissions. Electric pumps and other electric-powered equipment would be used to control the Yakima River diversion and other facility control structures. Power supply would come from the regional power grid; therefore, air quality effects are not anticipated in the primary study area. The regional grid draws power from hydropower sources and from some fossil fuel powered electricity generation facilities, so there may be minor air quality effects at locations where power is generated. Therefore, no new emissions would be associated with actual pump operations.

Vehicle trips necessary for pumping plant operations and maintenance would result in minor increases in emissions along Kachess Dam Road (NF-4818); however, these increases would not result in air quality impacts on nearby sensitive receptors.

Bull Trout Enhancement

Operation impacts of the BTE would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.11.4.2).

4.11.7 Alternative 3B – KKC South Tunnel Alignment

4.11.7.1 Construction

KKC South Tunnel Alignment Facilities

Construction impacts would be similar to those described for *Alternative 3A – KKC North Tunnel Alignment* Section 4.11.6.1. However, under *Alternative 3B – KKC South Tunnel Alignment*, the longer overall tunnel length would result in 5 to 10 percent more spoils, with a similar increase in dump truck trips (12,100 versus 11,600) compared to *Alternative 3A – KKC North Tunnel Alignment*. Excavated spoils would be hauled from the I-90 Exit 62 portal. As with *Alternative 3A – KKC North Tunnel Alignment*, disposal areas for project spoils have yet to be identified (the same options for disposal are being considered under both alternatives). Due to proximity to the existing quarry as well as I-90 access, there are no existing sensitive receptors along potential spoils hauling routes for *Alternative 3B – KKC South Tunnel Alignment*.

Under the worst-case scenario for spoils hauling, construction emissions would be less than 5 percent of EPA General Conformity *de minimis* thresholds for all relevant criteria pollutants (Table 4-60). Anticipated emissions would be only slightly higher than those from *Alternative 3A – KKC North Tunnel Alignment*.

Table 4-60. Emissions from *Alternative 3B – KKC South Tunnel Alignment* Construction Hauling

Criteria Pollutant	Emissions — Worst-Case Scenario (tons/year)	Percent of *De Minimis* Threshold
Carbon monoxide (CO)	0.83	0.8
Ozone		
NO_x	4.63	4.6
VOC	0.13	0.1
Particulate pollutants		
PM_{10}	0.31	0.3
$PM_{2.5}$	0.31	0.3

The I-90 Exit 62 portal is close to I-90, which could minimize emission impacts on sensitive residential receptors and avoid the large majority of haul route trips along Kachess Lake Road. These impacts would occur over the 3-year duration of construction, intermittently over the course of the workday.

Generation of fugitive dust from clearing, grading, and truck trips would have minimal impacts, similar to *Alternative 3A – KKC North Tunnel Alignment*. There are no residential or recreational sensitive receptors located in the immediate vicinity of primary facilities (including the I-90 Exit 62 portal), and proposed hauling routes are along paved roads.

Bull Trout Enhancement
Emissions and construction impacts from the BTE would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.11.4.1).

4.11.7.2 Operation

KKC South Tunnel Alignment Facilities
Operation impacts would be similar to those of *Alternative 3A – KKC North Tunnel Alignment* as described in Section 4.11.6.2.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.11.4.2).

4.11.8 Alternative 4 – Combined KDRPP and KKC

4.11.8.1 Construction

KDRPP and KKC Facilities
Combining KDRPP and KKC would not cause any additional construction impacts other than those discussed above for *Alternatives 2* and *3*. Delivering materials and importing and exporting fill and spoil materials would require a total of approximately 20,400 to 41,000 truck roundtrips over the life of the project, or approximately 6 to 11 trucks per hour. If Reclamation constructed KDRPP and KKC at the same time, sensitive receptors, including residential and recreational uses, could be disrupted simultaneously by construction emissions and fugitive dust from truck trips. However, due to the minimal air quality impacts anticipated under *Alternatives 2* and *3*, there are no significant impacts anticipated for *Alternative 4 -Combined KDRPP and KKC*.

Bull Trout Enhancement
Emissions and impacts from the BTE would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.11.4.1).

4.11.8.2 Operation

KDRPP and KKC Facilities
Combining KDRPP and KKC would not cause any additional long-term impacts as discussed above for *Alternatives 2* and *3*.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.11.4.2).

4.11.9 Mitigation Measures

Overall, existing air quality in the project area meets the national standards for criteria pollutants. Reclamation would implement construction BMPs to minimize the impact on existing residential and recreational uses from construction-related emissions and nuisance dust. For these reasons, construction impacts on air quality would be temporary, relatively minor, and not expected to cause exceedances of national standards. BMPs the contractor could use to reduce construction impacts include the following:

- Complying with the BMPs required in WAC 173-400-040 (general standards for maximum emissions)
- Complying with applicable dust control policies and plans
- Spraying dry soil with water to reduce dust
- Using temporary ground covers
- Minimizing idling of equipment when not in use
- Planning construction areas to minimize soil exposure for extended periods
- Covering dirt and gravel piles
- Establishing wheel wash stations at exits from spoils handling and truck loading sites
- Sweeping paved roadways to reduce mud and dust
- Replanting exposed areas as soon as possible after construction

4.12 Climate Change

4.12.1 Methods and Impact Indicators

Methods. Reclamation considered both impacts of emissions of greenhouse gases (GHGs) from KDRPP and KKC as well as the effects of potential climate change on KDRPP and KKC. Reclamation analyzed climate change impacts by considering the GHG emissions that construction and operation of KDRPP and KKC would generate. Construction activities would generate GHG emissions through truck shipments of materials to the construction sites and use of construction equipment. KDRPP and KKC operations would generate GHG emissions through operation of pumps and other equipment. Reclamation estimated GHG emissions related to construction using Washington Department of Ecology (Ecology) guidance and emission factors from the Climate Registry. Reclamation also considered potential emissions associated with KDRPP and KKC operations; these emissions were evaluated qualitatively due to the short-term, intermittent nature of operational activities.

For construction, Reclamation assumed that the GHG emissions generated would result from the use of diesel fuel, which has higher carbon dioxide equivalent (CO_2e) emissions than gasoline. Total GHG emissions are reported as the total CO_2e emissions that would be expected from every gallon of diesel fuel burned. The three major GHGs that would be emitted are CO_2, methane (CH_4), and nitrous oxide (N_2O). The total CO_2e emissions were calculated using the estimated amount of diesel fuel required for KDRPP and KKC construction and the expected CO_2e GHG emissions per gallon of diesel fuel consumed (10.3074 kilograms per gallon [kg/gal]). Table 4-61 presents the expected emissions of the three major GHGs from 1 gallon of diesel fuel burned, which are referred to as emission factors (Climate Registry 2013a, 2013b). To convert CH_4 and N_2O into CO_2e, the global warming potential of each gas was compared to the global warming potential of CO_2. For example, one unit of CH_4 warms the atmosphere at 21 times the rate of CO_2 (Table 4-61). In other words, every unit of CH_4 emitted is the equivalent of 21 units of CO_2. As shown in Table 4-61, the expected CO_2e emissions for all three gases is 10.3074 kg/gal of diesel fuel burned.

Table 4-61. CO_2 Equivalents and Emission Factors per 1 Gallon of Diesel Fuel

Greenhouse Gas	Emission Factor (kg/gal)	Global Warming Potential	CO_2 Equivalent Emission Factor[1] (kg CO_2e/gal)
Carbon dioxide (CO_2)	10.21	1	10.21
Methane (CH_4)	0.0008	21	0.0168
Nitrous oxide (N_2O)	0.00026	310	0.0806
		Total	**10.3074**

[1] Emission factors from Climate Registry (2013a, 2013b).

Calculations of the GHG emissions from truck trips are based on the estimated number of trucks required for each KDRPP and KKC element, the distance each truck would be required to travel, and a fuel efficiency of 8.0 miles per gallon. The analysis assumed a travelling distance of 4 to 20 miles for each truck, depending on the KDRPP and KKC element being constructed.

While running, construction equipment would consume diesel fuel. The potential CO_2e emissions from operation of construction equipment were calculated by evaluating the types of construction equipment required and estimating the time that each piece of equipment would operate during construction. The analysis assumed that the construction equipment would consume between 3 and 11 gallons of diesel fuel per hour of operation, depending on the equipment.

The effects of potential climate change on the Proposed Action were modeled by comparing the expected changes in precipitation, snowmelt, and runoff that could result under the Adverse scenario (a future with climate change) and the Baseline scenario (a future based on historical conditions) described in Section 3.12. The scenarios described in Section 3.12 would occur independently from the Proposed Action and alternatives.

Impact Indicators. The indicator of significance for GHG emissions generated by construction is the EPA and Ecology guideline that GHG emissions of less than 25,000 metric tons per year are presumed not to be significant (Ecology, 2011).

For operation impacts, a potential impact from climate change on KDRPP and KKC would be anticipated if climate change resulted in changes to the operational parameters of KDRPP and KKC and reservoirs, including more frequent droughts requiring more frequent release of water from the reservoirs. An impact would also result if the hydrologic changes produced by climate change resulted in a decrease in the benefits of KDRPP and KKC. A significant impact would occur if climate change affected operation of KDRPP or KKC to the extent that KDRPP or KKC could no longer improve the delivery of water to proratable users toward the target of 70 percent or no longer assist in meeting the target river flows defined in Section 3.3.

The climate change and hydrologic modeling described in Section 3.12 evaluated the potential for these changes. Climate change impact indicators and criteria for determining impact significance are shown in Table 4-62. All criteria are assessed relative to *Alternative 1 – No Action*. For additional information, see the *Hydrologic Modeling Report* Reclamation and Ecology prepared for the Proposed Action (Reclamation and Ecology, 2014o).

Table 4-62. Impact Indicators and Significance Criteria for Climate Change

Impact Indicator	Significance Criteria
Production of GHG emissions	GHG emissions > 25,000 metric tons per year (Ecology, 2011)
Effect of climate change on operation of the Proposed Action, including more frequent need to operate KDRPP and KKC and more frequent releases from the reservoirs	Climate change affects operation of KDRPP or KKC to the extent that KDRPP or KKC can no longer contribute to meeting the goal of supplying 70 percent of proratable water rights
Effect of climate change on water supply benefits of KDRPP and KKC in terms of deliveries to proratable water users	Climate change affects operation of KDRPP or KKC to the extent that KDRPP or KKC can no longer meet the project purpose of supplying 70 percent of proratable water rights
Effect of climate change on the ability of KDRPP and KKC to achieve flow targets in stream reaches within the study area	Climate changes impacts operation of KDRPP and KKC to the extent that target river flows as defined in Section 3.3 are no longer achieved

4.12.2 Summary of Impacts

None of the *alternative*s would generate enough GHG emissions to exceed the threshold for significant impacts of 25,000 metric tons per year; therefore, the Proposed Action would not cause significant impacts on climate change.

Climate change could affect the operational parameters of Kachess and Keechelus reservoirs and therefore could affect the frequency at which KDRPP or KKC is operated. Under *Alternative 1 – No Action*, climate change could adversely impact operation of the reservoirs because of changes in runoff timing and volume, as described in Section 3.12. Under all action alternatives, climate change predictions indicate that Reclamation would need to increase operation of KDRPP over time and that climate change would increase demand for proratable water. However, a significant impact is not anticipated because KDRPP or KKC would be expected to continue to contribute toward increasing water supply toward 70 percent of proratable water rights.

Under all action alternatives, the effects of climate change would decrease winter, spring, and fall attainment of instream flow targets. Under *Alternatives 2A*, *2B*, and *4*, summer attainment of instream flow targets in the Keechelus Reach of the Yakima River would be improved by the effects of climate change. Under *Alternatives 1*, *3A*, and *3B*, summer attainment of instream flow targets would be unchanged. However, it is anticipated under all action alternatives that target river flows would be achieved and that no significant impacts would occur.

The BTE actions would be implemented as part of all the action alternatives and would not generate GHG emissions following construction because the actions included in the plan would consume no additional energy. The BTE actions were developed to improve the resiliency of bull trout populations in the Keechelus and Kachess reservoirs, as well as the Yakima River basin as a whole. Climate change could offset some of the potential benefits of the BTE because increased shortages of proratable water supply would cause more frequent drawdowns. As outlined in the BTE, reservoir drawdown is one of the primary threats to bull trout populations in the reservoirs. Climate change would therefore increase the need for the BTE actions.

Table 4-63 summarizes the impacts for each alternative.

Table 4-63. Summary of Impacts for Climate Change

Impact Indicator	Summary of Impact
Production of greenhouse gas (GHG) emissions	All Alternatives would generate less than 25,000 metric tons per year of GHG emissions; therefore, impacts would not be significant.
Effect of climate change on operation of the Proposed Action, including more frequent need to operate KDRPP and KKC and more frequent releases from the reservoirs.	Under all the action alternatives, climate change is predicted to increase the need for operation of KDRPP or KKC; however, a significant impact is not anticipated because KDRPP or KKC would be expected to continue to contribute to supplying 70 percent of proratable water rights. Under *Alternative 1*, climate change is predicted to result in reduced water availability for irrigation, fish, and municipal uses, and in decreases in spring and summer runoff that could accelerate irrigation-induced depletion of water stored in Keechelus and Kachess reservoirs.
Effect of climate change on KDRPP and KKC water supply benefits in terms of deliveries to proratable water users	Under all action alternatives, climate change would cause increased demand for proratable water; however, a significant impact is not anticipated because climate change is not expected to the extent that KDRPP or KKC could no longer contribute to supplying 70 percent of proratable water rights. Under *Alternative 1*, climate change would cause a decrease in proratable water supply during the high-demand period.
Effect of climate change on the ability of KDRPP and KKC to achieve flow targets in stream reaches within the study area	Under *Alternative 1* and all action alternatives, the effects of climate change would decrease winter, spring, and fall attainment of instream flow targets. Under *Alternatives 2A, 2B*, and *4*, climate change would improve the summer attainment of instream flow targets. Under *Alternatives 1, 3A*, and *3B*, climate change would have no effect on summer attainment of instream flow targets. However, under all action alternatives, it is expected that target river flows would be achieved and that no significant impacts would occur.

4.12.3 Alternative 1 – No Action Alternative

Construction associated with the I-90 Phase 2A project under *Alternative 1 – No Action* would generate increased carbon emissions; however, the level of those emissions would likely be far below Ecology's significance level. WSDOT anticipates that the completed I-90 project would reduce CO_2e emissions by reducing traffic congestion and the frequency of pass closure. An increase carbon emissions is not expected.

Possible changes in precipitation, snowmelt, and runoff with climate change could affect the existing Keechelus and Kachess reservoir facilities included in *Alternative 1 – No Action*. Changes in water availability for irrigation, fish, and municipal uses may occur, as discussed in Section 3.12. The Adverse scenario described in Section 3.12.1) shows that climate change could worsen existing shortages of proratable water supply and adversely affect streamflows and fish in the basin. Additionally, a decrease in spring and summer runoff would cause water stored in the Keechelus and Kachess reservoirs to be depleted at a faster rate to meet irrigation demand. The combined effects would likely cause a decrease in overall supply during the high-demand period.

Several factors related to climate change could affect the availability of water-related recreation in the primary and extended study areas, including changes in snowpack and in the timing and quantity of streamflow. Expected climate change would reduce the quantity and quality of freshwater habitat for salmonid populations across Washington State (Mantua et al., 2010). Predicted increases in water temperature and thermal stress for salmonids in eastern Washington would be minimal for the 2020s, but of greater concern later in the century (Mantua et al., 2010).

Based on projections for the 2040s, climate change may significantly alter the temperature, amount, and timing of runoff, causing adverse impacts on fish habitat in the Yakima River basin. Average expected annual air temperature would increase, with accompanying increase water temperatures, and more precipitation would fall as rain rather than snow (RMJOC, 2010). These temperature changes could affect fish in the project area and the Yakima River basin, including the federally listed threatened fish species MCR steelhead and bull trout.

Climate change would have a direct impact on water temperature and indirect impact on dissolved oxygen. In general, an increase in air temperature causes water temperatures to increase. In the upper Yakima River, climate change models predict that the number of weeks when average water temperatures exceed 21^{o}C may increase from less than 5 weeks in historical conditions to over 10 weeks in the 2040s (Mantua et al., 2009). Warmer water can hold less DO than cooler water, so DO would decrease as air and water temperatures increase due to climate change (Karl et al., 2009).

4.12.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.12.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

The construction activities proposed under *Alternative 2A – KDRPP East Shore Pumping Plant* would generate approximately 8,686 metric tons of total CO_2e emissions. This is below the 25,000-metric ton significance threshold established by Ecology.

Bull Trout Enhancement

The construction activities proposed under the BTE would generate approximately 460 metric tons of total CO_2e emissions. This is well below the 25,000-metric ton significance threshold established by Ecology.

4.12.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Climate change is predicted to increase the need for Reclamation to operate KDRPP over time; however, a significant impact is not anticipated because climate change would not reduce performance of KDRPP to the extent it would no longer contribute to supplying 70 percent of proratable water rights. Under *Alternative 2A – KDRPP East Shore Pumping Plant*, average pumping volume would increase by 178 percent from 33,000 acre-feet per year to 91,000 acre-feet per year under the Adverse scenario when compared to the Baseline scenario. This would generate increased CO_2e emissions, but any potential increase is expected to be well below the significance threshold (25,000 metric tons per year).

As discussed in Section 3.12, the effects of climate change could alter temperature and precipitation in the Yakima River basin and affect water management throughout the region. Changes in runoff and precipitation would require Ecology, Reclamation, and other agencies to adapt water management to respond to changing conditions as they occur. KDRPP is one element of Reclamation’s water management system in the Yakima River basin.

As described in Section 3.12, climate change would alter the timing and volume of inflow to Kachess Reservoir, as well as the need for the additional proratable water supply provided by *Alternative 2A*. The Adverse scenario model results for *Alternative 2A* are summarized in Table 4-64 and Figure 4-15 through Figure 4-18.

Table 4-64. Effects of Climate Change on Water Supply Results for Water Years 1926 to 2006

Condition		September 30 Prorationing (percent)	July 1 TWSA (thousand acre-feet)	April to September Deliveries (thousand acre-feet)
No Action				
Baseline	Minimum	19	842	923
	Average	88	1,520	1,577
	Maximum	100	2,210	1,675
Adverse	Minimum	0	692	649
	Average	66	1,188	1,459
	Maximum	100	1,819	1,820
Change	Minimum	-19	-150	-274
	Average	-21	-332	-118
	Maximum	0	-391	145
Alternatives 2A and 2B				
Baseline	Minimum	37	935	1,111
	Average	89	1,514	1,590
	Maximum	100	2,210	1,675
Adverse	Minimum	2	733	697
	Average	66	1,200	1,460
	Maximum	100	1,831	1,820
Change	Minimum	-35	-202	-413
	Average	-23	-313	-130
	Maximum	0	-379	145
Alternatives 3A and 3B				
Baseline	Minimum	20	843	924
	Average	88	1,522	1,577
	Maximum	100	2,211	1,675
Adverse	Minimum	0	692	649
	Average	67	1,196	1,462
	Maximum	100	1,848	1,820
Change	Minimum	-20	-151	-274
	Average	-21	-326	-115
	Maximum	0	-362	145
Alternative 4				
Baseline	Minimum	38	941	1,125
	Average	89	1,521	1,592
	Maximum	100	2,211	1,675
Adverse	Minimum	6	751	732
	Average	68	1,216	1,475
	Maximum	100	1,835	1,820
Change	Minimum	-33	-190	-393
	Average	-21	-305	-117
	Maximum	0	-376	145

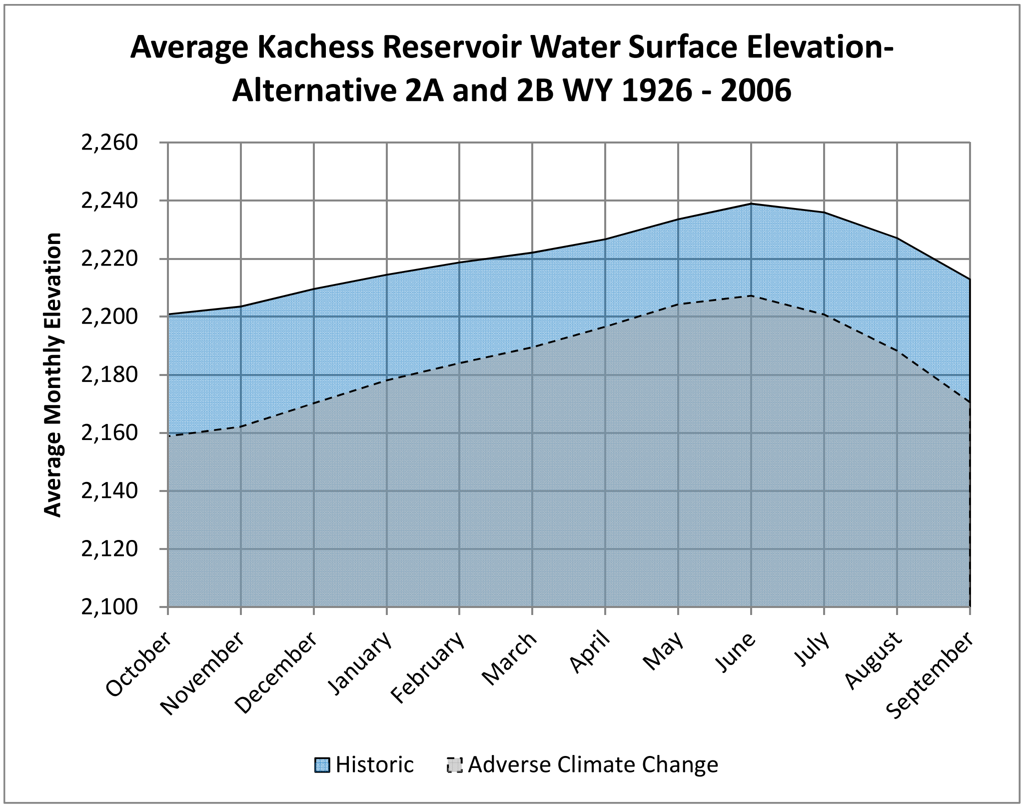

Figure 4-15. Effect of Climate Change on Average Kachess Reservoir Water Surface Elevation – *Alternatives 2A* and *2B*

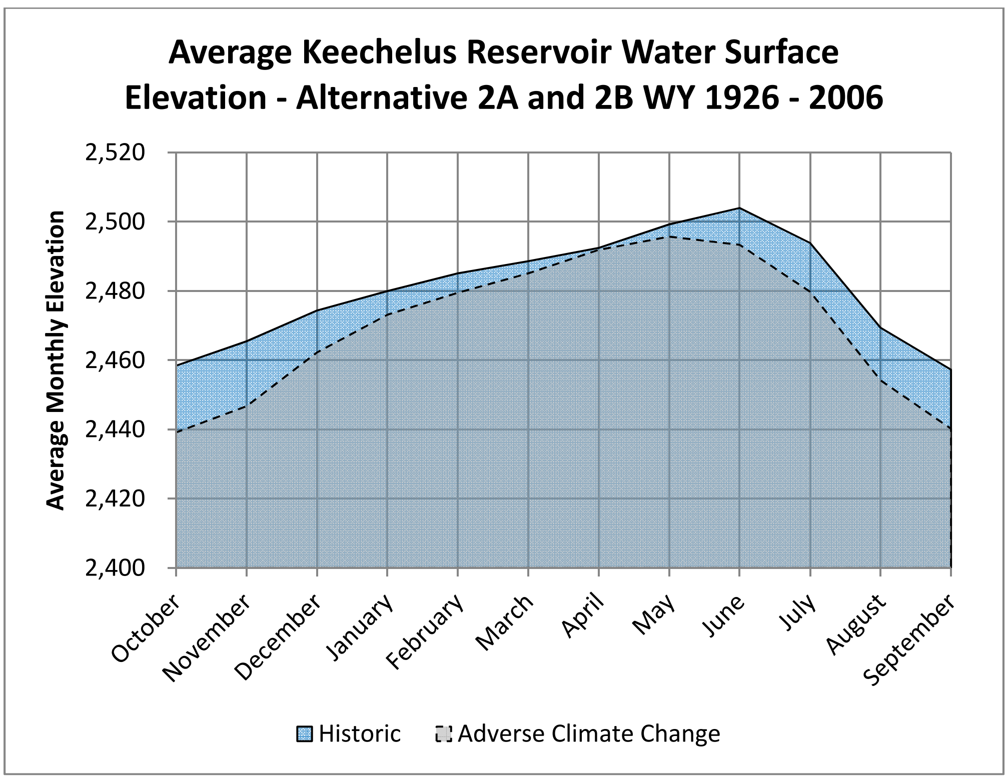

Figure 4-16. Effect of Climate Change on Average Keechelus Reservoir Water Surface Elevation – *Alternatives 2A* and *2B*

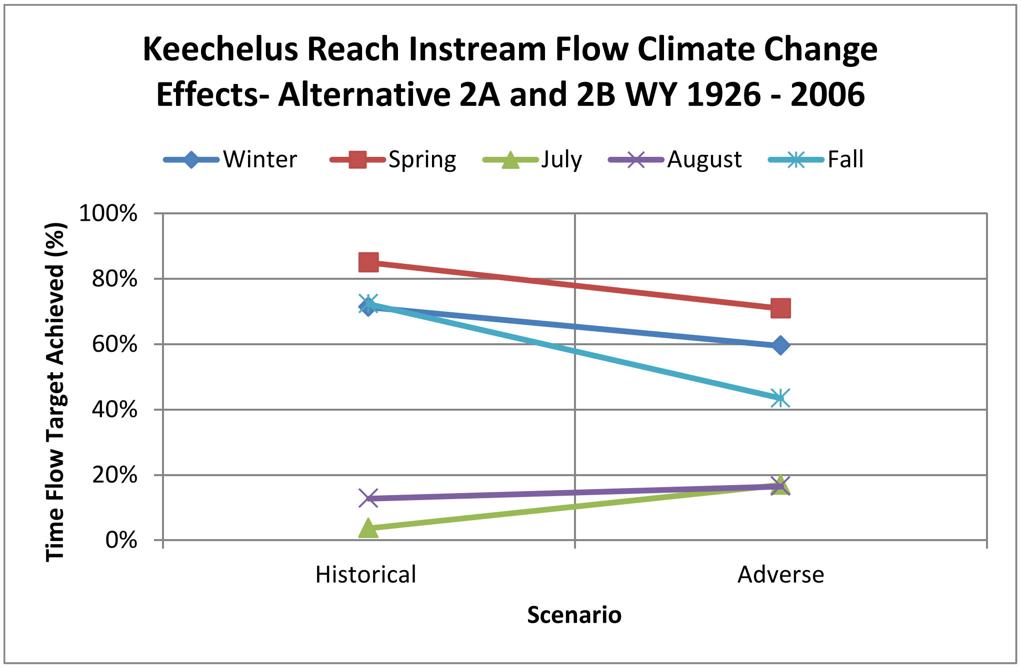

Figure 4-17. Effect of Climate Change on Seasonal Keechelus Reach Instream Flow – *Alternatives 2A* and *2B*

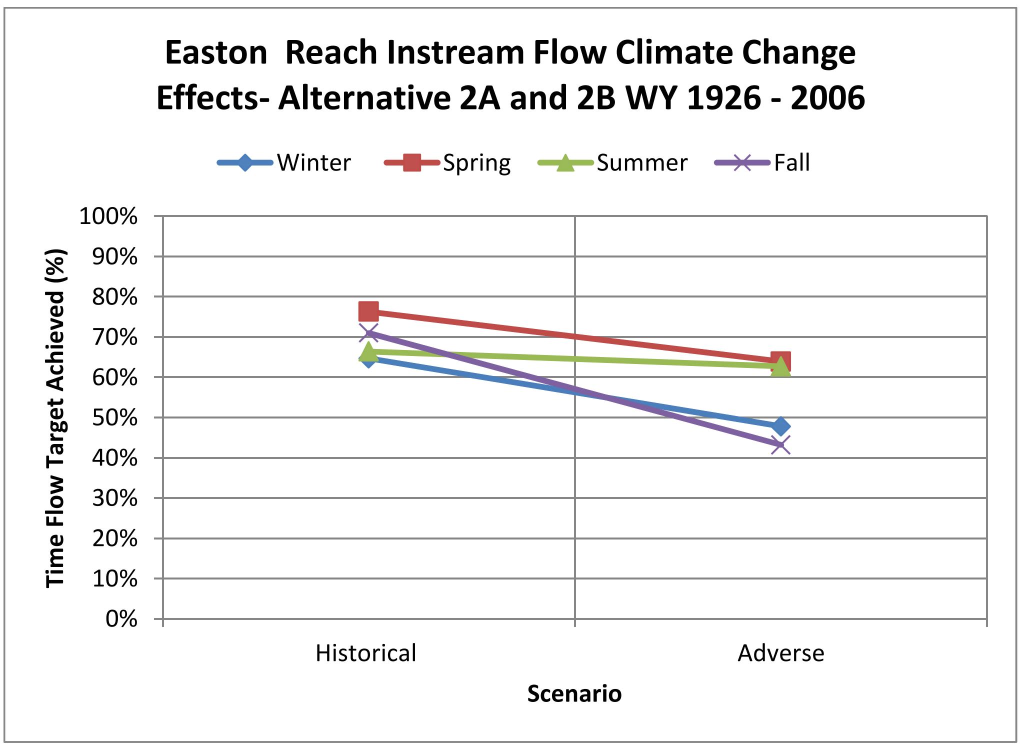

Figure 4-18. Effect of Climate Change on Seasonal Easton Reach Instream Flow – *Alternatives 2A* and *2B*

Alternative 2A – KDRPP East Shore Pumping Plant would be affected by climate change, including a need for more frequent drawdown of Kachess Reservoir and more frequent use of the pumps. The hydrologic modeling results show that *Alternative 2A – KDRPP East Shore Pumping Plant* would be used in 67 out of 81 years, as compared to use in 21 out of 81 years under Baseline scenario conditions. As shown in Table 4-64, climate change would decrease the proratable water supply performance of *Alternative 2A – KDRPP East Shore Pumping Plant*. The July 1 TWSA is projected to decrease by 313,000 acre-feet on average, and deliveries are projected to decrease by 130,000 acre-feet, on average. At the same time, however, the need for KDRPP would increase because of the higher agricultural water demands expected with the warmer temperatures and more severe proratable water supply shortages predicted under the Adverse scenario.

Figure 4-15 summarizes the impact of climate change on Kachess Reservoir levels. Simulations indicate that on average the Kachess Reservoir level would be 36 feet lower under Adverse scenario climate conditions than under Baseline scenario conditions. Figure 4-16 summarizes the impact of climate change on Keechelus Reservoir levels. On average, Keechelus Reservoir is projected to be 11 feet lower under Adverse climate conditions than under Baseline scenario conditions.

Figure 4-17 and Figure 4-18 show the simulated instream flow conditions under *Alternative 2A – KDRPP East Shore Pumping Plant*. Reclamation would not operate KDRPP to improve flow conditions in the Keechelus or Easton reaches of the Yakima River, and the only differences in streamflows would be due to the effects of climate change on hydrology. The effects of climate change would decrease the winter, spring, and fall attainment of instream flow targets. However, in the Keechelus Reach of the Yakima River, climate change effects would somewhat improve the July and August attainment of reducing instream flows in the Keechelus Reach, probably due to smaller proratable water supply deliveries during times of shortage.

In general, *Alternative 2A* would have a positive impact on the ability of water agencies, the agriculture sector, and fish and wildlife to better withstand and adapt to changing conditions, including the changes associated with climate change. The predicted changes in snowpack and runoff associated with climate change would require changing KDRPP operations by producing larger and more frequent drawdowns, and would result the number of years when the reservoir fails to refill. These changes could decrease the effectiveness of *Alternative 2A – KDRPP East Shore Pumping Plant*. The changes associated with climate change would increase proratable water supply shortages and thereby increase the need to operate KDRPP during drought years when water supply falls below 70 percent of proratable water rights.

Bull Trout Enhancement
Following construction, the BTE would not generate CO_2e emissions because the actions included in the plan would consume no additional energy.

The BTE actions were developed to improve the resiliency of bull trout populations in the Keechelus and Kachess reservoirs, as well as the Yakima River basin as a whole. Climate change could offset some of the potential benefits of the BTE because increased proratable water supply shortages would cause more frequent drawdowns. As outlined in the BTE, reservoir drawdown is one of the primary threats to bull trout populations in the reservoirs. Climate change would therefore increase the need for the BTE actions.

4.12.5 Alternative 2B – KDRPP South Pumping Plant

4.12.5.1 Construction

KDRPP South Pumping Plant Facilities
The construction activities proposed under *Alternative 2B – KDRPP South Pumping Plant* would generate approximately 5,284 metric tons of total CO_2e emissions. This is below the 25,000-metric ton significance threshold established by Ecology.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.12.4.1).

4.12.5.2 Operations

KDRPP South Pumping Plant Facilities
Impacts under *Alternative 2B – KDRPP South Pumping Plant* would be the same as those under *Alternative 2A – KDRPP East Shore Pumping Plant.* Reclamation would operate KDRPP the same regardless of the location of the facilities.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.12.4.2).

4.12.6 Alternative 3A – KKC North Tunnel Alignment

4.12.6.1 Construction

KKC North Tunnel Alignment Facilities
The construction activities proposed under *Alternative 3A – KKC North Tunnel Alignment* would generate approximately 10,920 metric tons of total CO_2e emissions. This is below the 25,000-metric ton significance threshold established by Ecology.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.12.4.1).

4.12.6.2 Operations

KKC North Tunnel Alignment Facilities

Operation of *Alternative 3A – KKC North Tunnel Alignment* would generate negligible emissions because KKC would operate by gravity and would consume no additional energy.

As described in Section 3.12, climate change would alter the timing and volume of inflow to Keechelus Reservoir, slightly decreasing the need to bypass water through the KKC tunnel. Table 4-64 and Figure 4-19 through Figure 4-22 summarize the Adverse scenario model results for *Alternative 3A*. A significant impact is not anticipated because KKC is expected to continue to help reduce instream flows in the Keechelus Reach of the Yakima River.

Figure 4-19 and Figure 4-20 summarizes the impact of climate change on Kachess and Keechelus Reservoir levels. On average, model simulations predict that both reservoirs would be approximately 12 feet lower under Adverse climate conditions than under Baseline scenario conditions. Climate change would slightly affect operation of *Alternative 3A – KKC North Tunnel Alignment* because of reduced runoff into Keechelus Reservoir. *Alternative 3A – KKC North Tunnel Alignment* would not increase proratable water supply; therefore, changes to proratable water supply performance are a result of climate change rather than KKC. Simulated July 1 TWSA values decrease by an average of 326,000 acre-feet. Simulated deliveries decrease by an average of 115,000 acre-feet. Figure 4-21 and Figure 4-22 show the simulated instream flow conditions under *Alternative 3A – KKC North Tunnel Alignment*. As shown, July and August instream flow targets in the Keechelus Reach would be met 100 percent of the time. The effects of climate change would decrease winter, spring, and fall attainment of instream flow targets. July and August attainment of maximum instream flow targets would be unchanged under the effects of climate change.

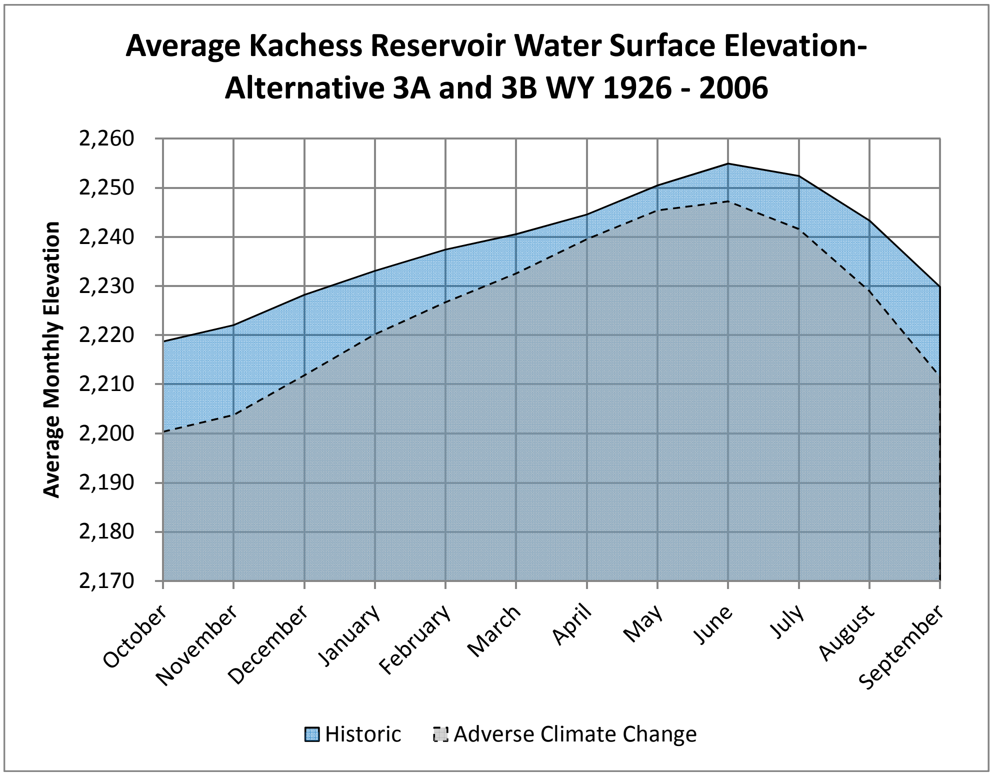

Figure 4-19. Effect of Climate Change on Average Kachess Reservoir Water Surface Elevation – *Alternatives 3A* and *3B*

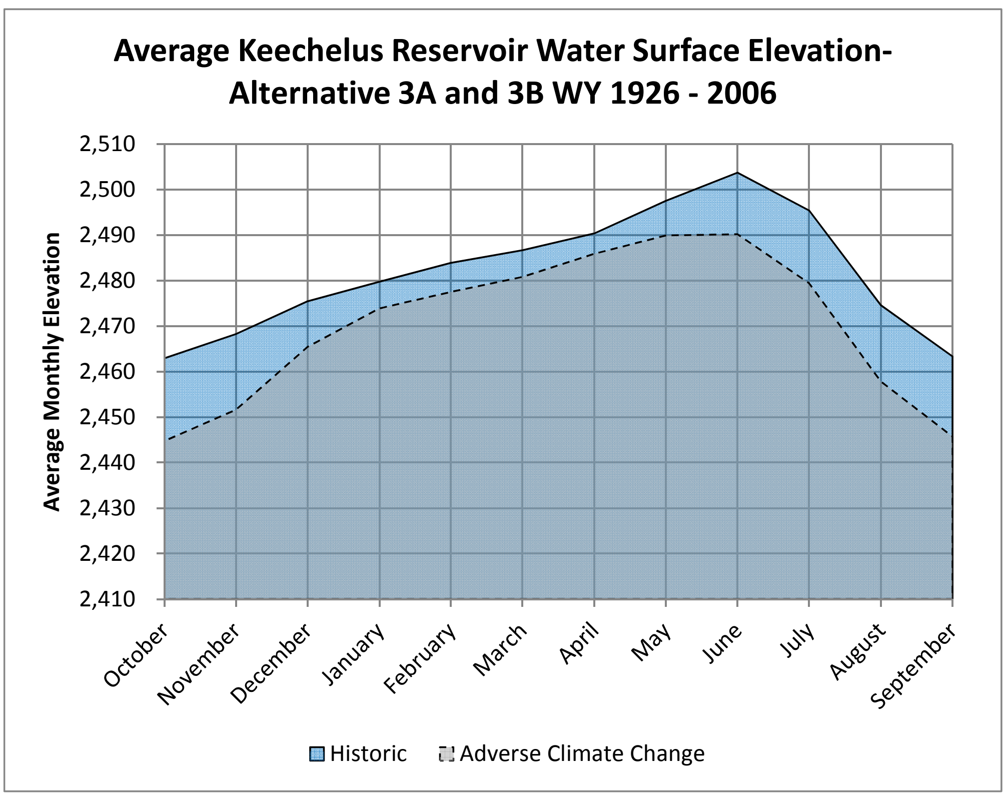

Figure 4-20. Effect of Climate Change on Average Keechelus Reservoir Water Surface Elevation – *Alternatives 3A* and *3B*

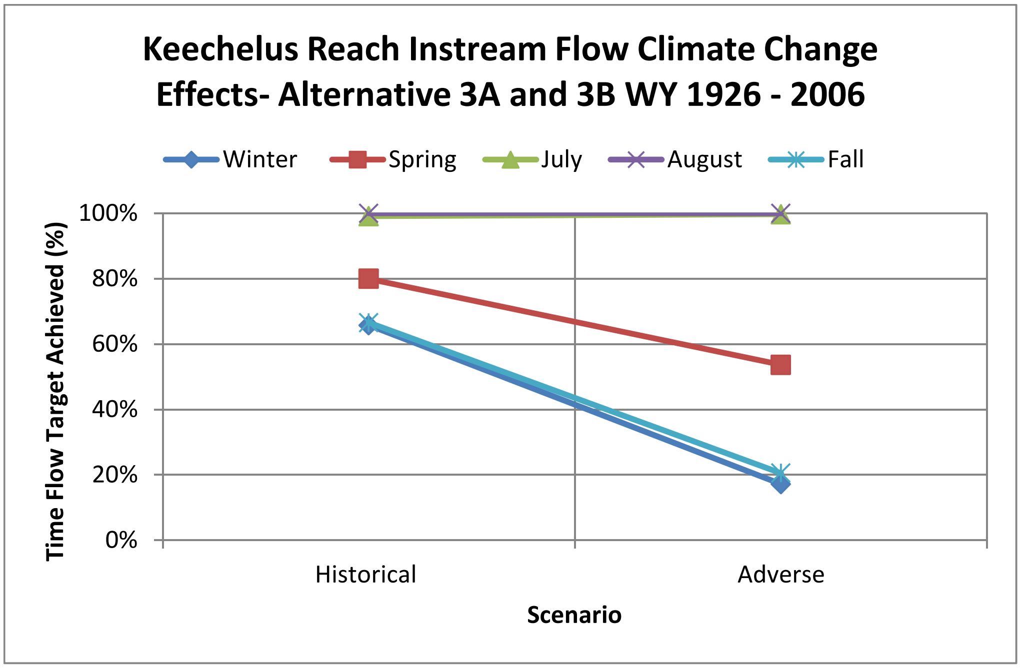

Figure 4-21. Effect of Climate Change on Seasonal Keechelus Reach Instream Flow – *Alternatives 3A* and *3B*

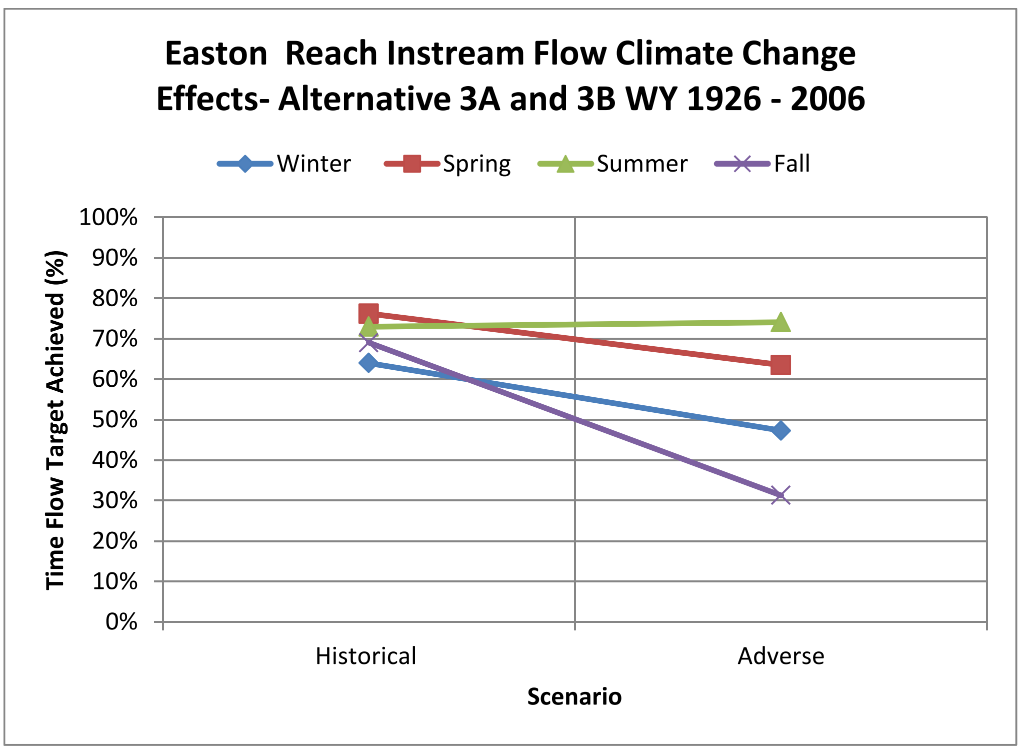

Figure 4-22. Effect of Climate Change on Seasonal Easton Reach Instream Flow – *Alternatives 3A* and *3B*

Alternative 3A would have a positive impact on the ability of water agencies, the agriculture sector of the economy, and fish and wildlife to better withstand and adapt to changing conditions, including the changes associated with climate change. The predicted changes in snowpack and runoff associated with climate change would alter *Alternative 3A – KKC North Tunnel Alignment* operations only slightly. These changes could slightly decrease the need for KKC, because reduced storage in Keechelus Reservoir would reduce the amount of water released from the reservoir that causes artificially high flows in Keechelus Reach of the Yakima River. On the other hand, the smaller proratable water supply associated with climate change could increase the need to release large volumes of water late in the summer, and thus increase the need for the operational flexibility provided by KKC.

Bull Trout Enhancement
Operation impacts of the BTE actions would be the same as those described for *Alternative 2A- KDRPP East Pumping Plant* in Section 4.12.4.2.

4.12.7 Alternative 3B – KKC South Tunnel Alignment

4.12.7.1 Construction

KKC South Tunnel Alignment Facilities
The construction activities proposed under *Alternative 3A – KKC North Tunnel Alignment* would generate approximately 13,631 metric tons of total CO_2e emissions. This is below the 25,000-metric ton significance threshold established by Ecology.

Bull Trout Enhancement
Construction impacts associated with the BTE actions are the same as those described for *Alternative 2A- KDRPP East Pumping Plant* in Section 4.12.4.1.

4.12.7.2 Operations

KKC South Tunnel Alignment Facilities
Operation impacts under *Alternative 3B – KKC South Tunnel Alignment* would be the same as those under *Alternative 3A – KKC North Tunnel Alignment*.

Bull Trout Enhancement
Operation impacts of the BTE actions would be the same as those described for *Alternative 2A- KDRPP East Pumping Plant* in Section 4.12.4.2.

4.12.8 Alternative 4 – Combined KDRPP and KKC

4.12.8.1 Construction

KDRPP and KKC Facilities
The construction activities proposed under *Alternative 4 – Combined KDRPP and KKC* would generate up to 22,317 metric tons of total CO_2e emissions. This is below the 25,000-metric ton significance threshold established by Ecology.

Bull Trout Enhancement
Construction impacts associated with the BTE actions are the same as those described for *Alternative 2A- KDRPP East Pumping Plant* in Section 4.12.4.1.

4.12.8.2 Operations

KDRPP and KKC Facilities
The operation impacts anticipated under *Alternative 4 – Combined KDRPP and KKC* would be similar to those described under *Alternatives 2A* and *3A*. A significant impact is not anticipated because KKC and KDRPP would be expected to continue to help meet the goal of supplying 70 percent of proratable water rights. It is anticipated that target river flows would be met.

The use of KKC to refill the inactive storage in Kachess Reservoir reduces the number of years when Reclamation would utilize KDRPP to 52 out of 81 years. Under Baseline scenario conditions, KDRPP would be utilized 19 out of 81 years. Climate change is predicted to increase the need to operate KDRPP. Under *Alternative 4 – Combined KDRPP and KKC*, average pumping volume would increase by 150 percent from 30,000 acre-feet per year up to 75,000 acre-feet per year (under the Adverse scenario) when compared to the Baseline scenario. This would generate increased emissions, but the increase is expected to be well below the 25,000-metric ton per year measure of significance.

Figure 4-23 summarizes the impact of climate change on Kachess Reservoir levels. On average, Kachess Reservoir is simulated to be 28 feet lower under Adverse climate conditions than under Baseline scenario conditions. This is 8 feet less change than for *Alternative 2A – KDRPP East Shore Pumping Plant*, reflecting the degree to which KKC helps accelerate the refill of Kachess Reservoir. Figure 4-24 summarizes the impact of climate change on Keechelus Reservoir levels. On average, Keechelus Reservoir is projected to be 14 feet lower under Adverse climate conditions than under Baseline scenario conditions.

As shown in Table 4-64, climate change would decrease the proratable water supply performance of *Alternative 4 – Combined KDRPP and KKC*. The July 1 TWSA is simulated to decrease by 305,000 acre-feet on average, and deliveries are estimated to decrease by 117,000 acre-feet on average. At the same time, however, the need for *Alternative 4 – Combined KDRPP and KKC* would increase because of higher agricultural water demands expected with warmer temperatures and the more severe proratable water supply shortages predicted under the Adverse scenario. Figure 4-25 and Figure 4-26 show the simulated instream flow conditions under *Alternative 4 – Combined KDRPP and KKC*. The effects of climate change decrease the winter, spring, and fall attainment of instream flow targets. July and August attainment of maximum instream flow targets is at 100 percent under the Adverse scenario.

Alternative 4 – Combined KDRPP and KKC would have a positive impact on the ability of water agencies, the agriculture sector of the economy, and fish and wildlife to better withstand and adapt to changing conditions, including those associated with climate change. The predicted changes in snowpack and runoff associated with climate change would alter KKC and KDRPP operations by producing larger and more frequent drawdowns, and would more frequently result in years when the reservoir fails to refill. These changes could increase the need for this alternative, but could also decrease its effectiveness. The changes associated with climate change would worsen proratable water supply shortages and thereby increase the need for the extra storage and operational flexibility provided by KDRPP and KKC.

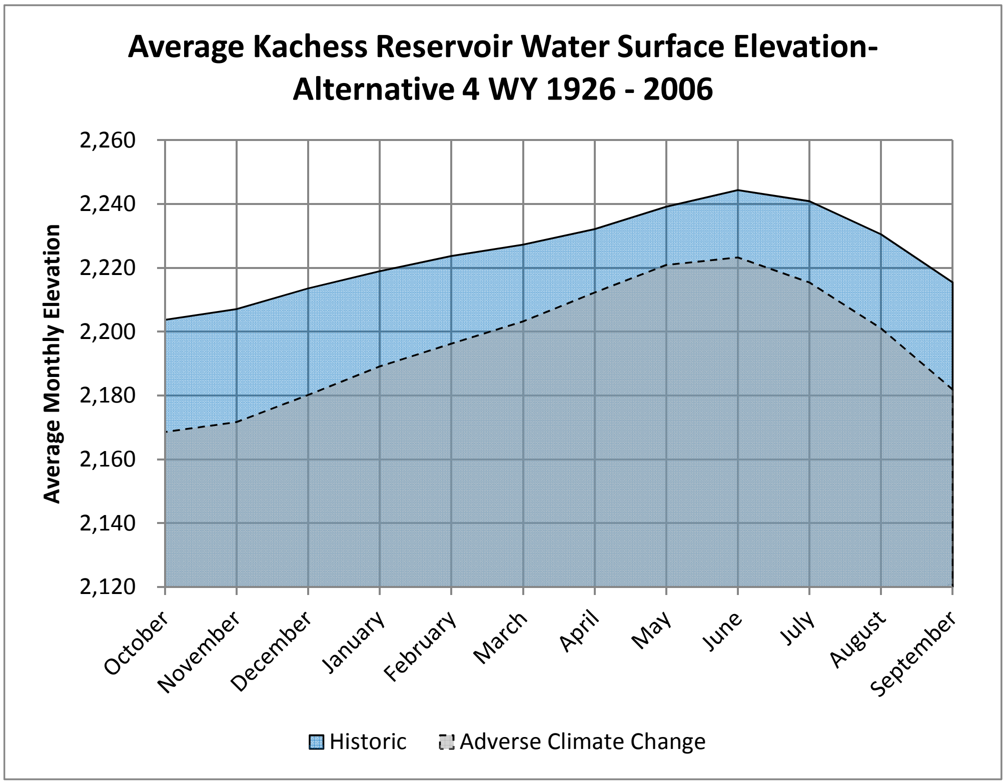

Figure 4-23. Effect of Climate Change on Average Kachess Reservoir Water Surface Elevation – *Alternative 4*

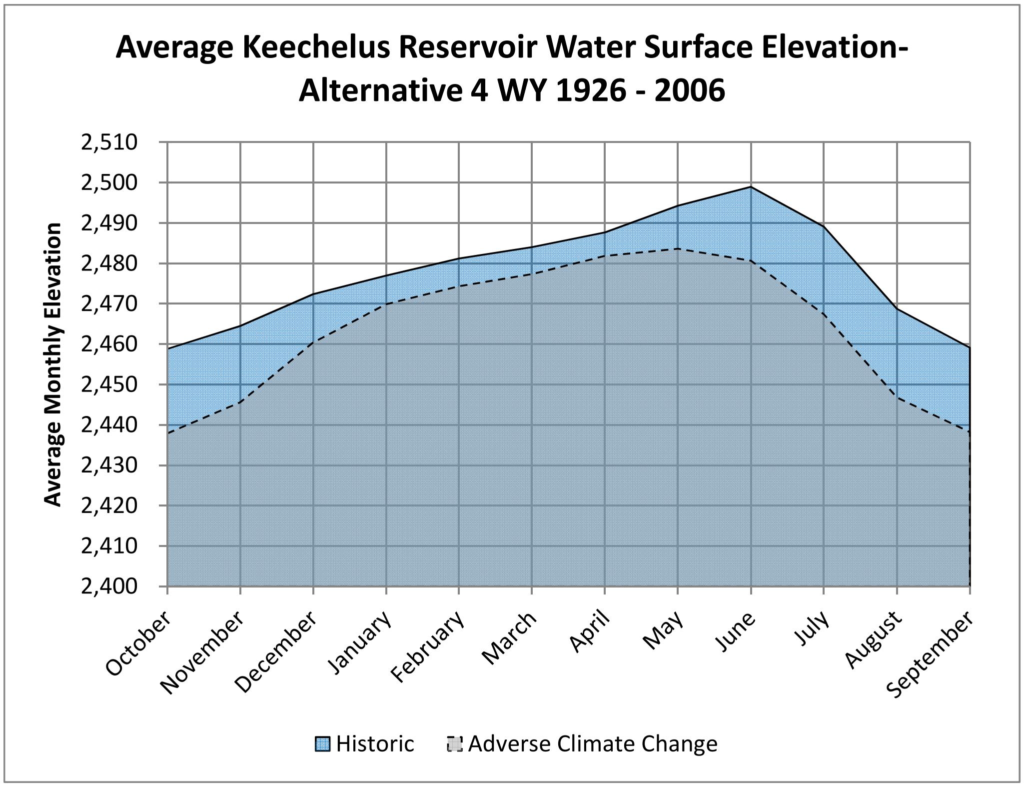

Figure 4-24. Effect of Climate Change on Average Keechelus Reservoir Water Surface Elevation – *Alternative 4*

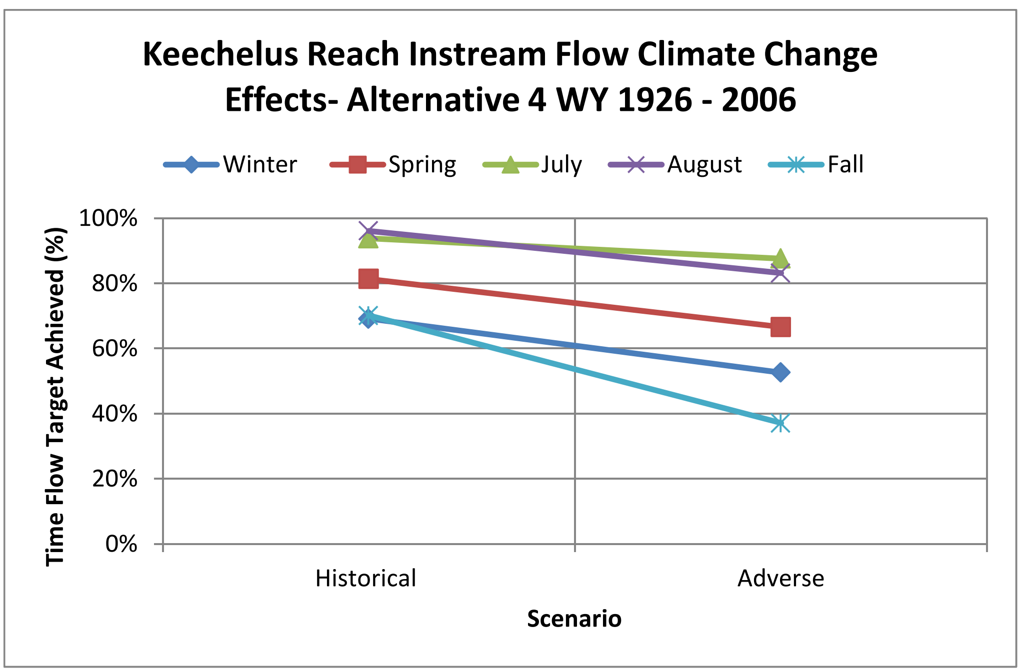

Figure 4-25. Effect of Climate Change on Average Keechelus Reach Instream Flow – *Alternative 4*

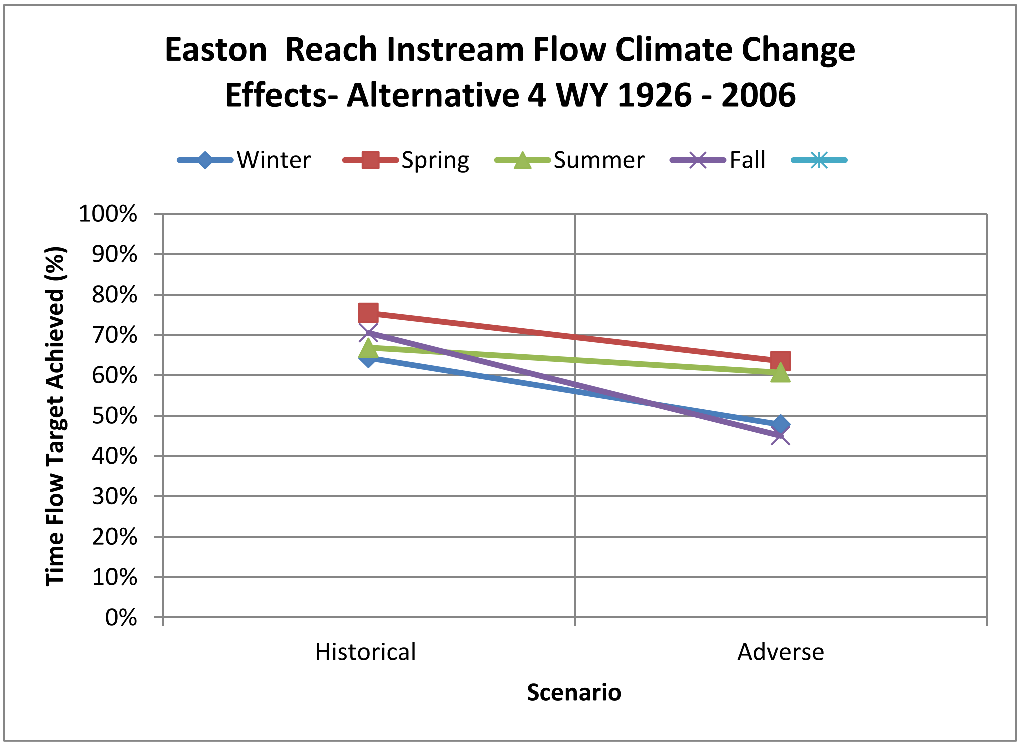

Figure 4-26. Effect of Climate Change on Average Easton Reach Instream Flow – *Alternative 4*

Because of predicted increased temperatures and decreased summer stream flow, adverse effects on water quality due to climate change are also likely under *Alternative 4 – Combined KDRPP and KKC,* although KDRPP would tend to reduce these effects by providing additional proratable water supply releases during drought years.

The Adverse scenario indicates that lower water levels would result in the existing reservoirs filling less frequently. This effect may mean that Reclamation would operate the KKC less often (because there might not be a need to move water from the Keechelus Reservoir to the Kachess Reservoir to meet Keechelus Reach flow targets). It would also be more difficult to refill the reservoir compared to Baseline scenario conditions. The Adverse scenario predicts increased irrigation water demands that would increase the need for the flexibility provided by KDRPP and KKC to meet proratable water supply needs and instream flow targets.

Bull Trout Enhancement
Operation impacts of the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.12.4.2).

4.12.9 Mitigation Measures

KDRPP and KKC would not generate carbon emissions at a level above Ecology and EPA's threshold for significance, so no mitigation measures are required. No significant impacts are anticipated from the effects of climate change on KDRPP and KKC; therefore, no mitigation measures are required.

4.13 Noise

4.13.1 Methods and Impact Indicators

Methods. The generalized discussion of changes in noise during construction activities is based on standard information about noise levels from typical construction equipment. Reclamation used a streamlined approach to quantitative noise modeling to determine whether significance criteria thresholds would be exceeded for each impact indicator. Because construction noise is exempt from regulation if conducted between 7 a.m. and 10 p.m. (daytime hours) per WAC 173-60-050 and all construction activities would occur during these hours, detailed noise modeling was not conducted. In addition, noise created by traffic (including heavy construction vehicles) on public roads is exempt from regulation under WAC 173-60-050.

The State government provides guidance on acceptable sound levels to ensure that the public's health and well-being are maintained. State law establishes maximum permissible environmental noise levels from one land use designation to another. Each land use designation is defined as an environmental designation for noise abatement (EDNA) (WAC 173-60 – Maximum Environmental Noise Levels). EDNAs are defined as an area or zone (environment) within which maximum permissible noise levels are established. The maximum permissible noise levels detailed in Table 4-66 are measured at the edge of property of the receiving property.

Although construction noise (including blasting) and traffic noise (including use of roads by heavy construction vehicles) is exempt from maximum permissible noise level limits per WAC 173-60-050, nearby noise-sensitive receptors may nonetheless experience temporary disturbance. Construction noise primarily comes from use of equipment. Noise generated from construction using TBMs would be associated with support equipment used at the tunneling portal, including ventilation fans, compressors, and other construction equipment; a TBM itself is generally not audible at the surface. Reclamation used noise levels of typical construction equipment to analyze the potential noise generated during construction (Table 4-65).

Table 4-65. Construction Equipment Average Maximum Noise Level (L_{max})

Equipment Type	Examples	Actual Measured Average L_{max}[1] at 50 feet
Earth moving	Compactors Front end loader Backhoe Tractors Graders Pavers	83 79 78 84 89 77
Materials handling	Concrete mixer truck Concrete pump truck Crane	79 81 81
Stationary	Pumps Compressors Generators	81 78 81
Hauling	Dump truck	76
Impact equipment	Pile drivers	110
Blasting	Explosive charges for rock removal or excavation	94

Source: WSDOT measured data. Federal Highway Administration (FHWA) Roadway Construction Noise Mode Database (2006).

[1] L_{max} is the maximum value of a noise level that occurs during a single event (in dBA).

Depending on the activity, peak noise levels from equipment shown in Table 4-65 would range from 69 to 110 dBA at 50 feet from the source. However, noise levels decrease with distance from the source at a rate of approximately 6 to 7.5 dBA per doubled distance. As such, noise received farther from construction activities would be lower than that listed in Table 4-65. For example, at 200 feet from the noise source, noise levels from construction equipment would range from 64 to 96 dBA.

Impact Indicators. Noise impact indicators and criteria for determining impact significance are shown in Table 4-66. All criteria are assessed relative to the *Alternative 1 – No Action*. This section describes potential noise impacts to humans. Sections 4.6, 4.8, and 4.9 describe potential noise impacts to fish and wildlife. The impact indicators for noise are increases in noise above ambient noise levels, exposure to damaging ground-borne vibration, or exceedance of maximum permissible environmental noise levels.

Table 4-66. Impact Indicators and Significance Criteria for Noise

Impact Indicator	Significance Criteria
Construction noise exceeding maximum permissible environmental noise levels	Construction noise of an intensity that would exceed the threshold of pain (generally considered 130 dBA)
Operation noise exceeding maximum permissible environmental noise levels	Increase in noise above maximum permissible environmental noise levels (above 55 dBA for residential and recreational uses)
Exposure to ground-borne vibration resulting from construction	Construction activities that produce vibration levels that are damaging to humans or nearby structures

4.13.2 Summary of Impacts

The noise environment in the primary and expanded study areas under *Alternative 1 – No Action* would remain the same as it exists today. The exception is a short-term increase in noise related to construction on I-90; no permanent adverse impact to the noise environment is expected as a result of the I-90 Phase 2A project (WSDOT, 2008). For *Alternatives 2* through *4*, construction noise would be moderate to loud over the construction period. Under *Alternatives 2A, 2B,* and *3B*, construction noise would not exceed maximum permissible environmental noise levels. *Alternative 3A* (truck hauling along Kachess Lake Road) would potentially exceed maximum permissible noise levels, but noise would be intermittent and well below the 130 dBA pain threshold levels that affect human health. *Alternatives 2* through *4* would not expose existing structures or sensitive uses to ground-borne vibration. Construction would cause loud noise and vibration immediately surrounding primary construction sites and along tunneling routes, but these areas are isolated from existing noise- and vibration-sensitive receptors. None of the alternatives would generate noise exceeding maximum permissible environmental noise levels once construction is complete. Therefore, there would be no significant noise and vibration impacts from either construction or operation under any of the alternatives, as summarized in Table 4-67.

The BTE actions would be implemented as part of all the action alternatives and would result in localized generation of noise, primarily from heavy equipment and truck trips required to move fill material as part of the Gold Creek channel narrowing, Gold Creek Pond fill, and Heli's Pond fill. Construction noise impacts, however, would not be significant.

Table 4-67. Summary of Impacts for Noise

Impact Indicator	Impact Summary
Construction noise exceeding maximum permissible environmental noise levels	Construction would result in increased noise throughout the 3-year construction period, primarily due to activity at excavation portal sites and truck hauling of spoils to the disposal area. Noise impacts would generally be minimized by the large setbacks between areas of construction and noise-sensitive receptors. Impacts are not considered significant for *Alternatives 2A, 2B*, and *3B* because noise would remain below Class A noise levels at existing noise-sensitive receptors. *Alternative 3A – KKC North Tunnel Alignment* would result in noise impacts (truck hauling along Kachess Lake Road); however, impacts are not considered significant because noise levels would remain well below the 130 dBA pain threshold that affects human health.
Exposure to ground-borne vibration resulting from construction	Ground-borne vibration that would expose existing residential structures or occupants to substantial vibration associated with the conveyance tunnel route under Via Kachess Road are not expected. Vibrations could be an occasional nuisance during daytime construction hours; however, they are not anticipated to cause extended periods of disturbance and would be well below levels that could cause damage. No significant impacts would occur.

4.13.3 Alternative 1 – No Action Alternative

Under the *Alternative 1 – No Action*, Reclamation and Ecology would not implement either KDRPP or KKC. The projects identified as occurring under *Alternative 1*, as described in Section 2.3, include the WSDOT I-90 Phase 2A project, which includes expanding the highway to six lanes along a 2.1-mile section of I-90 near the primary study area. On completion by fall 2019, the WSDOT project would increase I-90 capacity through the corridor. In the EIS for the I-90 Phase 2A project, WSDOT found that there would be no permanent adverse impact on the noise environment expected from the I-90 Phase 2A project (WSDOT, 2008).

Beyond the I-90 expansion, no new noise sources are anticipated under *Alternative 1 – No Action*; therefore, noise conditions would remain generally consistent with existing conditions.

4.13.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.13.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Construction noise associated with *Alternative 2A – KDRPP East Shore Pumping Plant* would be primarily associated with excavation for the intake tunnel and pumping plant shaft. These activities would require significant excavation, handling, and transport of spoils, all involving extended use of noise-generating heavy equipment and trucks. Noise would also originate from the confined blasting by which Reclamation proposes to excavate the lower portion of the pumping plant shaft. Because of the depth of the blasting (approximately 100 to 180 feet below the surface), noise levels are expected to attenuate to acceptable levels well before reaching existing noise sensitive receptors.

Construction of other facilities for *Alternative 2A – KDRPP East Shore Pumping Plant*, such as the transmission line, would also require use of heavy equipment and trucks. By comparison to the intake tunnel and pumping plant shaft, noise from construction of the other facilities is expected to be minimal. This is because the duration and intensity of construction for these other facilities would be relatively short term and minor compared to the intake tunnel and pumping plant shaft.

The nearest anticipated sensitive receptor is located 1.4 miles south of the proposed pumping plant site and 0.4 miles south of the abandoned spillway. Residential and vacation home areas include rural residences along Silver Trail Road and Silver Trail Lane. The substantial setback between the proposed pumping plant site and sensitive receptors eliminates potential noise impact. Under the worst-case scenario—all construction equipment (e.g., excavator, backhoe, dump truck) active when blasting occurs at the pumping plant site—the noise level would be 96 dBA at a 50-foot setback. In practice, noise levels would vary from day to day depending on specific activities under way. At 1.4 miles from the site, construction noise would be reduced to approximately 56 dBA, below maximum permissible environmental noise levels and well below the 130 dBA threshold of pain for humans. For context, 56 dBA is equivalent to sound levels associated with conversational speech. Some vibration would result from the blasting; however, the vibration would be minimally perceptible at the surface and is not anticipated to impact existing structures or vibration-sensitive receptors. See Section 4.6, Fish for information regarding impacts to fish from vibration.

Truck trips would also cause noise during construction. Mining and excavation required as part of *Alternative 2A – KDRPP East Shore Pumping Plant* would result in approximately 28,900 total truck round trips (approximately 49 truck round trips during each day of construction at six trips per hour; as described in Section 4.17.4.1). Truck hauling trips represent the large majority of machinery- and vehicle-derived noise associated with *Alternative 2A – KDRPP East Shore Pumping Plant* construction. Under *Alternative 2A*, spoils would be transported to a disposal area at one of two proposed locations: an abandoned spillway on the southeast Kachess Reservoir shoreline, approximately 1.75 miles south of the proposed pumping plant and 0.6 miles east of the existing Kachess Dam; or an offsite location within approximately 12 miles of the reservoir (not yet identified). In both cases, the contractor would transport spoils in dump trucks along the east shore of Kachess Reservoir. If the spillway site is determined to be unavailable, the haul route would continue to the end of Kachess Dam Road and pass rural residential areas off of Sparks Road. The offsite spoil disposal location would pose additional potential for construction noise to impact existing residences along the extended haul route. The residences along Sparks Road are approximately 200 feet from I-90. Given the existing loud noise environment associated with nearby I-90 traffic (existing noise condition assumed to have a daytime equivalent continuous noise level well above 55 dBA), and the temporary and intermittent nature of passing construction trucks, there would not be significant noise impacts associated with spoils hauling.

Construction noise generated by *Alternative 2A – KDRPP East Shore Pumping Plant* activities would occur within a localized area surrounding the construction site, with no anticipated impacts to nearby sensitive receptors. There are no rural residential or recreational uses between the existing Kachess Dam and the proposed east bank pumping plant location (along the southeast and east shorelines of the reservoir), other than boating and other water recreational activities on Kachess Reservoir. Dispersed recreational users on the reservoir and shoreline could experience short-term increases in noise or vibration when near the construction areas; however, recreational uses could avoid these areas during construction and areas closest to construction would be closed to boaters. Impacts would occur over the 3-year duration of construction, but would be temporary and occur only during normal daytime construction hours. Additional analysis would be conducted as part of PSE's route study and environmental analysis to characterize any nearby sensitive receptors and potential impacts to those receptors during construction of the transmission line.

Bull Trout Enhancement

Construction of BTE actions would result in localized generation of noise, primarily from heavy equipment and truck trips required to move fill material as part of the Gold Creek channel narrowing, Gold Creek Pond fill, and Heli's Pond fill. Approximately 10 existing residences occur within an area where construction noise could potentially be a nuisance. Noise impacts could result in temporary daytime noise levels above the 55 dB EDNA for these residential receptors. Construction noise impacts, however, would not be significant, as construction activities would be temporary and occurring only during daytime hours. Additional analysis of potential noise impacts will be developed as the design of these actions progresses.

4.13.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Operation of the pumping plant would cause minor increases in noise, localized to the proposed pumping plant site. The pumping plant would use electric pumps and, potentially, ventilation fans, neither of which is anticipated to exceed maximum permissible noise levels for surrounding recreational uses. All regularly operated noise generating equipment would be housed within the pumping plant structure. If determined necessary, based on actual facility design, technologies and insulation strategies could be used to further reduce noise from operational equipment. Therefore, operation of *Alternative 2A – KDRPP East Shore Pumping Plant* would not cause noise impacts.

Bull Trout Enhancement

None of the BTE proposals would have operation impact on the noise environment. None of the BTE proposals would generate significant noise after construction is over.

4.13.5 Alternative 2B – KDRPP South Pumping Plant

4.13.5.1 Construction

KDRPP South Pumping Plant Facilities

Construction impacts under *Alternative 2B – KDRPP South Pumping Plant* would be similar to those under Alternative 2A, as described in Section 4.13.4.1, except that less overall excavation would be involved. Construction of the intake tunnel under *Alternative 2B* would require use of a TBM. TBMs are generally not audible at the surface, even in areas immediately surrounding tunnel portal sites (SFMTA, 2008). Some vibration would result from the TBM; however, the vibration would be minimally perceptible at the surface and is not anticipated to impact existing structures or vibration-sensitive receptors, the nearest of which is more than 900 feet away. Because construction activities would take place closer to Kachess Dam, where recreational activities are more limited, temporary noise and vibration effects associated with *Alternative 2B* would affect fewer recreational users. See Section 4.6 Fish for information regarding impacts to fish from vibration.

Reclamation is evaluating the same spoils disposal options for *Alternatives 2A* and *2B*. Excavation for the intake tunnel and pumping plant shaft would result in approximately 8,800 total truck round trips (approximately 15 truck round trips during each day of construction, or 2trips per hour; Section 4.17.5.1). This is approximately 30 percent of the total truck trips required for *Alternative 2A – KDRPP East Shore Pumping Plant*. Reduced truck trips for spoils disposal would further limit noise impacts from *Alternative 2B*. As with *Alternative 2A, Alternative 2B* construction would not result in significant noise impacts.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.13.4.1).

4.13.5.2 Operation

KDRPP South Pumping Plant Facilities
Operation impacts under *Alternative 2B* would be similar to those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.13.4.2).

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.13.4.2).

4.13.6 Alternative 3A – KKC North Tunnel Alignment

4.13.6.1 Construction

KKC North Tunnel Alignment Facilities
Construction noise associated with *Alternative 3A – KKC North Tunnel Alignment* would be primarily associated with transport of excavation spoils for the tunnel between the Kachess portal and the Keechelus portal. Excavation for the proposed tunnel would require approximately 11,600 truck trips from the Kachess Lake Road portal site to the spoils disposal site, approximately 18 truck trips during each day of construction (Section 4.17.6.1). Truck trips would be a primary noise source during construction of *Alternative 3A*.

Although Reclamation has not yet identified the soils disposal areas, two primary options are available: disposal at an existing quarry near Keechelus Dam or reuse by WSDOT as fill material for I-90 improvements. Truck noise could impact existing sensitive receptors along spoils hauling routes. Impacted residences and vacation home properties would include those along Kachess Lake Road between the Kachess Lake Road portal and I-90 Exit 62. These rural areas occur in a very quiet existing noise environment, with noise levels generally between 30 and 45 dBA. At a 50-foot setback, noise from passing trucks would be approximately 76 dBA. Most rural residential structures along *Alternative 3A – KKC North Tunnel Alignment* haul routes are set back at least 175 feet from adjacent roads. At this setback, sound from trucks would be at or below 65 dBA. This level is above the 55 dBA threshold for environmental noise for residential and recreational uses; however, construction noise is exempt from regulation if conducted between 7:00 am and 10:00 pm (see Section 4.13.1), which would be the case for this construction. The noise levels would be noticeable but would be intermittent and well below the 130 dBA pain threshold levels that affect human health. Therefore, *Alternative 3A* noise would not result in a significant noise and vibration impacts on existing residential structures along Kachess Lake Road over the course of construction. The impact from construction trucks would be minimized by the low frequency occurrence (a maximum of three times per hour on average over the duration of construction) and timing (temporary and only during daytime construction hours).

Underground tunneling activities – such as use of TBMs and explosives – are generally not audible at the surface, even in areas immediately surrounding tunnel portal sites (SFMTA, 2008). Noise from support activities at the surface, including use of heavy equipment and stationary equipment listed in Table 4-65, is generally the source of most surface-audible noise associated with underground tunneling.

As with noise, vibration from construction would be temporary over the course of the tunnel construction. Intrusive vibrations and vibrations that could damage buildings are known to result from both blasting and tunnel-boring activities. Past studies and assessment for tunneling projects in urban areas have shown that while activities can produce vibrations that are intrusive to overlying residential uses, the vibration is well below any damage threshold (SFMTA, 2008).

Residential or other structures are not present along the *Alternative 3A – KKC North Tunnel Alignment* tunneling route. Therefore, no vibration impacts to people or structures due to construction are expected.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.13.4.1).

4.13.6.2 Operation

KKC North Tunnel Alignment Facilities
Operation of KKC under *Alternative 3A* could cause minor increases in noise at the Keechelus inlet facility and at the Kachess outfall. The increase due to intermittent use of electric-powered equipment at the inlet facility (a change of less than 3 dBA) would be inconsequential. Noise would likely increase at the outfall location, where water from the tunnel would cascade into the Kachess Reservoir. No noise-sensitive receptors are located within 2,000 feet of the outfall location. Minor increases in noise from operation of *Alternative 3A* facilities would not increase noise above maximum permissible environmental noise levels; as such, no impact on sensitive receptors is expected.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.13.4.2).

4.13.7 Alternative 3B – KKC South Tunnel Alignment

4.13.7.1 Construction

KKC South Tunnel Alignment Facilities
Construction impacts under *Alternative 3B* would be similar to those under *Alternative 3A*, as described in Section 4.13.6.1. However, the longer overall tunnel length of *Alternative 3B* would result in approximately 4 percent more spoils, with a similar percent increase in truck

trips and truck-related noise (12,100 total truck trips). Excavated spoils would be hauled from the I-90 Exit 62 portal, to an as yet undetermined location (the same options for disposal are being considered under both *Alternatives 3A* and *3B*). During construction hours, noise from the passing trucks would impact existing noise-sensitive receptors along spoils hauling routes.

The proximity of the I-90 Exit 62 portal to I-90 would likely minimize or eliminate impacts to noise-sensitive residential receptors, as it would avoid the large majority of haul route trips along Kachess Lake Road. As such, *Alternative 3B – KKC South Tunnel Alignment* would greatly reduce construction noise compared to *Alternative 3A – KKC North Tunnel Alignment*.

Surface vibration could result from use of the TBM during tunnel construction, as described for *Alternative 3A.* However, because there are no residential structures or other structures along the *Alternative 3B* tunneling route, no vibration impacts due to construction are expected.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.13.4.1).

4.13.7.2 Operation

KKC South Tunnel Alignment Facilities
Long-term operation impacts would be similar to those under *Alternative 3A*, as described in Section 4.13.6.2.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.13.4.2).

4.13.8 Alternative 4 – Combined KDRPP and KKC

4.13.8.1 Construction

KDRPP and KKC Facilities
Combining KDRPP and KKC would not cause construction impacts other than those discussed for *Alternatives 2* and *3*. Delivering materials and importing and exporting fill and spoil materials would result in a total of approximately 20,400 to 41,000 total truck roundtrips, or approximately 6 to 11 trucks per hour. If Reclamation constructs KDRPP and KKC at the same time, sensitive receptors, including residential and recreational uses, could be disrupted by simultaneous construction noise, primarily from truck trips. However, because short-term and nonsignificant noise impacts are anticipated under *Alternatives 2* and 3, and because combined KDRPP and KKC construction activities would primarily occur in separate areas, no additional impacts are expected for *Alternative 4*. The combined noise

from simultaneous construction would not result in any noise of an intensity that would exceed 130 dBA; therefore, no significant impacts would occur.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.13.4.1).

4.13.8.2 Operation

KDRPP and KKC Facilities
Combining KDRPP and KKC would not cause any long-term impacts other than those discussed above for *Alternatives 2* and *3*.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.13.4.2).

4.13.9 Mitigation Measures

The proposed work would comply with applicable noise regulations by restricting construction activities to daytime hours. Although not required for construction noise during normal daytime hours, Reclamation would implement BMPs to reduce construction noise and avoid construction noise nuisance to the extent feasible. Those measures could include regular notification to affected property owners (via email, website updates, or mailings), site layout that minimizes the need for trucks to back up, use of broadband backup alarms, and regular maintenance of heavy equipment. Construction workers would comply with safety regulations regarding noise, including maintenance of heavy machinery and trucks to reduce noise (both to workers and surrounding noise-sensitive receptors). Because the expected noise impacts are minor and temporary, no mitigation is proposed.

4.14 Recreation

4.14.1 Methods and Impact Indicators

Methods. Reclamation analyzed potential construction impacts by first identifying construction activities that would occur in the vicinity of existing recreational uses or facilities. For operation impacts, Reclamation identified water-dependent and water-oriented recreational uses and facilities in or adjacent to the project area. The analysis includes areas that would be indirectly affected, such as the Yakima River downstream and roads that would be used for construction access. Reclamation analyzed the lowered reservoir levels at recreational sites on Kachess and Keechelus reservoirs to determine whether the new reservoir levels would limit, disrupt, or eliminate recreational uses over the short or long term.

Impact Indicators. Recreation impact indicators and significance criteria are shown in Table 4-68. Reclamation assessed all criteria relative to *Alternative 1 – No Action*.

The impact indicators for recreation relate to whether construction activities, new reservoir operations, or other project actions would conflict with or diminish recreational use of and access to developed recreation sites or dispersed recreation sites in the study area.

Table 4-68. Impact Indicators and Significance Criteria for Recreation

Impact Indicator	Significance Criteria
Boating capacity and access	Loss of use of developed boat ramps that exceeds current seasonal loss of use due to existing drawdown conditions by more than 10 days in the recreation season (June through September).
Fishing opportunities	Loss of fishing access or reduction of fishing opportunities that exceeds current seasonal loss of use due to existing drawdown conditions.
Usability or quality of recreation at developed recreation facilities	Reduction of usability or quality of recreation at developed sites due to construction activities or the receding of the shoreline more than 100 feet from the recreation site or with a slope greater than 20 degrees.
Usability or quality of recreation at private or undeveloped recreation sites	Reduction of usability or quality of recreation at undeveloped or private sites due to construction activities or the receding of the shoreline more than 100 feet from the recreation site or with a slope greater than 20 degrees.

4.14.2 Summary of Impacts

Under *Alternative 1 – No Action*, recreation would continue to be a major use at and around Kachess and Keechelus reservoirs. Public demand for recreational access to rivers and reservoirs in the Yakima River basin would continue to increase as population grows. Existing operations at Keechelus and Kachess reservoirs would continue to cause boat launches to become inaccessible in late summer due to drawdown conditions. The availability of water-related recreation in the Yakima River basin could be affected by climate change. Additionally, WSDOT would construct the I-90 Phase 2A project, which would cause temporary impacts on recreation, including changes to access, detours, and noise from blasting and other construction activities.

Under *Alternatives 2A* and *2B*, impacts on boating during construction of KDRPP would be minor because developed boat launches would not be affected. Long-term impacts from reservoir drawdown would be significant because the boat launch at Kachess Campground would be inaccessible for an average of 59 days during the recreation season (June to September) in 80 percent of years (an increase of 25 days over current conditions). Loss of fishing opportunities would also be significant due to loss of boating access and impacts on fish species. Construction would impact usability and quality of recreation at adjacent undeveloped recreation sites, but the impacts would be minor as the majority of the reservoir shore would remain available for recreational use. The drawdown of Kachess and Keechelus reservoirs would significantly impact usability and quality of recreation at these sites during drought years and as the reservoir refills because of the extent and slope of the exposed reservoir bed.

Under *Alternatives 3A* and *3B,* impacts would be minor because no recreational uses would become unusable. Construction of *Alternative 3A – KKC North Tunnel Alignment* would temporarily realign Kachess Lake Road, but recreational access would be maintained to the west side of Kachess Reservoir and to parking areas used for winter recreation activities (sno-parks). Operation of *Alternative 3A – KKC North Tunnel Alignment* would include a discharge structure into Kachess Reservoir in the vicinity of private parcels; this structure could disrupt private or undeveloped recreational uses of the shoreline in that location. *Alternative 3B – KKC South Tunnel Alignment* would not have these impacts at Kachess Reservoir because the outlet portal would be located on federally managed land and would not require temporary realignment of Kachess Lake Road.

Alternative 4 – Combined KDRPP and KKC would have the same impacts as *Alternatives 2* and 3. If KDRPP and KKC were constructed simultaneously, recreational uses at multiple sites at Kachess Reservoir could be disrupted simultaneously by construction noise, emissions, and truck trips. More roads used to access winter recreation could also be disrupted simultaneously. Combined operation could reduce the drawdown of Kachess Reservoir during drought years. However, impacts from the drawdown on recreation at both reservoirs would still be significant during drought years due to loss of boating access and to the extent and slope of the exposed reservoir during drawdown conditions.

The BTE actions would be implemented as part of all the action alternatives and would impact recreation at the Gold Creek Pond Picnic Area and John Wayne Pioneer Trail in Iron Horse State Park during construction and operation. If not closed during construction, the Gold Creek Pond Picnic Area would be subject to disruption from construction activities. After construction, the wheelchair-accessible trail would be relocated and the pond would be partially or completely filled and restored to a wetland complex. A portion of the John Wayne Pioneer Trail would be directly adjacent to construction activities, and the slope and historical character of the trail in that segment would be altered permanently. Recreational use of the trail would be maintained during and after construction.

Table 4-69 summarizes recreation impacts.

Table 4-69. Summary of Impacts for Recreation

Impact Indicator	Summary of Impacts
Boating capacity and access	*Alternatives 2* and *4* would have significant negative impacts on boating access, as boat launches at both reservoirs would be rendered unusable by the extended drawdown in drought years and for 2 to 5 years after.
Fishing opportunities	*Alternatives 2* and *4* would have significant negative impacts due to the effects of reservoir drawdown on fish in Kachess Reservoir and to the loss of boating access and increased distance from the shore for shore fishing at both reservoirs in drought years and for several years after.
Usability or quality of recreation at developed recreation facilities	*Alternatives 2* and *4* would have significant impacts on developed recreation at Kachess Reservoir as drawdown in drought years would reduce access to water and aesthetic quality. The BTE actions at the Gold Creek Pond Picnic Area and the John Wayne Pioneer Trail would disrupt recreation during construction. Recreational use would be restored following construction, but the character of recreation at these sites would change.
Usability or quality of recreation at private or undeveloped recreation sites	*Alternatives 2* and *4* would have significant impacts on undeveloped and private recreation at Kachess Reservoir, as drawdown in drought years would reduce access to water and aesthetic quality. Construction of all action alternatives and BTE could disrupt quality of recreation for private and undeveloped recreation uses in the vicinity of the construction areas, and construction traffic could cause temporary delays in access to recreation sites.

4.14.3 Alternative 1 – No Action Alternative

Under *Alternative 1 – No Action*, recreation would continue to be a major use at and around Kachess and Keechelus reservoirs. Public demand for recreational access to rivers and reservoirs in the Yakima River basin would continue to increase as population grows. Existing operations at Keechelus and Kachess reservoirs would continue to cause boat launches to become inaccessible in late summer due to drawdown conditions. Information from USFS suggests that the boat launch at Kachess Campground becomes inaccessible for larger boats at elevation 2,235 and inaccessible for all boats several feet below that elevation. Hydrologic modeling shows that under existing conditions, the reservoir pool is below elevation 2,235 during the recreation season (June to September) in approximately 79 percent of years for an average of 34 days in those years. Existing drawdown at Keechelus Reservoir in summer would continue to interfere with usability and quality of recreation at developed and undeveloped recreation sites. As described in Section 3.12.2, the availability of water-related recreation in the Yakima River basin could be affected by climate change.

Under *Alternative 1 – No Action*, WSDOT would construct the I-90 Phase 2A project. As described in the *I-90 Snoqualmie Pass East Project Final Environmental Impact Statement*, construction of the project would cause temporary impacts on recreation, including changes to access, detours, and noise from blasting and other construction activities (WSDOT, 2008).

4.14.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.14.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Construction impacts would be limited to the primary study area described in Section 3.14. Use of a barge to construct the reservoir intake and tunnel could have a minor impact on boating. The launch and transportation of the barge could temporarily limit access to boat launch areas (depending on where the barge is launched) and disrupt boating uses in areas through which the barge passes. During construction, the barge would often be located in areas near Kachess Dam that are already closed to recreational boating. However, during some portions of construction, Reclamation may close a larger area at the south end of the reservoir to boating. The majority of the reservoir would remain open to recreational boating. Impacts would not be significant because boat launches would not become unusable for 10 or more days and because boating uses would not be displaced.

No developed recreation facilities are located in the vicinity of construction activities. Construction traffic could briefly delay access to the Kachess Campground and to sno-parks, which are used to access winter recreation such as snowmobiling; however, access would be maintained. Construction would require that access roads, including FS-4818, be plowed, which would disrupt snowmobile use of these roads in winter. However, Reclamation would maintain groomed snowmobile paths alongside plowed roads so that snowmobile use would not be precluded. Construction would take place year-round over a 3-year period. Impacts would not be significant because no developed recreation sites would become unusable. However, construction workers could stay at campsites, which would displace some recreationists (see Section 4.21.4.2).

Dispersed camping and undeveloped recreation activities such as fishing, picnicking, hiking, or berry-picking occur in the vicinity of construction. The quality of recreation for these uses adjacent to the construction site would be impaired by construction noise and dust. Construction traffic could delay access to undeveloped recreation areas for short periods of time. These impacts would occur over the 3-year duration of construction and recreationist may avoid these areas during the construction period. Impacts would not be significant because recreationists could access Kachess Reservoir at many other sites on the east shore.

Construction of the transmission line from the Easton substation to the pumping plant would likely cross the John Wayne Pioneer Trail in Iron Horse State Park, pass through Lake Easton State Park within an existing road right-of-way, and follow roads (e.g., Kachess Dam Road and NF-4818) that provide access to recreational opportunities at Kachess Reservoir. Construction of the transmission line could cause temporary delays or construction noise in these areas, but would not reduce the usability or quality of recreation. Additional analysis would be conducted as part of PSE's route study and environmental analysis.

Bull Trout Enhancement

Construction of the BTE actions could disrupt recreation activities. Both Gold Creek and Cold Creek are located within the Okanagan-Wenatchee National Forest. Construction noise could disrupt recreational use of the National Forest and use of forest roads that provide recreational access and winter recreation.

Construction at Gold Creek Pond would impact recreation at the Gold Creek Pond Picnic Area, which includes a wheelchair-accessible hiking trail. Use of the trail would be maintained during construction, but portions may need to be closed for the duration of construction. If the trail and picnic area remain open, construction noise and vehicle access would disrupt recreational use of the site.

Cold Creek fish passage improvements would impact recreation on the John Wayne Pioneer Trail in Iron Horse State Park. A portion of the trail would be excavated to an elevation approximately 55 feet below the existing trail elevation and a bridge would be installed at an elevation of approximately 35 feet lower than the existing trail crossing. The new bridge would be built parallel to the existing trail and would be completed before the existing trail is excavated to avoid closure of the trail during construction. However, while under way, construction activities and noise would disrupt recreation on this portion of the trail. Construction could limit access to the campsite and construction activities and noise would disrupt recreational use of the site. Additional analysis of potential recreation impacts will be developed as the design of these actions progresses.

4.14.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Under *Alternative 2A – KDRPP East Shore Pumping Plant*, Reclamation would draw down Kachess Reservoir by as much as 80 additional feet in drought years, which is expected to occur in about one-third of the model years analyzed for a mean duration of between 179 and 191 days. The time for Kachess Reservoir to refill to normal operating levels would be 2 to 5 years following a drought. Kachess Reservoir levels would be lower than those under *Alternative 1 – No Action* in 51 percent of years during drawdown and reservoir refilling, and in those years it would be lower for 314 days out of the year on average. Drawdowns in drought years would have major impacts on recreation as described below for each impact indicator.

The boat launches at Kachess Campground become unusable in late summer under current drawdown conditions. Information from USFS suggests that the boat launch at Kachess Campground becomes inaccessible for larger boats at elevation 2,235 and inaccessible for all boats several feet below that elevation. Hydrologic modeling shows that under existing conditions, the reservoir pool is below elevation 2,235 during the recreation season (June to September) in approximately 79 percent of years for an average of 34 days in those years. Additional drawdown in drought years would make the boat launches unusable earlier in the summer and for longer duration during 2 to 5 years as the reservoir refills. Under this alternative, the reservoir pool would be below elevation 2,235 during the recreation season in approximately 80 percent of years for an average of 59 days. This condition represents an increase of 25 days over *Alternative 1 – No Action*. Additionally, undeveloped and private access for boats such as kayaks and canoes would be restricted as the distance to the water line from developed and undeveloped recreation sites is increased. In some areas, topography could preclude access to launch sites for kayaks and canoes. Loss of boating access during and after drought years would be significant because the increased loss of boating access for 25 additional days during the recreation season is greater than the significance criterion of 10 days. Boating use would be precluded during these times, and recreational pressure on other reservoirs in the area would increase.

The drawdown would also affect fishing. The decrease in boat launch opportunities described above would have a significant impact on fishing opportunities during drought years and as the reservoir refills. Shore fishing could also be impacted as the distance to the shore increases with the drawdown. In some areas, the water line may become inaccessible for shore fishing as the reservoir is drawn down. As described in Section 4.6.4.2, reduced reservoir elevations are likely to reduce the abundance of prey, reducing the survival and productivity of all fish species in the reservoir. Reduced habitat complexity may affect some resident fish species. Higher reservoir temperature may reduce the survival and productivity of native salmonids. The impact on fishing would be significant as boating access, shore fishing access, and fish abundance would all be reduced. Fishing uses would be precluded during the drawdown period, and recreational pressure on other reservoirs in the area would increase.

Kachess Campground and the East Kachess Group Site would also be impacted by the drawdown. The campgrounds would remain functional regardless of reservoir water elevation. However, these facilities are located on the reservoir because they provide access to the water. According to USFS, campsites nearest to the reservoir are the most popular. For this reason, substantial receding of the water line from the developed campgrounds would decrease the quality of recreation. The decrease in quality of recreation would occur in drought years and for 2 to 5 years as the reservoir refills. Due to the duration of the drawdown and the distance the shoreline would recede from the campgrounds, the impact would be significant.

Boat launches at the campground would not be usable during this period as described above. Because Kachess Reservoir has not been drawn down much during the summer recreation season of recent years, the extended drawdown under this alternative would be very noticeable to recreationists and significantly alter the quality of recreation compared to *Alternative 1 – No Action*. Under maximum drawdown conditions, the distance from Kachess Campground to the water line of the reservoir would exceed 1,500 feet. At the East Kachess Group Site, the distance to the shore of the reservoir would exceed 200 feet. These distances would constitute a significant impact because they would exceed the100-foot threshold identified in Table 4-68. Additionally, the shallow well at Kachess Campground could be impacted by receding water levels, as described in Section 4.5.3. However, as with all shallow wells at Kachess Reservoir, Reclamation would monitor groundwater levels at the well and work with property owners to develop appropriate mitigation if needed, as described in Section 4.5.9.

As with construction, operation of KDRPP would require that access roads, including FS-4818, be plowed, which would disrupt snowmobile use of these roads in winter. However, Reclamation would maintain groomed snowmobile paths alongside plowed roads so that snowmobile use would not be precluded.

Private and undeveloped recreation uses that are water-dependent (such as swimming) or water-adjacent (such as picnicking and dispersed camping) would be impaired because of reduced access to the water. The aesthetic quality of the recreation activities would be reduced as the distance to the water line from recreation sites increases. The reservoir would have reduced appeal for these activities. These impacts would occur in drought years and for the next 2 to 5 years as the reservoir refills. Given the duration of the drawdown and the distance the shoreline would recede from the campgrounds, the impact would be significant. Under the maximum drawdown condition, most of the reservoir's shoreline would recede over 200 feet. The distance would exceed 1,500 feet at some locations adjacent to private development on the west side of the reservoir. These distances would constitute a significant impact because they exceed the 100-foot criterion for significant impact (see Table 4-69).

In addition to the increased distance from the shoreline during drawdown conditions, the slope of the exposed reservoir bed could impede access to the water. From Kachess Campground, most of the exposed reservoir bed is relatively flat, but during full drawdown conditions, the last 150 to 200 feet to the water would have slopes of 20 to 30 degrees. These slopes would constitute a significant impediment to water access because they exceed the 20 degree criterion for significant impact (see Table 4-69). On the west side of the reservoir near private development, the shoreline would recede over 1,500 feet, but the exposed bed would be relatively flat. Although isolated areas of exposed bed with slopes greater than 20 degrees would be present, recreation users would be able to access the water without traversing extended areas of steep slope. Along the east shore of the reservoir, slopes within the drawdown area would be 20 to 40 degrees, with some areas having slopes of 40 to

60 degrees. Because these slopes exceed 20 degrees, they would constitute a significant impediment to water access for developed (East Kachess Group Site) and undeveloped recreation along the east shore of the reservoir.

In the years following a drought year, Reclamation would transfer more water from Keechelus Reservoir to Kachess Reservoir, allowing the latter to refill more quickly. Under *Alternative 2A – KDRPP East Shore Pumping Plant*, the minimum level of Keechelus Reservoir would be 15 feet lower than under *Alternative 1 – No Action*. Keechelus Reservoir levels would be lower than *Alternative 1 – No Action* in 50 percent of years, and in those years it would be lower for 232 days out of the year on average. The resulting effects would be similar to those caused by drawdown at Kachess Reservoir.

Under current conditions, boating and fishing opportunities at Keechelus Reservoir are less prevalent than at Kachess Reservoir. The boat launch at Keechelus Reservoir is currently unavailable for use in late summer due to drawdown. Recreational sites at the reservoir, including the Keechelus Lake Boating Site and Picnic Area, Iron Horse State Park and its associated campgrounds, and private and undeveloped recreation sites on the southeast side of the reservoir are also already impacted throughout most of the summer by existing drawdown conditions. An additional 15-foot drawdown is not anticipated to cause significant impacts because boat launches, fishing sites, and developed and undeveloped recreation uses already become unusable and the quality of recreation is already reduced under existing conditions.

Significant impacts on boating and fishing opportunities and on the quality of recreation at Kachess Reservoir would increase recreational pressure at other recreation sites, particularly Cle Elum Reservoir and other reservoirs, in the Yakima River basin and central Washington.

Bull Trout Enhancement

The Gold Creek Pond actions included in the BTE would reconstruct the ADA-accessible hiking trail around a new wetland complex that would replace the existing Gold Creek Pond. This action would change the character of the site from open water to wetland, but would not remove or restrict any of the current recreational uses.

The Cold Creek passage improvements would permanently change the John Wayne Pioneer Trail in Iron Horse State Park. The new bridge over Cold Creek would be 35 feet lower than the current trail, which would create a new and gradual slope of 6 percent on both sides of the new bridge. John Wayne Pioneer Trail is a historical railroad grade, and replacing a portion of that grade with a steel or concrete bridge would change the character of the trail and the experience of recreation at this site. However, the new bridge would be designed to be visually appealing, and could be considered an upgrade to the visual experience of that segment of the trail by some recreational users. Additional analysis of potential recreation impacts will be developed as the design of these actions progresses.

4.14.5 Alternative 2B – KDRPP South Pumping Plant

4.14.5.1 Construction

KDRPP South Pumping Plant Facilities

Construction impacts under *Alternative 2B – KDRPP South Pumping Plant* would be similar to those under *Alternative 2A – KDRPP East Shore Pumping Plant*, as described in Section 4.14.4.1. However, fewer recreational users would be affected than with *Alternative 2A – KDRPP East Shore Pumping Plant* because construction activities would take place closer to Kachess Dam, where recreational activities are more limited. The transmission route would be shorter than for *Alternative 2A – KDRPP East Shore Pumping Plant* and construction traffic would not delay access to recreation on NF-4818.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.14.4.1).

4.14.5.2 Operation

KDRPP South Pumping Plant Facilities

Operation impacts would be the same as those for *Alternative 2A – KDRPP East Shore Pumping Plant*, as described in Section 4.14.4.2. Reclamation would operate KDRPP the same regardless of the location of the facilities.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.14.4.2).

4.14.6 Alternative 3A – KKC North Tunnel Alignment

4.14.6.1 Construction

KKC North Tunnel Alignment Facilities

According to all impact indicators, recreation at Keechelus Reservoir would not be affected by construction for *Alternative 3A – KKC North Tunnel Alignment.* This is the case because construction would not occur on the reservoir side of the dam. Recreationists using roads near Keechelus Reservoir, such as NF-5480, could experience delays of short duration due to construction traffic.

While driving to Kachess Lake Sno-Park, winter recreationists, including snowmobile users, could experience temporary delays of short duration due to construction traffic. Other sno-parks in the area would not be affected.

Construction at the Kachess portal site would require temporary realignment of 1,200 feet of Lake Kachess Road to maintain local traffic access around the site during the 3-year construction period. Realignment of Lake Kachess Road, in conjunction with construction traffic, could cause truck and construction traffic leading to delays in access to recreation opportunities on the west side of Kachess Reservoir, including Kachess Campground and its two boat launches. This potential delay could add travel time for recreationists heading to and from boat access points for the duration of construction. Noise and dust from construction could temporarily decrease the quality of private and undeveloped recreation near construction sites. Recreationists may avoid areas near construction activities during the construction period. Construction would not occur within the vicinity of developed recreation sites. Impacts would not be significant because other undeveloped recreation sites are available in the vicinity and no users would be displaced.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.14.4.1).

4.14.6.2 Operation

KKC North Tunnel Alignment Facilities
Alternative 3A – KKC North Tunnel Alignment would have no operation impacts on recreation at Keechelus Reservoir because new facilities would not be located in recreation areas. Operations of KKC would cause the minimum levels of Keechelus Reservoir in drought years to be approximately 14.3 feet higher than under *Alternative 1 – No Action*, which could improve recreation conditions at the reservoir during drought years. However, even in nondrought years, drawdown at the reservoir makes the boat launch unusable and exposes large portions of the Keechelus Reservoir shoreline.

Alternative 3A – KKC North Tunnel Alignment would have no long-term impacts on boating or fishing access at Kachess Reservoir because operations would not cause variability in reservoir levels outside of the existing range. *Alternative 3A* also would have no long-term impacts on developed recreation sites because none are present in the vicinity of the Kachess discharge structure. The discharge structure would include a roughly 12-foot-wide by 6-foot-high double box culvert or similar pipe under Lake Kachess Road and an energy spillway channel, stilling basin, and riprap directly into Kachess Reservoir. The discharge structure would be located in the vicinity of private parcels and could disrupt private and undeveloped recreational uses of the shoreline in that location. However, adjacent shoreline areas provide equal recreational opportunities, so no recreational users would be displaced.

Alternative 3A – KKC North Tunnel Alignment could impact recreation opportunities in the Keechelus Reach of the Yakima River. Flows would be about 50 percent lower in summer months than under *Alternative 1 – No Action*. Lower flows could impact some recreational uses, but generally the flows in the river would be sufficient for recreation. Fishing in the Keechelus Reach would not be adversely impacted because the lowered flows would benefit fish.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.14.4.2).

4.14.7 Alternative 3B – KKC South Tunnel Alignment

4.14.7.1 Construction

KKC South Tunnel Alignment Facilities
Impacts associated with *Alternative 3B – KKC South Tunnel Alignment* would be similar to those for *Alternative 3A – KKC North Tunnel Alignment* (Section 4.14.6.1). However, Lake Kachess Road would not need to be rerouted, reducing the possibility of delay in access to boat launches and recreation areas.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.14.4.1).

4.14.7.2 Operation

KKC South Tunnel Alignment Facilities
Operation impacts would be similar to those for *Alternative 3A – KKC North Tunnel Alignment* (Section 4.14.6.2), except that the discharge structure would consist of a partially buried concrete weir located at the Kachess Reservoir west shoreline on a USFS-managed parcel located below a residential development. Because the USFS-managed parcel is not used for recreation, no recreational uses would be impacted by the discharge structure.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.14.4.2).

4.14.8 Alternative 4 – Combined KDRPP and KKC

4.14.8.1 Construction

KDRPP and KKC Facilities
Combining KDRPP and KKC would not cause any additional construction impacts other than those discussed above for *Alternatives 2* and *3*. If KDRPP and KKC were constructed simultaneously, recreational uses at multiple sites at Kachess Reservoir could be disrupted simultaneously by construction noise, emissions, and truck trips. Delays to recreational access could be greater as construction traffic for both actions would occur simultaneously.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.14.4.1).

4.14.8.2 Operation

KDRPP and KKC Facilities
Combined operation could reduce the drawdown of Kachess Reservoir during and after drought years. However, recreation impacts from the drawdown at Kachess Reservoir would still be significant during drought years and similar to those described individually for KDRPP and KKC. The boat launch at Kachess Reservoir would become inaccessible to boats during the recreation season for an average of 78 percent of years and for 53 days during those years. This is an increase of 19 days over *Alternative 1 – No Action* and would constitute a significant impact. The boat launch would be accessible for 6 more days a year on average than under *Alternative 2A* and *2B* alone.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.14.4.2).

4.14.9 Mitigation Measures

Reclamation would implement construction BMPs to minimize the impact on recreation facilities and their users from nuisance dust, noise, and conflicts with temporary construction traffic (Sections 4.11.9 and 4.17.9). To maintain access to recreational facilities on the west side of Kachess Reservoir, Reclamation would reroute approximately 1,200 feet Kachess Lake Road during the construction period.

Reclamation would not mitigate the significant impacts on developed and undeveloped recreation uses due to the increased drawdown of Kachess and Keechelus reservoirs. Reclamation would explore the possibility of extending the boat ramp at Kachess Campground. However, preliminary analysis of bathymetry data shows that the steep slopes near the campground area make it impossible to extend the boat ramp far enough to access the current minimum pool or the proposed minimum pool.

Many recreationists in the area originate from communities within the region. Therefore, a public communication strategy using community media such as newspapers, local television, and radio would be effective in preparing recreation users for the significant impacts of the Proposed Action and possible construction-related delays, traffic slowdowns associated with slow-moving construction equipment, increased dust and noise, and potential road congestion from all action alternatives.

4.15 Land and Shoreline Use

4.15.1 Methods and Impact Indicators

Land and shoreline use impact indicators and criteria for determining impact significance are shown in Table 4-70. Reclamation assessed all criteria relative to *Alternative 1 – No Action*.

Table 4-70. Impact Indicators and Significance Criteria for Land and Shoreline Use

Impact Indicator	Significance Criteria
Changes in land or shoreline use, from one use to another	Temporary disruption of existing uses or long-term change in land or shoreline use or Federal management, either by direct impact or introduction of adjacent incompatible uses
Acquisitions of or easements through private property	Any involuntary change in land ownership, such as involuntary Federal acquisition of land rights or not following Federal property acquisition policies
Compatibility with applicable Federal, State, and local land use plans and regulations	Any substantive inconsistency with local land or shoreline use designations or relevant goals, objectives, and policies or applicable State or Federal management plans and programs
Changes in irrigation water supply or reliability	Increased potential for prorationing of irrigation water

Methods. Reclamation conducted the land and shoreline use analysis using existing published information supplemented by limited field reconnaissance. Primary sources of information for existing land ownership and use included mapping available from Kittitas County and available aerial photography. Potential impacts were analyzed by evaluating whether the Proposed Action would change land and shoreline uses; would be compliant with applicable Federal, State, and local land use policies and regulations; or would require acquisition of private real property or easements. Indirect impacts on land use caused by increased reliability of irrigation water supply were also considered.

Section 4.14, Recreation addresses changes in shoreline access. Effects on property values of private lands adjacent to the Kachess Reservoir due to drawdowns are addressed in Section 4.21.

Impact Indicators. The impact indicators relate to whether construction activities or new reservoir operations would change land and shoreline uses, conflict with applicable land use policies and regulations, require acquisition of private real property or easements, or change the reliability of irrigation water supply.

4.15.2 Summary of Impacts

Alternative 1- No Action would not change land use or conflict with applicable plans and regulations. Under *Alternatives 2A, 2B* and *4,* lower reservoir levels in drought and refill years would affect recreation and visual quality at Kachess Reservoir, with accompanying potential impacts on land uses. Under *Alternative 2A – KDRPP East Shore Pumping Plant* and *Alternative 2B – South Pumping Plant,* some property easements or acquisitions would be necessary for the pumping plant site (*Alternative 2A*) and possibly for the new transmission line needed to supply power to the pumping plants. Under *Alternatives 3A – KKC North Tunnel Alignment* and *Alternative 3B – KKC South Tunnel Alignment*, some property easements for the construction of the tunnel or portals could be necessary. Habitat restoration at Gold and Heli's ponds under the BTE may require acquisition of land or easements.

All action alternatives would be consistent with local land and shoreline use designations; relevant local goals, objectives, and policies; and applicable State or Federal management plans and programs. Reclamation is exercising its primary authority as delegated by Congress to implement KDRPP and KKC. Therefore, Reclamation would adhere to the laws and regulations that govern its own actions in implementing the proposal.

Under *Alternative 1 – No Action* there would be indirect impacts on the reliability of irrigation water. Current trends would continue and there would be an increased potential for the prorationing of irrigation water due to climate change. Long-term negative changes in land use could potentially result from these indirect impacts on water reliability. Under *Alternatives 2A, 2B, 3A, 3B,* and *4,* the improved reliability of proratable water supply to existing irrigated lands would help to ensure continued agriculture use. The actions would not increase the amount of irrigated land. These impacts are summarized in Table 4-71.

The BTE actions would be implemented as part of all the action alternatives. The BTE actions are located mostly on federally managed land. However, some of the land around Gold and Heli's ponds is privately owned, and acquisition of private real property or easements may be required. Reclamation would acquire land and easements from willing sellers and follow its property acquisition procedures, minimizing the impact of property acquisition. The BTE actions would temporarily affect access to some public land during construction. The BTE actions would be compatible with existing Federal, State, and local policies, and no significant impacts are anticipated.

Table 4-71. Summary of Impacts for Land and Shoreline Use

Impact Indicator	Summary of Impact
Changes in land or shoreline use	Temporary disruptions of land use would occur, but in most areas, there would be no long-term changes in land or shoreline use or Federal management. Under Alternatives 2A, 2B and 4, lower reservoir levels in drought and refill years would affect recreation and visual quality at Kachess Reservoir, with accompanying potential impacts on land uses.
Acquisitions or easements of private property	Acquisition of up to 2 acres of private property could be necessary for the construction of the pumping plant under *Alternative 2A*. Easements of land could be required for the construction of *Alternatives 3A* and *3B*. Additional acquisition of private real property or easements may be needed for habitat restoration at Gold and Heli's ponds. Impacts would not be considered significant because Reclamation would follow Federal guidelines for property acquisition.
Compatibility with applicable Federal, State, and local land use plans and regulations	All alternatives would be compatible with applicable Federal, State, and local land use plans and regulations.
Changes in irrigation water supply or reliability	*Alternatives 2A, 2B, 3A, 3B,* and *4* would provide improved reliability of proratable irrigation water supply, helping to ensure continued agricultural use of irrigated lands.

4.15.3 Alternative 1 – No Action Alternative

Under *Alternative 1 – No Action*, existing land use patterns and development trends would continue. *Alternative 1 – No Action* could result in long-term land use changes as a result of reduced water reliability, as discussed in Section 5.16.1 of the Integrated Plan PEIS (Reclamation and Ecology, 2012).

4.15.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.15.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Alternative 2A – KDRPP East Shore Pumping Plant would require acquisition or easements of up to 2 acres of private real property at the pumping plant site, and additional easements for the new transmission line needed to supply power to the pumping plant. This impact is not considered significant because Reclamation would comply with Federal property acquisition policies. Reclamation would survey properties before construction to determine whether acquisition is required. Reclamation would follow the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 USC 4601) and the procedures described in the Reclamation Manual Directives and Standards

(LND 06-01, 2003) for any property or easement acquisition. Using these processes would reduce the impact to less-than-significant.

Alternative 2A – KDRPP East Shore Pumping Plant would result in temporary traffic impacts due to construction truck trips (see Section 4.17). This could affect how and when public and private land in and near the construction areas are accessed, but would not prevent the land from being available for its intended use throughout the construction period. Temporary impacts would be limited to the 3-year construction period and are not expected to result in significant or permanent changes to land use.

Bull Trout Enhancement

The BTE actions are located mostly on federally managed land. However, some of the area around Heli's Pond is privately owned, and acquisitions of private real property or easements could be required. Reclamation would follow the property acquisition procedures described above for minimizing the impact of property acquisition. Construction of the BTE would temporarily affect access to some public land during construction. Additional analysis of potential land use impacts would be developed as the design of these actions progresses. The actions would be compatible with existing Federal, State, and local policies and no significant impacts are anticipated.

4.15.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

A number of Federal, State, and local plans and policies guide management of the Keechelus and Kachess reservoirs and their surrounding lands. Reclamation and the USFS share jurisdiction for Federal lands and resources in the primary study area because Reclamation manages Keechelus and Kachess reservoirs, which are located in a USFS managed forest area. Reclamation would exercise its primary authority as delegated by Congress to implement KDRPP. Therefore, Reclamation would adhere to the laws and regulations that govern its own actions in implementing the Proposed Action.

Alternative 2A – KDRPP East Shore Pumping Plant would result in lake levels as much as 80 feet lower than current levels during drought years. This change would affect recreation and visual quality, with accompanying potential impacts on land uses. Refer to Sections 4.10 and 4.14 for additional discussion of these impacts.

Alternative 2A – KDRPP East Shore Pumping Plant would provide an additional 200,000 acre-feet of water that Reclamation can access in drought years, improving the reliability of water supply for irrigators. This is a beneficial effect. KDRPP would not support an increase the amount of irrigated land but rather would serve existing agricultural properties. The improved reliability of water supply to existing irrigated lands could encourage irrigators in prorationed districts to retain or plant more permanent crops and maintain existing agricultural land uses.

Bull Trout Enhancement
The BTE actions would be compatible with existing land and shoreline use, and with Federal, State, and local policies. No long-term impacts are anticipated.

4.15.5 Alternative 2B – KDRPP South Pumping Plant

4.15.5.1 Construction

KDRPP South Pumping Plant Facilities
Impacts would be the same as those for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.15.4.1), except no property acquisitions would be necessary for *Alternative 2B – KDRPP South Pumping Plant*.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.15.4.1).

4.15.5.2 Operation

KDRPP South Pumping Plant Facilities
Impacts would be the same as those for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.15.4.2). Reclamation would operate KDRPP the same regardless of the location of facilities.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.15.4.2).

4.15.6 Alternative 3A – KKC North Tunnel Alignment

4.15.6.1 Construction

KKC North Tunnel Alignment Facilities
Constructing *Alternative 3A – KKC North Tunnel Alignment* would cause temporary traffic impacts due to construction truck trips (see Section 4.17, Transportation), which could delay access to land uses in and near the construction area. The temporary relocation of a portion of Lake Kachess Road would allow continued access to properties along the road during construction. Both local residents and recreational users of the area would be affected, but access to all properties would be maintained. Section 4.14 describes impacts on recreation. Construction impacts would be limited to a 3-year period, and are not expected to result in significant or permanent changes to land use.

Alternative 3A – KKC North Tunnel Alignment could result in the permanent or temporary acquisition of property easements needed for the construction of the tunnel or portals. Reclamation would survey private properties prior to construction and would acquire any needed easements in accordance with of the Uniform Relocation Assistance and Real

Property Acquisition Policies Act of 1970 (42 USC 4601) and the procedures described in the Reclamation Manual Directives and Standards (LND 06-01, 2003). Some facilities may be located on USFS-managed property. Reclamation would coordinate with the USFS on any needed easements. Using these processes would reduce the impact to a less-than-significant level.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.15.4.1).

4.15.6.2 Operation

KKC North Tunnel Alignment Facilities

As described in Section 4.15.4.2, a number of Federal, State, and local plans and policies guide management of the Keechelus and Kachess reservoirs and their surrounding lands. Reclamation would exercise its primary authority as delegated by Congress to implement KKC. Therefore, Reclamation would adhere to the laws and regulations that govern its own actions in implementing KKC.

Alternative 3A – KKC North Tunnel Alignment would allow Reclamation greater flexibility in balancing water storage between Keechelus and Kachess reservoirs. This could slightly improve the reliability of water supply for proratable irrigators and contribute to the continuation of agricultural land uses in these areas. This is a beneficial effect. This alternative would support existing agricultural uses only and would not result in an increase the amount of irrigated land.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.15.4.2).

4.15.7 Alternative 3B – KKC South Tunnel Alignment

4.15.7.1 Construction

KKC South Tunnel Alignment Facilities

Construction of *Alternative 3B – KKC South Tunnel Alignment* would result in temporary traffic impacts due to construction truck trips (see Section 4.17), which could affect access to land uses in and near the construction area. Temporary impacts would be limited to the period of construction, and access would be maintained throughout the construction period for all properties. Fewer properties would be affected compared to *Alternative 3A – KKC North Tunnel Alignment* (Section 4.15.6.1) because Lake Kachess Road would not be temporarily relocated.

Alternative 3B – KKC South Tunnel Alignment could result in acquisition of property easements needed for the construction of the tunnel and portals. Reclamation would follow the same procedures described for *Alternative 3A* to acquire property or easements. Impacts would not be considered significant because Reclamation would follow Federal guidelines for property acquisition.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.15.4.1).

4.15.7.2 Operation

KKC South Tunnel Alignment Facilities
The impacts would be the same as those described for *Alternative 3A – KKC North Tunnel Alignment* (Section 4.15.6.2). Reclamation would operate KKC the same regardless of the tunnel alignment.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.15.4.2).

4.15.8 Alternative 4 – Combined KDRPP and KKC

4.15.8.1 Construction

KDRPP and KKC Facilities
The combined construction of KDRPP and KKC would not cause any additional construction impacts other than those discussed above for KDRPP and KKC in Sections 4.15.4.1 and 4.15.5.1 respectively.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.15.4.1).Operation

KDRPP and KKC Facilities
The combined operation of KDRPP and KKC would slightly reduce drawdown of the Kachess Reservoir and would provide improved water supply for proratable irrigation districts. This is a beneficial effect.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.15.4.2).

4.15.9 Mitigation Measures

Reclamation would continue to coordinate with the USFS for mitigation of potential impacts on USFS-managed land. Continued coordination would ensure that access impacts during and following construction are minimized.

Reclamation would work with potentially affected property owners regarding acquisition of private real property or easements, and would comply with all applicable Federal regulations. Reclamation would reduce property and easement acquisition impacts to below a level of significance by following the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 USC 4601) and the procedures described in the Reclamation Manual Directives and Standards (LND 06-01, 2003).

4.16 Utilities

4.16.1 Methods and Impact Indicators

Methods. After identifying existing utilities (including electricity, telecommunications, wastewater, and water) in the primary and extended study areas, Reclamation examined utility requirements of the proposed facilities. Reclamation also considered physical impacts on existing utilities, both public and private, service interruptions during construction, and the need to relocate lines. Section 4.5 describes potential impacts on groundwater wells. For KKC, Reclamation also evaluated the potential for hydropower generation as generally discussed in Section 4.16.2.

Impact Indicators. Impact indicators are based on changes in demand and service interruptions. Impact indicators and criteria for determining impact significance for utilities are shown in Table 4-72. Reclamation assessed all criteria relative to *Alternative 1 – No Action*.

Table 4-72. Impact Indicators and Significance Criteria for Utilities

Impact Indicator	Significance Criteria
Sufficiency of existing utilities to serve the Proposed Action	Substantial changes in the demand for utilities (electricity, telecommunications, and wastewater), including the construction or expansion of facilities
Interruption of existing utilities	Likely or anticipated interruption of any utility service during construction for more than an 8-hour duration

4.16.2 Summary of Impacts

Reclamation does not anticipate construction or operation impacts on electrical services, wastewater, or telecommunications under any alternative. Table 4-73 includes a summary of impacts for utilities.

Table 4-73. Summary of Impacts for Utilities

Impact Indicator	Summary of Impacts
Sufficiency of existing utilities to serve the Proposed Action	For *Alternatives 2A* and *2B*, Reclamation would install a new transmission line from the existing PSE Easton Substation in Easton to serve the pumping plants. Operation of the new transmission line and power plant would not have a significant impact on existing electrical systems. *Alternatives 3A* and *3B* would operate by gravity flow and require no new power supply. There would be no impacts on wastewater or telecommunications from construction or operation.
Interruption of existing utilities	Interruption of services during construction is not anticipated. There would be no impacts on wastewater or telecommunications from construction or operation.

4.16.3 Alternative 1 – No Action Alternative

Reclamation would continue existing operations at Kachess and Keechelus reservoirs under *Alternative 1 – No Action*. No changes to utilities would be needed. The WSDOT I-90 Phase 2A project would not require additional utilities and would not change the demand for utilities in the area. Demand for electricity and other services would continue to keep pace with residential and commercial development throughout Kittitas County.

4.16.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.16.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

From the Easton substation, the new overhead transmission line would be constructed along existing road and transmission line rights-of-way to the extent feasible. Additional analysis would be conducted as part of PSE's route study to determine the alignment. The transmission line to the east shore pumping plant would be constructed parallel to Kachess Dam Road, then through forested area to the new power supply building. Existing power or onsite generators would supply temporary power for construction. Power needed for construction would represent a minor increase and would not impact existing uses.

Power or telecommunication lines and overhead poles may need to be relocated for construction. Any such relocation would be temporary, short-term, and unlikely to impact services. No on-site sewage systems (OSS) are located in areas that would be impacted by construction. There would be no impacts on wastewater or telecommunications from construction.

Bull Trout Enhancement

Telecommunication lines underneath John Wayne Pioneer Trail would likely need to be relocated for construction of Cold Creek fish passage improvements. Any such relocation would be coordinated with Washington State Parks and Recreation Commission, and would be temporary, short-term, and unlikely to interrupt or impact services. There would also be no impacts on electrical services or wastewater from construction of BTE actions. Electrical needs for construction would be minimal and temporary, and generators would likely be used.

4.16.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

The east shore pumping plant would have three large synchronous motor pumps rated for approximately 10 megawatts (MW) each and with a full load no less than 35 megavolt amperes (MVA) total. Power would be supplied to the east shore pumping plant by an approximately 3- to 5-mile-long 115 kilovolt (kV) transmission line connected to the existing PSE Easton Substation in Easton. In drought years, when the Kachess Reservoir is below the existing gravity outlet and Reclamation operates KDRPP, the Proposed Action would increase electrical demand. However, this anticipated increase falls within normal ratings for bulk electrical systems under normal operating conditions and would not be a significant impact (Reclamation and Ecology, 2014n). In the event of a power failure, a permanent diesel-powered generator would likely provide backup power supply. However, Reclamation could reduce power requirements during such times by turning off one or more pumps.

Reclamation does not anticipate long-term impacts on wastewater or telecommunications from *Alternative 2A – KDRPP East Shore Pumping Plant* because operation would not increase the demand for these utilities.

Bull Trout Enhancement

The BTE actions would not cause long-term impacts on electrical systems, wastewater, or telecommunications because the proposed improvements would not require any utilities.

4.16.5 Alternative 2B – KDRPP South Pumping Plant

4.16.5.1 Construction

KDRPP South Pumping Plant Facilities

Impacts from construction of *Alternative 2B – KDRPP South Pumping Plant* would generally be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant*. Unlike *Alternative 2A*, the new transmission line would be constructed only to Kachess Dam where the south pumping plant and power supply building would be located.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.16.4.1).

4.16.5.2 Operation

KDRPP South Pumping Plant Facilities
The south pumping plant would use three synchronous motor pumps rated for approximately 5.5 MW each and a total maximum full-load rating of 20 MVA. Operation impacts from *Alternative 2B – KDRPP South Pumping Plant* would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant*.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.16.4.2).

4.16.6 Alternative 3A – KKC North Tunnel Alignment

4.16.6.1 Construction

KKC North Tunnel Alignment Facilities
Overhead transmission lines to Keechelus Dam run northwest away from the dam towards I-90. Existing power or onsite generators would supply temporary power for construction. Power needed for construction would not impact existing uses because it would be a small increase in power demand.

Power or telecommunication lines and overhead poles may need to be relocated for construction. Any such relocation would be temporary, short-term, and unlikely to impact services. There are no OSSs located in areas that would be impacted by construction.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.16.4.1).

4.16.6.2 Operation

KKC North Tunnel Alignment Facilities
An additional power source would not be needed for operation of *Alternative 3A – KKC North Tunnel Alignment* because the KKC would operate by gravity flow. Power requirements for operating KKC are limited to lighting and instrumentation. Reclamation does not anticipate operation impacts on electrical services, wastewater, or telecommunications from *Alternative 3A – KKC North Tunnel Alignment*.

During early planning, Reclamation considered the feasibility of hydropower generation from the flow of water in the KKC tunnel (Reclamation and Ecology, 2014n). The feasibility study showed that the cost of a hydropower facility would be approximately 2 to 3 times higher than economically feasible based upon the potential benefits. The study also determined that hydropower generation was infeasible because KKC would not operate continuously and flow rates would not be sufficient for hydropower. For these reasons, hydropower facilities are not included in the KKC. However, Reclamation would construct the KKC so that future addition of power recovery facilities would not be precluded.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.16.4.2).

4.16.7 Alternative 3B – KKC South Tunnel Alignment

4.16.7.1 Construction

KKC South Tunnel Alignment Facilities
Impacts from construction of *Alternative 3B – KKC South Tunnel Alignment* would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant*.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.16.4.1).

4.16.7.2 Operation

KKC South Tunnel Alignment Facilities
Long-term impacts from *Alternative 3B – KKC South Tunnel Alignment* would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant.* Reclamation would operate KKC the same regardless of the tunnel alignment.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.16.4.2).

4.16.8 Alternative 4 – Combined KDRPP and KKC

4.16.8.1 Construction

KDRPP and KKC Facilities
Impacts from *Alternative 4 – Combined KDRPP and KKC* would be the same as those described for KDRPP and KKC individually. The power demand for construction of both KDRPP and KKC is small and within the capacity of the power system.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.16.4.1).

4.16.8.2 Operation

KDRPP and KKC Facilities
Impacts from *Alternative 4 – Combined KDRPP and KKC* would be the same as described for KDRPP and KKC individually. As described in Section 4.16.6.2, power demands for operating KKC are limited to lighting and instrumentation.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.16.4.2).

4.16.9 Mitigation Measures

During final design, Reclamation would conduct utility surveys and take appropriate measures to minimize conflicts with utilities in construction areas. Reclamation would coordinate with the affected utility to relocate or replace affected utilities, as appropriate. Reclamation would employ appropriate BMPs during construction to prevent disruption of utility services. These practices would minimize impacts on utilities; therefore, no additional mitigation would be required.

4.17 Transportation

4.17.1 Methods and Impact Indicators

Methods. The transportation analysis includes evaluating changes to the following aspects of transportation systems:

- Vehicle traffic levels and potential traffic flow disruptions
- Interruptions to school bus routes and emergency service vehicle response caused by an increase in traffic or road closures
- Disruptions to the use or accessibility of other means of transportation (e.g., snowmobiles, pedestrian, bicycles) through closure of trails, sidewalks, or bicycle paths
- Reduction in available parking
- Potential for increased vehicle conflicts and safety concerns

Impact Indicators. The impact indicators for transportation relate to whether construction activities would cause temporary increases in construction traffic; delays of vehicles and emergency service providers caused by detours or short-term traffic disruptions; and increased safety concerns on primitive, rural, or residential roadways for local travel. Impact indicators also include deterioration of local roadways and increased maintenance requirements caused by additional traffic or the presence of oversized vehicles on local roadways. Impact indicators and significance criteria for transportation are shown in Table 4-74. Reclamation assessed all criteria relative to *Alternative 1 – No Action*.

Table 4-74. Impact Indicators and Significance Criteria for Transportation

Impact Indicator	Significance Criteria
Increase in vehicle traffic levels or traffic flow disruptions	Increase of 25 or more peak-period (am, pm, or both) construction roundtrips (50 one-way trips)[1] which could result in the following: • Interruption of emergency service vehicle access or more than a minor increase in emergency service response time • Interruptions to school bus routes • More than a moderate increase in vehicle travel time • More than a moderate interruption to or potential conflict with other means of transportation (e.g., snowmobiles, pedestrians, bicycles) • More than a minor increase in safety risk to motorists or other users of local roads
Reduction in existing parking	More than minor reduction in available parking spaces
Condition of roadways and maintenance requirements	More than moderate deterioration of local roadways

[1] This screening criterion relates to that recommended by the Institute of Transportation Engineers (ITE) (1989) for assessing the effects of construction projects that create temporary traffic increases.

4.17.2 Summary of Impacts

The condition of transportation systems in the primary and the expanded study areas under *Alternative 1 – No Action* would remain the same as exists today, with the exception of increased construction traffic on I-90 and the long-term beneficial effects resulting from the I-90 Phase 2A project. Table 4-75 summarizes construction traffic trips associated with each of the alternatives.

Table 4-75. Summary of Construction Roundtrips

Alternative	Total Construction Materials Haul Trips[1]	Average Hourly Construction Materials Haul Trips During Construction	Maximum Hourly Worker Trips During Construction	Maximum Hourly Trips for Construction and Workers
2A	28,900	6	50	56
2B	8,800	2	50	52
3A	11,600	3	50	53
3B	12,100	3	50	53
4	20,400 to 41,000	4 to 9	50	54 to 59

[1]Construction materials haul trips calculated for each alternative do not include the 2,800 trips associated with the BTE – Gold Creek Bridge replacement.

Impacts on transportation from *Alternatives 2A, 2B, 3A, 3B,* and *4* would be similar. With the exception of I-90, the roads in the primary study area generally have light traffic and are rural in nature. Construction under all action alternatives would result in a more-than-moderate increase in vehicle traffic time. The increase would exceed the 25 peak period roundtrip threshold and is therefore considered a significant impact. The increase would neither affect the ability of emergency personnel to respond to an incident nor interrupt school bus routes, because the delays would be intermittent and of short-term duration. No road closures are planned. No changes are anticipated to existing access for pedestrians, snowmobiles, or bicycles along local roadways. Construction parking would be provided at staging areas; therefore, the projects are not anticipated to impact existing parking areas, including sno-parks.

No weight or height limitations are in effect to restrict construction equipment access to the sites. No oversized vehicles would be required during construction. Therefore, no upgrades to existing roadways would be required to facilitate construction vehicle access. The overall increase in vehicle traffic would likely result in minor to moderate deterioration of local roads; however, Reclamation would require contractors to repair any damage and restore roadways to a condition similar to or better than that prior to construction (see Section 4.17.10). Finally, the increase in vehicle traffic is not expected to contribute more than a minor incremental safety risk to motorists and other users of local roads. The presence of additional construction traffic on local roadways would inherently increase the accident risk. However, a traffic management plan would be developed prior to construction to minimize the potential safety risks (see Section 4.17.9). Once construction is complete, the actions would require infrequent trips for maintenance or operation; therefore, no impacts are expected.

The BTE actions, which would be implemented as part of all the action alternatives, would require additional truck shipments of construction materials, transportation of construction workers to work sites, and truck haul shipments of fill and spoil materials. Impacts on traffic on local roadways would primarily be from trucks importing and exporting fill and spoil materials and delivering materials to construction sites. This additional traffic is not anticipated to result in any impacts beyond those already described for the action alternatives.

Table 4-76. Summary of Impacts for Transportation

Impact Indicator	Summary of Impact
Increase in vehicle traffic levels or traffic flow disruptions	*Alternatives 2A, 2B, 3A, 3B*, and *4* – Significant impacts anticipated because there could be more than a moderate increase in traffic delays; no interruption to other means of transportation; no interruption to emergency service vehicle response time; and no more than a minor increase in safety risk
Reduction in existing parking	*Alternatives 2A, 2B, 3A, 3B*, and *4* – Impacts not significant during construction and operation because construction parking would be provided at staging areas and operation would not result in additional parking demand; no impacts on sno-parks anticipated
Condition of roadways and maintenance requirements	*Alternatives 2A, 2B, 3A, 3B*, and *4* – Impacts not significant during construction and operation because no alternative would result in more than a moderate increase in deterioration of local roadways

4.17.3 Alternative 1 – No Action Alternative

Alternative 1 – No Action would include WSDOT's I-90 Phase 2A project, in which the highway would be expanded to six lanes along the 2.1 miles from the north side of Keechelus Reservoir south to Lake Easton. Construction would begin in 2015 and continue through 2020. As analyzed in the 2008 EIS (WSDOT, 2008), this expansion project would cause delays on I-90 during construction due to lane closures, but the transportation system would benefit over the long term. Traffic levels along I-90 are anticipated to increase on a yearly basis and the expansion of I-90 would help alleviate some of the anticipated congestion. As discussed in the 2008 EIS for the I-90 Project (WSDOT, 2008) and summarized in Section 3.17 of this DEIS, the I-90 project is anticipated to improve the LOS through this portion of the I-90 corridor. LOS-D would be maintained until 2041 and LOS-E would not be reached until 2058. Without the project, LOS-D would only be maintained until 2025. Beyond the I-90 expansion, no new traffic sources are anticipated under *Alternative 1 – No Action.* In particular, no new traffic sources are anticipated on local roads and the expansion of I-90 is not anticipated to impact local traffic. Therefore, the conditions of transportation systems in the primary study area and the expanded study area would remain the same as exist today, with the exception of the increased traffic on I-90 and the long-term beneficial effects resulting from the I-90 Phase 2A project.

4.17.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.17.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Construction for *Alternative 2A – KDRPP East Shore Pumping Plant* would require truck shipments of construction materials, transportation of construction workers to work sites, and truck haul shipments of spoil materials. New access roads would be required for the pump station, pipeline, and spillway and release structure. Construction workers would access the construction sites and new access roads from NF-4818 via Kachess Dam Road, West Sparks Road, and I-90. A 20- to 25-foot-wide access road would be constructed alongside the entire pipeline alignment. Construction of the access road would not impact continued use of any local roadways.

Construction worker trips and delivery of construction materials would be distributed across the 3-year construction period. Impacts on traffic on local roadways would be caused by trucks importing and exporting fill and spoil materials and delivering materials to construction sites. The number of trips for these activities was calculated for this analysis based upon the amount of materials anticipated to be hauled to and from construction sites as reported in the KDRPP Feasibility Design Report (Reclamation and Ecology, 2014f). Approximately 28,900 truck roundtrips are anticipated over the life of the project, or an average 49 during each day of construction (or 6 trips per hour). A maximum of 100 vehicle roundtrips per day would be expected for construction workers access to and from the site. Because most workers would arrive in the morning and depart in the evening, 50 vehicles per hour were assumed to arrive between the hours of 7 and 9 am and then depart between the hours of 4 and 6 pm.

Together, construction worker trips and delivery of materials would require a maximum of 56 roundtrips per hour; however, during the nonpeak hours of the day, traffic would be much lower as there would be much less construction worker traffic. With the exception of I-90, the roads in the primary study area are generally rural with light traffic. A significant impact from a more-than-moderate increase in vehicle travel time would be anticipated, as the increase in vehicle traffic under all build alternatives would exceed the threshold of 25 peak period roundtrips. The increased peak period traffic could result in an increase in delays for traffic along local roadways. However, the increase in traffic delays would not impact the ability of emergency personnel to respond to an incident, or interrupt any school bus routes because there would be only short-term, intermittent delays for construction activities, and no road closures are planned. Longer travel time could be caused by reduced speed limits through construction areas; however, delays would be limited in space to the specific area of construction and in time (they would be temporary). The construction-driven increase of 56 vehicles per peak period hour would increase peak period traffic on I-90 by approximately 3 percent if all construction-related workers and equipment utilized I-90 (which is not anticipated to occur). This small increase is not anticipated to noticeably change the existing traffic conditions, as I-90 is generally already congested during the peak period.

Changes to existing access for pedestrians, snowmobiles, and bicycles along local roadways are not anticipated, because no sidewalks, snowmobile routes, or bicycle routes would be impacted by construction activities. During the construction period, Reclamation would plow roads needed to access construction sites. Reclamation would obtain a permit from the USFS prior to plowing on any National Forest roads. Snowmobile access would be maintained on designated routes that are also used for construction access by preserving snow along the side of the plowed area. Construction parking would be located at project staging areas; therefore, construction is not anticipated to affect existing parking areas or demand. No changes to parking at or access to any of the sno-parks in the primary study area anticipated.

No weight or height limitations are in effect that would restrict access of construction equipment to the sites, and no oversized vehicles would be required during construction. Therefore, no upgrades to existing roadways would be required to facilitate construction vehicle access. Reclamation expects that the overall increase in vehicle traffic would result in minor to moderate deterioration of local roads; however, Reclamation would require contractors to repair any damage and restore roadways to a condition similar to or better than that prior to construction (see Section 4.17.9).

The increase in vehicle traffic during construction would contribute to a minor increased safety risk to motorists or other users of local roads. The presence of additional construction traffic on local roadways would inherently increase the accident risk. However, a traffic management plan would be developed prior to construction to minimize the potential safety risks (see Section 4.17.9).

The offshore drilling and intake installation in the reservoir would be supported by a barge or semipermanent offshore platform. These facilities would be in place temporarily during construction. The area immediately around the construction boat launch and the barge or offshore platform would be restricted to construction activities and would preclude boaters. This would result in a temporary impact on boating use of this area. However, the restricted area would be limited and boaters would have access to the rest of the reservoir.

Bull Trout Enhancement

Construction of the BTE actions would require truck shipments of construction materials, transportation of construction workers to work sites, and truck haul shipments of fill and spoil materials. As described in the 2011 Forest Service EA analyzing the replacement of the Gold Creek USFS bridge along NF-4832, construction would require a temporary road closure and detour around the construction site (USFS, 2011a). This would be expected to increase travel time through the area; however, the Forest Service roads in this area are lightly traveled and negligible impacts would be anticipated. Traffic impacts on local roadways would primarily be from trucks for import and export of fill and spoil materials and for delivery of materials. These activities would result in approximately 2,800 truck roundtrips over the life of the BTE construction activities, or approximately 14 truck roundtrips during each day of construction (approximately 2 trips per hour) (USFS, 2011a). Additional traffic would be anticipated from construction workers travelling to and from construction sites. The number of construction worker trips for the BTE is unknown at this time. This additional traffic is not anticipated to result in any additional impacts beyond those already described for this alternative. Additional analysis of potential transportation impacts associated with BTE will be developed as the design of these Proposed Actions progresses.

4.17.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Reclamation does not anticipate transportation impacts during operation and maintenance because *Alternative 2A – KDRPP East Shore Pumping Plant* would not result in additional traffic on local or regional roadways. Therefore, there would be no operation increase in delays for vehicles and emergency service providers, disruptions to the use or accessibility of other means of transportation, reduction in parking availability, or deterioration of local roadways leading to increased maintenance requirements.

Easton State Airport is approximately 3,000 feet to the southeast of the proposed discharge facilities for *Alternative 2A – KDRPP East Shore Pumping Plant*. The proposed transmission line could lie within the zone that would require notification of the Federal Aviation Administration (FAA). Under 49 CFR 77, the FAA is to be notified via Form 7460-1 of proposed construction activities that would take place within 10,000 feet of an airport with a runway of less than 3,200 feet in length and exceed a 50-to-1 imaginary surface height. The 50–to-1 ratio establishes a threshold of 1 foot of height for every 50 feet of horizontal distance. For example, FAA would require notification if the proposed transmission line was located 3,000 feet from the airport and exceeded 60 feet in height. If FAA notification were required, it would be made after the transmission line route is established.

Bull Trout Enhancement

Following construction of BTE actions there would be no operation impacts on transportation.

4.17.5 Alternative 2B – KDRPP South Pumping Plant

4.17.5.1 Construction

KDRPP South Pumping Plant Facilities

The potential transportation impacts from construction of *Alternative 2B – KDRPP South Pumping Plant* would be less than those described for *Alternative 2A – KDRPP East Shore Pumping Plant* because fewer vehicle trips would be needed. *Alternative 2B -KDRPP South Pumping Plant* does not include construction of a pipeline; therefore, it would not require the truck trips for transportation of fill and spoil materials associated with pipeline construction under *Alternative 2A*. Kachess Dam Road would provide local access to the site of the proposed pumping plant. Construction worker trips and delivery of construction materials would be minimal (see Table 4-75) and spread out over the 3-year construction period.

Traffic impacts on local roadways would come from trucks importing and exporting fill and spoil materials, and from trucks delivering materials. These activities would result in a total of approximately 8,800 truck roundtrips over the life of the project, or approximately 15 truck roundtrips during each day of construction (approximately 2 trips per hour). A maximum of 100 vehicle roundtrips per day would be expected for construction worker access to and from the site. Because most workers would arrive in the morning and depart in the evening, 50 vehicles per hour were assumed to arrive between the hours of 7 and 9 am and depart between the hours of 4 and 6 pm. Together, construction worker trips and delivery of construction materials would require a maximum of 52 roundtrips per hour; however, during the day, traffic would be much lower as there would be much less construction worker traffic. Although this number of truck trips is lower than described under *Alternative 2A – KDRPP East Shore Pumping Plant*, the impacts from this increase in traffic would be generally the same.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.17.4.1).

4.17.5.2 Operation

KDRPP South Pumping Plant Facilities

The transportation impacts from operation of *Alternative 2B – KDRPP South Pumping Plant* would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant*.

Bull Trout Enhancement

The transportation impacts associated with operation of the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.17.4.2).

4.17.6 Alternative 3A – KKC North Tunnel Alignment

4.17.6.1 Construction

KKC North Tunnel Alignment Facilities

Construction of the components for *Alternative 3B – KKC North Tunnel Alignment* would require truck shipments of construction materials, transportation of construction workers to work sites, and truck haul shipment of fill and spoil materials. Construction workers would access construction sites along the west side of the Kachess Reservoir via NF-4828 or Kachess Lake Road. Workers would likely access Kachess Lake Road directly from I-90 and NF-4828 via West Sparks Road from I-90. Construction access and material hauling to and from the tunnel would be conducted from the Kachess Lake Road portal. Approximately 1,200 feet of Lake Kachess Road would be temporarily realigned around the Kachess portal area to enlarge the portal work area and to maintain local traffic access around the site during construction. The road would be realigned prior to construction such that Lake Kachess Road would remain open until the bypass is constructed; therefore, there would be no disruptions to traffic along Lake Kachess Road. Tunneling under I-90 would not result in any impacts on traffic along the highway.

Construction worker trips and delivery of construction materials would be distributed across the 3-year construction period. Traffic impacts on local roadways would be from trucks for import and export of fill and spoil materials and for delivery of materials. The number of trips for these activities was calculated for this analysis based upon the amount of materials anticipated to be hauled to and from construction sites reported in the KKC Feasibility Design Report (Reclamation and Ecology, 2014g). Approximately 11,600 truck roundtrips are anticipated over the life of the project, or approximately 18 truck roundtrips during each day of construction (approximately 3 trucks per hour). A maximum of 100 vehicle roundtrips per day would be expected from the transportation of construction workers to and from the site. Because most workers would arrive in the morning and depart in the evening, 50 vehicles per hour were assumed to arrive between the hours of 7 and 9 am and depart between the hours of 4 and 6 pm.

Together, construction worker trips and delivery of construction materials would require a maximum of 53 roundtrips per hour; however, during the day, traffic would be much lower as there would be much less construction worker traffic. With the exception of I-90, the roads in the primary study area are generally rural with light traffic. A significant impact from a more-than-moderate increase in vehicle travel time would be anticipated as the increase in vehicle traffic under all build alternatives would exceed the threshold of 25 peak period roundtrips. The increased peak period traffic could result in an increase in delays for traffic along local roadways. In addition, impacts could be anticipated on travel time for vehicles arriving at and departing from the neighborhood located to the south of the Kachess portal. The construction-drive increase of 55 vehicles per peak period hour would increase peak period traffic on I-90 by approximately 3 percent if all construction-related vehicles utilized I-90 (which is not anticipated to occur). This small increase is not anticipated to noticeably change the existing traffic conditions, as I-90 is generally already congested during the peak period.

Emergency response, school bus routes, sidewalks, snowmobile routes, and bicycle routes would not be impacted by construction activities. Reclamation would plow roads needed to access sites during construction activities. Reclamation would obtain a permit from the USFS prior to plowing on any National Forest roads. Snowmobile access would be maintained on designated routes that are also used for construction access by preserving snow along the side of the plowed area. Construction parking would be located at project staging areas and therefore would not require parking in areas that are currently used for public parking. No changes to parking at or access to any of the sno-parks in the primary study area anticipated.

As described for *Alternative 2A – KDRPP East Shore Pumping Plant,* no upgrades to existing roadways would be required to facilitate construction vehicle access. Reclamation expects that the overall increase in vehicle traffic would result in minor to moderate deterioration of local roads; however, Reclamation would require contractors to repair damage and restore roadways to a condition similar to or better than that prior to construction (see Section 4.17.9). The increase in vehicle traffic during construction would contribute to a minor increased safety risk to motorists or other users of local roads. The presence of additional construction traffic on local roadways would inherently increase the accident risk. However, a traffic management plan would be developed prior to construction to minimize the potential safety risks (see Section 4.17.9).

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.17.4.1).

4.17.6.2 Operation

KKC North Tunnel Alignment Facilities
Reclamation does not expect operation transportation impacts, because operation of *Alternative 3A – KKC North Tunnel Alignment* would not result in additional traffic on local or regional roadways. There would be no post-construction increase in delays for vehicles or emergency service providers, disruption to the use or accessibility of other means of transportation, reduction of available parking, or no deterioration of local roadways leading to increased maintenance requirements.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.17.4.2).

4.17.7 Alternative 3B – KKC South Tunnel Alignment

4.17.7.1 Construction

KKC South Tunnel Alignment Facilities

The impacts on transportation from construction of *Alternative 3B – KKC South Tunnel Alignment* would be similar to those described for *Alternative 3A – KKC North Tunnel Alignment*. The KKC south tunnel would not require temporary realignment of Lake Kachess Road.

This alternative would require additional truck trips beyond those described for *Alternative 3A – KKC North Tunnel Alignment*. *Alternative 3B – KKC South Tunnel Alignment* would require approximately 12,100 truck roundtrips over the life of the project, or approximately 19 truck roundtrips during each day of construction (approximately 3 trips per hour). A maximum of 100 vehicle roundtrips per day would be expected from the transportation of construction workers to and from the construction site. Because most workers would arrive in the morning and depart in the evening, 50 vehicles per hour were assumed to arrive between the hours of 7 and 9 am and depart between the hours of 4 and 6 pm.

Together, construction worker trips and delivery of construction materials would require a maximum of 53 roundtrips per hour; however, during the day, traffic would be much lower as there would be much less construction worker traffic. The impacts from this increase in traffic would be the same as those described for *Alternative 3A – KKC North Tunnel Alignment*.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.17.4.1).

4.17.7.2 Operation

KKC South Tunnel Alignment Facilities

The operation transportation impacts from *Alternative 3B – KKC South Tunnel Alignment* would be the same as those described for *Alternative 3A – KKC North Tunnel Alignment*.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.17.4.2).

4.17.8 Alternative 4 – Combined KDRPP and KKC

4.17.8.1 Construction

KDRPP and KKC Facilities

The impacts on transportation systems from construction of *Alternative 4 – Combined KDRPP and KKC* would be the same as those described individually for KDRPP and KKC. Reclamation does not expect additional or increased impacts associated with building both KDRPP and KKC because they are located in different areas and different local roads would be affected by each action. Depending on timing and phasing of construction, it is possible that the combined total truck trips on local or regional roads on a given day could be greater than the expected number of trips expected for either action by itself.

Construction worker trips and delivery of construction materials would be distributed across the 3-year construction period. Traffic impacts on local roadways would come from trucks for the import and export of fill and spoil materials and for delivery of materials. These activities would result in 20,400 to 41,000 truck roundtrips over the life of the construction phase, or approximately 6 to 11 trucks per hour. A maximum of 100 vehicle roundtrips per day would be expected from the transportation of construction workers to and from the construction site. Because most workers would arrive in the morning and depart in the evening, 50 vehicles per hour were assumed to arrive between the hours of 7 and 9 am and depart between the hours of 4 and 6 pm.

Together, construction worker trips and delivery of construction materials would require a maximum of 54 to 59 roundtrips per hour; however, during the day, traffic would be much lower as there would be much less construction worker traffic.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.17.4.1).

4.17.8.2 Operation

KDRPP and KKC Facilities

Operation impacts associated with *Alternative 4 – Combined KDRPP and KKC* would be the same as the impacts described for *Alternatives 2* and *3*.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.17.4.2).

4.17.9 Mitigation Measures

A temporary but significant impact on travel time is anticipated, as the increase in vehicle traffic under all of the action alternatives would exceed the threshold of 25 roundtrips during the peak period. This impact is anticipated to occur only during the construction period. To mitigate this potential impact, Reclamation would implement a construction traffic management plan with specific traffic management measures and procedures that construction contractors would follow.

To mitigate potential damage from construction activities, Reclamation would require contractors to repair any substantial damage to local roadways caused by construction activities. The expectation is that roadways would be left in a condition similar to or better than that found prior to construction.

Reclamation would also require the contractor to implement BMPs to reduce transportation impacts and maintain safety during construction, including maintaining access to properties, installing signs, flagging, providing information to the public, and giving advance notice of construction activities. Safety BMPs would include restricting public access to construction sites, reducing speed limits, and providing signage on access roads.

4.18 Cultural Resources

4.18.1 Methods and Impact Indicators

Methods. Reclamation analyzed impacts to cultural and historic resources by conducting a literature review and a preliminary on-the-ground cultural resource survey of the study areas to estimate the extent to which the alternatives would impact cultural or historic resources. Chapter 3, Section 3.18 provides examples of the types of resources and the types of impacts that could result from the Proposed Action. Table 4-77 shows the impact indicators used in this analysis to report potential for impact on cultural resources.

Impact Indicators. As defined by Federal regulations, cultural resources deemed significant are subject to additional determination of effects and the design of special mitigation measures. The Criteria of Adverse Effect (36 CFR 800.5) are used to determine whether a Proposed Action would affect an historic property. Any element of an action would have an adverse effect if it changes the characteristics that qualify a historic property for inclusion in the National Register of Historic Places in a manner that would diminish the integrity of that property. Potential adverse effects include the following:

- Physical impact on an historic property or cultural resource, through agents such as inundation and shoreline fluctuation
- Damage or alteration of a portion of a historic property, or removal or modification of a portion of the property
- Introduction of audible, visible, or atmospheric elements that are out of character with the historic property or alter its setting

Table 4-77. Impact Indicators and Significance Criteria for Cultural Resources

Impact Indicator	Significance Criterion
Physical impact on an historic property, sacred site, or cultural resource, through agents such as changes in reservoir drawdown and fluctuation	Changes the characteristics that qualify a historic property for inclusion in the NRHP in a manner that would diminish its integrity; disturbance of a cultural item protected under the Native American Grave Protection and Repatriation Act (NAGPRA); or prevention of access to or disturbance of a sacred site
Damage or alteration of a portion of a historic property, or removal or modification of a portion of the property through construction, installation, or habitat activity	Changes the characteristics that qualify a historic property for inclusion in the NRHP in a manner that would diminish its integrity; disturbance of a cultural item protected under NAGPRA; or prevention of access to or disturbance of a sacred site

4.18.2 Summary of Impacts

Table 4-78 summarizes the potential impacts.

Alternative 1 – No Action would have no additional impact on cultural and historic resources beyond those occurring due to current reservoir operations.

Table 4-78. Summary of Impacts for Cultural Resources

Impact Indicator	Summary of Impacts
Physical impact on an historic property, sacred site, or cultural resource through agents such as changes in shoreline drawdown and reservoir fluctuation	Additional 80-foot drawdown of Kachess Reservoir under *Alternatives 2A, 2B*, and *4* and 15-foot drawdown at Keechelus Reservoir under *Alternatives 3A, 3B,* and *4* would expose large portions of shoreline that are currently inundated, potentially exposing cultural resources to degradation, looting, or vandalism.
Damage or alteration of a portion of a historic property, or removal or modification of a portion of the property through construction, installation, or habitat activity	Construction at Kachess Reservoir under *Alternatives 2A, 2B*, and *4* could damage or alter one identified NRHP-eligible site and potential additional sites that have not yet been identified. Construction at Keechelus Reservoir under *Alternatives 3A, 3B,* and *4* could damage or alter one identified NRHP-eligible site and potential additional sites that have not yet been identified.

Construction for *Alternative 2A – KDRPP East Shore Pumping Plant* and *Alternative 2B - KDRPP South Pumping Plant* would include activities such as clearing, grubbing, excavation, and establishment of access roads in the vicinity of an NRHP-eligible site (a fishing and dam-construction camp near Kachess Dam first identified in 1993; see Section 3.18.3). Construction could disturb, damage, or alter historic features and artifacts associated with the site. More construction activities would take place in the vicinity of the site under *Alternative 2B* than under *Alternative 2A*. It is possible that subsequent surveys would identify additional cultural resources that could be impacted by construction of elements under both alternatives. Operation-related impacts would result from the additional drawdown at Kachess Reservoir. Drawing the reservoir down an additional 80 feet would expose large stretches of shoreline for the first time since Kachess Dam was constructed in 1912. The drawdown could expose previously inundated cultural resources. Such exposure could lead to site degradation over time and increase the potential looting or vandalism, if eligible resources exist and are determined, in consultation with State Historic Preservation Officer (SHPO), to be adversely affected. Exposure of these resources would physically impact cultural resources, so the impact would be significant.

Construction for *Alternative 3A – KKC North Tunnel Alignment* and *Alternative 3B – KKC South Tunnel Alignment* would cause similar impacts to an NRHP-eligible site. Construction could disturb, damage, or alter historic features and artifacts associated with the site. It is possible that future surveys would identify additional cultural resources that could be impacted by construction of under both alternatives. Keechelus Reservoir could be drawn down an addition 15 feet during drought years, exposing stretches of shoreline that would be exposed for the first time since Keechelus Dam was constructed. The drawdown’s impacts on cultural resources would be similar to those of *Alternatives 2A* and *2B* and would be considered significant. *Alternative 4 – KDRPP and KKC Combined* would have the same construction and operation impacts at the reservoirs as *Alternatives 2A, 2B, 3A,* and *3B.*

The BTE actions at Gold and Cold creeks would be implemented as part of all the action alternatives and would include construction elements that could alter or damage historic resources (if present). Reclamation and Ecology would complete surveys of cultural resources at the Gold Creek and Cold Creek locations before construction. The Cold Creek passage improvements would permanently change the John Wayne Pioneer Trail in Iron Horse State Park, a historic railroad grade. The trail would be excavated to remove the existing culvert and a bridge would be installed. The new bridge would be steel or concrete and would change the historic character of the trail in this location.

4.18.3 Alternative 1 – No Action Alternative

Alternative 1 – No Action would have no additional impact on cultural and historic resources beyond those occurring under current operations; this alternative involves no change in reservoir drawdown patterns. The I-90 Phase 2A project would involve earthwork and is the associated risk of discovery previously unknown cultural resources. WSDOT is addressing compliance with applicable cultural resource regulations separately (WSDOT, 2008). If cultural or historic resources were discovered, WSDOT would implement a mitigation plan. Potential impacts related to the I-90 Phase 2A project are not expected to be significant.

4.18.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.18.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Elements of construction of the east shore pumping plant located south of Kachess Dam, including the spillway, the stilling basin, and an access road, would be in the area of site 45KT1014, which is considered eligible for the NRHP. Clearing, grubbing, excavation, and installation of project elements could disturb, damage, or alter historic features and artifacts associated with the site. Such impacts would be permanent. It is possible that future surveys would identify additional cultural resources that could be impacted by construction of the *Alternative 2A – East Shore Pumping Plant* facilities. Additional analysis would also be conducted as part of PSE's route study and environmental analysis for the transmission line. Section 4.18.9 describes the process to resolve adverse effects on cultural resources. If damage or alteration of historic features or artifacts cannot be avoided, the impact would be significant.

Construction would not take place on Kachess Dam, which is considered eligible for inclusion on the NRHP. Therefore, the historic character of the dam would not be disturbed by construction activities and significant impacts would not occur.

Bull Trout Enhancement

Reclamation and Ecology would complete surveys of cultural resources at the Gold Creek and Cold Creek action locations as the design of these actions progresses. Those surveys could identify cultural resources subject to permanent alteration or damage by clearing, grading, excavation, and construction of access roads. Section 4.18.9 describes the process to resolve adverse effects on cultural resources.

4.18.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

Operation impacts would result from the additional drawdown at Kachess Reservoir. The preliminary cultural resources survey (YCIP, 2014; Central Washington University, 2014) identified 10 known sites around the immediate shoreline or drawdown area of the reservoir. Future surveys may identify additional cultural resources in the drawdown area. As the reservoir is drawn down 80 feet lower than under existing low pool elevations, large stretches of shoreline would be exposed for the first time since Kachess Dam was constructed in 1912. The drawdown could expose previously inundated cultural resources. If eligible resources exist and are determined in consultation with SHPO to be adversely affected, increased exposure would lead to site degradation over time and would invite increased visitation and potential looting or vandalism. Exposure of these resources would physically impact cultural resources, so the impact would be significant.

Bull Trout Enhancement
The Cold Creek passage improvements would permanently change a portion of the John Wayne Pioneer Trail in Iron Horse State Park, a historical railroad grade. Reclamation and Ecology would excavate a portion of the existing trail at Cold Creek and build a new steel or concrete bridge, which would change the historic character of the trail in this location. Additional analysis of potential impacts would be developed as the design of Cold Creek passage improvements progresses.

4.18.5 Alternative 2B – KDRPP South Pumping Plant

4.18.5.1 Construction

KDRPP South Pumping Plant Facilities
Construction impacts would be similar to but greater than those described for *Alternative 2A-KDRPP East Shore Pumping Plant*. Under this alternative, the pumping plant, surge tank, power supply substation, intake, intake tunnel, and access road would be constructed in the area of site 45KT1014, which is considered eligible for listing on the NRHP. Clearing, grubbing, excavation, and installation could permanently disturb, damage, or alter historic features and artifacts associated with the site. It is possible that subsequent surveys would identify additional cultural resources that could be impacted by construction of the south pumping plant. Section 4.18.9 describes the process to resolve adverse effects on cultural resources. If damage or alteration of historic features or artifacts cannot be avoided, the impact would be significant.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.18.4.1).

4.18.5.2 Operation

KDRPP South Pumping Plant Facilities
Operation impacts would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.18.4.2). Reclamation would operate the reservoir the same regardless of the location of the pumping plant.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.18.4.2).

4.18.6 Alternative 3A – KKC North Tunnel Alignment

4.18.6.1 Construction

KKC North Tunnel Alignment Facilities
Construction of the Yakima River diversion and intake, the mechanical building, conveyance, and the Keechelus portal in the vicinity of Keechelus Dam would occur in the vicinity of NRHP-eligible site WF303 (an extensive multicomponent site with numerous features and artifacts, some of which are associated with construction of Keechelus Dam). Clearing, grubbing, excavation, and installation could permanently disturb, damage, or alter historic features and artifacts associated with the site. It is possible that subsequent surveys would identify additional cultural resources that could be impacted by construction near Keechelus Dam and the Kachess Lake Road portal and discharge structure. Section 4.18.9 describes the process to resolve adverse effects on cultural resources. If damage or alteration of historic features or artifacts cannot be avoided, the impact would be significant.

Tunneling would occur below depths likely to include historic resources, so no impacts to cultural resources are anticipated from tunneling.

Construction would not take place on Keechelus Dam itself, which is considered eligible for inclusion on the NRHP. Therefore, the historic property of the dam would not be disturbed by construction activities and significant impacts would not occur.

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.18.4.1).

4.18.6.2 Operation

KKC North Tunnel Alignment Facilities
Operation impacts would result from the additional drawdown at Keechelus Reservoir. The preliminary survey (YCIP, 2014; Central Washington University, 2014) identified one known site around the immediate shoreline or drawdown area of the reservoir. It is possible that future cultural resource surveys would identify additional cultural resources in the drawdown area. As the reservoir is drawn down 15 feet lower than under existing low pool elevations, portions of shoreline would be exposed for the first time since Keechelus Dam was constructed. The drawdown could expose previously inundated cultural resources. If eligible resources exist and are determined, in consultation with the SHPO, to be adversely affected, increased exposure would lead to site degradation over time and would invite increased visitation and potential looting or vandalism. Exposure of these resources would physically impact cultural resources, so the impact would be significant.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.18.4.2).

4.18.7 Alternative 3B – KKC South Tunnel Alignment

4.18.7.1 Construction

KKC South Tunnel Alignment Facilities

Construction impacts would be the same as those described for *Alternative 3A – KKC North Tunnel Alignment* (Section 4.18.6.1). The additional portal at I-90 Exit 62 would add a site where cultural resources could be disturbed by construction activities and excavation.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.18.4.1).

4.18.7.2 Operation

KKC South Tunnel Alignment Facilities

Operation impacts would be the same as those described for *Alternative 3A – KKC North Tunnel Alignment* (Section 4.18.4.2). Reclamation would operate KKC the same regardless of the tunnel alignment.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.18.4.2).

4.18.8 Alternative 4 – Combined KDRPP and KKC

4.18.8.1 Construction

KDRPP and KKC Facilities

Construction impacts associated with *Alternative 4* would be the same as those described for *Alternative 2A – KDRPP East Shore Alignment* and *Alternative 3A – KKC North Tunnel Alignment*. No additional disturbance would occur if KDRPP and KKC were constructed together.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.18.4.1).

4.18.8.2 Operation

KDRPP and KKC Facilities

Operation impacts associated with the KDRPP and KKC combined would be the same as those described for *Alternative 2A – KDRPP East Shore Alignment* and *Alternative 3A – KKC North Tunnel Alignment*. The combined KDRPP and KKC would not increase the potential for reservoir operations to expose cultural sites.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.18.4.2).

4.18.9 Mitigation Measures

Reclamation would complete additional field surveys and studies to identify cultural and historic resources as project designs are refined. Prior to construction, Reclamation would complete all necessary consultation with the SHPO, the USFS, Washington State Parks, and involved Tribes. It is Reclamation's policy to prevent impacts to historic resources whenever possible. In the event that avoidance is not possible, Reclamation would develop protective or mitigative measures.

For those cultural resources immediately and unavoidably affected by the Proposed Action, Reclamation would develop and implement a treatment plan. If historic facilities are likely to be modified, the treatment plan may involve examining ways to reduce impacts through design modifications and historic documentation performed to Washington State Department of Archaeology and Historic Preservation standards. In the case of archaeological resources, treatment would involve additional site documentation and mapping to better determine the nature and extent of the affected resource, followed by site stabilization, archaeological data recovery, or both, as determined necessary. Alternative mitigation, such as public education, may be implemented to resolve possible adverse effects. Any Proposed Actions to resolve adverse effects would be preceded by consultation with SHPO, the USFS, involved Indian Tribes, and the Federal Advisory Council on Historic Preservation, as necessary.

For those cultural resources affected by the long-term management or cumulative effects of the Proposed Action, Reclamation would prepare and implement a Cultural Resources Management Plan (CRMP) to address ongoing and future operational and land management implications. Reclamation would develop a Memorandum of Agreement (MOA) with the SHPO and involved affected Tribes to guide all parties in the development of the CRMP. Such an agreement would not only create a defined schedule for completion of the CRMP, but also document Reclamation's satisfaction of the requirements of the Section 106 compliance process.

To be integrated with similar efforts at Cle Elum Reservoir for the Cle Elum Pool Raise Project, the CRMP would address the long-term and cumulative effects on the full range of cultural resources, including archaeological sites, historic structures and objects, and traditional cultural properties (TCPs). Through this regulatory effort, Reclamation would define appropriate impact avoidance and mitigation, and long-term management objectives.

As the Yakama Nation Cultural Resources Program (YCIP) indicates in its preliminary survey of cultural resources (YCIP, 2014) (see Section 3.18), the natural Kachess and Keechelus lakes have spiritual and ceremonial associations to the Yakama Nation. The

Colville Confederated Tribes have similarly indicated that the project area (or portions thereof) lies within their traditional territory. The YCIP (2014) suggests that the reservoirs and associated precontact archaeological resources may qualify as TCPs. The Proposed Action has no immediate effect on nonarchaeological TCPs. Any effects on TCP values would be cumulative in nature and would be addressed in a CRMP.

As a component of the CRMP, Reclamation would provide for a study to identify and evaluate TCP values of the reservoirs and environs; examine associations of precontact habitation and resource procurement sites; and explore the linkage of the occupation with ethnographic villages, camps, and trails. In all cases, cultural resource management actions would be implemented using methods consistent with the Secretary of the Interior’s standards and guidelines.

4.19 Indian Sacred Sites

4.19.1 Methods and Impact Indicators

Impact indicators for Indian sacred sites are the potential for disturbing or limiting access to such sites.

4.19.2 Summary of Impacts

Reclamation does not anticipate impacts from any of the alternatives.

4.19.3 Alternative 1 – No Action Alternative

Reclamation anticipates no impacts to Indian sacred sites under the *Alternative 1 - No Action*.

4.19.4 Alternatives 2A and 2B – KDRPP

To date, Reclamation has identified no Indian sacred sites in the primary study area for KDRPP facilities and the BTE actions. However, consultation with affected Tribes is ongoing and may result in future identification. If this occurs, Reclamation would further evaluate impacts on these resources.

4.19.5 Alternatives 3A and 3B – KKC

Reclamation has not identified Indian sacred sites in the primary study area for KKC facilities and the BTE actions. However, if sites are identified in the future, Reclamation would evaluate impacts on these resources.

4.19.6 Alternative 4 – Combined KDRPP and KKC

Impacts would be the same as for KDRPP (Section 4.19.4) and KKC (Section 4.19.5).

4.19.7 Mitigation Measures

Reclamation's policy is to avoid impacts on Indian sacred sites whenever possible. Additional efforts to identify sacred sites would occur as a part of the cultural resources survey described in Section 4.18. Consultation with the Yakama Nation and the Umatilla and Colville Tribes would identify how to protect sacred sites if they were identified and provide continued access if any such sites were affected by construction.

4.20 Indian Trust Assets

4.20.1 Methods and Impact Indicators

Impact indicators for ITAs are the potential for affecting ITAs. To identify ITAs in the project area, Reclamation consulted with the Yakama Nation, the Colville Tribes, and BIA who identified no ITAs.

4.20.2 Alternative 1 – No Action Alternative

Reclamation anticipates no impacts on ITAs because none have been identified in the project area at this time.

4.20.3 Alternatives 2A and 2B – KDRPP

Because consultation has not identified ITAs in the primary study area for KDRPP facilities or the BTE actions, Reclamation anticipates no impacts to ITAs under any of the action alternatives.

4.20.4 Alternatives 3A and 3B – KKC

Impacts would be the same as for KDRPP (Section 4.20.3).

4.20.5 Alternative 4 – Combined KDRPP and KKC

Impacts would be the same as for KDRPP (Section 4.20.3).

4.20.6 Mitigation Measures

If Reclamation identifies ITAs during future consultation, Reclamation would comply with its Indian Trust Assets Policy (July 2, 1993) that impacts on ITAs will be avoided whenever possible.

4.21 Socioeconomics

4.21.1 Methods and Impact Indicators

Methods. For this analysis, Reclamation focused on several categories of socioeconomic effects that the people and communities in the primary study area may experience. The primary study area includes the four counties within the Yakima River Watershed (Kittitas, Benton, Yakima, and Franklin). For the analysis of temporary lodging, Reclamation used a narrower study area, more appropriate to the scale of the effect. Each study area is described in more detail below. Reclamation evaluated potential effects to property values because numerous factors combine to affect property values, and it is difficult to quantify the potential impact. As such, potential impacts on property values are discussed generally, and an impact indicator was not established.

Reclamation assessed changes in output, employment, and personal income using two models. The first model of irrigated agriculture in the Yakima basin accounts for cost, water requirements, and revenue differences among crops. This agriculture model allowed identification of the agricultural activity that could occur with increased water supply reliability relative to the baseline. Using outputs of the agriculture model, Reclamation analyzed economic impacts of agricultural activity attributable to the Proposed Action and costs associated with the Proposed Action. The analysis is based on IMPLAN (Impact Analysis for PLANning) software, which was used to understand the regional distribution and extent of direct, indirect, and induced impacts associated with these expenditures (IMPLAN, 2014). IMPLAN is an input-output (IO) model that works by tracing how spending associated with a specific project circulates through the defined impact area. The analysis describes economic impacts in the four-county study area (Kittitas, Benton, Yakima, and Franklin counties), and across the rest of the State of Washington, using data for 2012, which are the most current available. See the technical economic reports on KKC and KDRPP for more detail on the methods used to conduct the IMPLAN analysis (Reclamation and Ecology, 2014c; 2014d).

Reclamation evaluated potential impacts on temporary housing by surveying the temporary lodging supply in the four-county study area (with a focus on the communities of Cle Elum, Ellensburg, and Yakima) using Census data and business listings on Google maps (U.S. Census, 2012; Google Maps, 2014). Follow-up telephone calls to campground and RV facilities were conducted to determine seasonal availability and use patterns. The available supply is compared to the additional demand for temporary lodging that the Proposed Action would generate from workers.

Reclamation considered the effects of disrupted access during construction and lowered reservoir water levels on private property in the vicinity, in response to comments raised during scoping for the EIS. To assess the potential impact of the Proposed Action on property values, Reclamation focused on parcels that are all or partly within 0.1 mile surrounding Kachess Reservoir. Reclamation used hydrologic modeling results to describe changes in pool levels for each alternative, and relied on studies from other locations that describe the impact of decreases in surface water levels on property values.

Impact Indicators. Impact indicators and criteria for determining impact significance for socioeconomics are summarized in Table 4-79. All criteria are assessed relative to *Alternative 1 – No Action*. The indicators align with categories of benefits, costs and market impacts identified and analyzed. At the local scale, any increase in income or employment can be significant, as can any negative effect on recreation opportunities or property values. Based on review of other Reclamation evaluations and consideration of the absolute size of the industrial sectors, a threshold of 1 percent of the overall economic or private activity associated with key areas of impact was established. A 1 percent threshold results in a large absolute number of jobs and total value of income and output, but a threshold below 1 percent is uncommon. Reclamation evaluates impacts at these thresholds at the sector (e.g. agriculture) level.

Table 4-79. Impact Indicators and Significance Criteria for Socioeconomics

Impact Indicator	Significance Criteria
Changes in output (the value of production)	Increase or decrease in sector output by 1 percent of overall economic activity
Changes in personal income	Increase or decrease in sector personal income by 1 percent of regional activity
Changes in employment	Increase or decrease in jobs in sector by 1 percent of regional activity
Changes in demand or supply of temporary lodging	Displacement of customary visitors by workers or construction related disruption that consistently exceeds regional capacity

All impacts and indicators are evaluated on an annual basis. Some impacts would occur over a short period such as construction, while others involving operation and maintenance would occur more regularly over the life of the Proposed Action. Reclamation analyzes all impacts on an annual basis, and does not sum market (industry) impacts over multiple years for evaluation.

Impact indicators and criteria for determining impact significance for socioeconomics are summarized in Table 4-75. Reclamation assessed all criteria relative to the *Alternative 1- No Action.*

Impact indicators include the following types of economic impacts:

- ***Direct Impacts***. These impacts describe changes in economic activity directly tied to spending associated with the Proposed Action (e.g., wages paid to local construction workers).
- ***Indirect Impacts***. These impacts occur as businesses buy from other businesses, often referred to as "supply-chain" impacts. The impacts begin with changes in economic activity for businesses that supply directly affected businesses (e.g., the welding supply business that supplies or rents equipment to construction contractors). They continue as these businesses, in turn, purchase goods and services necessary to operate.
- ***Induced Impacts***. These impacts describe changes in economic activity attributable to changes in household income generated by direct and indirect impacts of the Proposed Action (e.g., spending by local construction workers on consumer goods and services).

Three variables that measure economic activity (output, personal income, and jobs) describe each type of economic impact. Increases in these measures are positive impacts, while decreases in these measures correspond to negative impacts.

4.21.2 Summary of Impacts

There would be no direct impacts associated with *Alternative 1 – No Action* although existing trends in the region would result in some changes to the regional economy relative to current conditions. For the action alternatives, socioeconomic impacts are generally positive, resulting in a gain in regional economic activity. Construction, including construction of BTE actions implemented as part of all action alternatives, would increase output in the short term.

Table 4-80 summarizes impacts for each impact indicator.

Table 4-80. Summary of Impacts for Socioeconomics

Impact Indicator	Summary of Impacts
Changes in output (the value of production)	With *Alternatives 2A, 2B,* and *4* as a result of improved water supply, agricultural output during drought years would be significantly higher relative to *Alternative 1*.
Changes in personal income	For all action alternatives, impacts on income from construction and operation would be generally positive, but not significant.
Changes in employment	For all action alternatives, impacts on employment from construction and operation would be generally positive, but not significant.
Changes in demand or supply of temporary lodging	For all action alternatives, construction workers may displace customary recreational visitors during summer season but would offset lost recreation related business. Operational impacts would not be significant.

4.21.3 Alternative 1 – No Action Alternative

No additional project-related employment would occur in the primary study area. Prevailing factors that influence employment in the area would continue. In the future, current sources of demand and patterns of use associated with visitors to the area would continue. Some additional demands for temporary accommodations would be associated with project workers for the WSDOT I-90 Phase 2A project (WSDOT, 2008). WSDOT anticipates the entire I-90 project would involve 4,800 workers in construction-related activities over a 10-year period.

The current economic factors and trends that influence the value of private property at the reservoirs, including demand for recreational properties and other economic and environmental conditions, would continue to influence property values.

With *Alternative 1 – No Action,* the amount of water available for proratable irrigators during drought years would continue to be dependent on the current water supply system, crop demands, climate change and other factors and trends that influence water availability in the basin. Agriculture is responsible for roughly 11 percent of the regional economy, and severe drought conditions can reduce the sector’s output by 10 percent or more. For comparison, construction is responsible for 5 percent of regional economic output, while manufacturing contributes 18 percent of regional economic output (See Section 3.21).

Crops that rely upon multi-year growth such as tree crops and perennials can suffer for multiple years following a drought. This could affect long-term regional trends in personal income and employment if agricultural output is reduced. If prorationed water supplies are reduced substantially over a number of years, the impact on the regional economic growth could be greater than 1 percent of the agricultural sector output, which would be considered significant.

4.21.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.21.4.1 Income and Employment

Construction

KDRPP East Shore Pumping Plant Facilities

Construction of *Alternative 2A – KDRPP East Shore Pumping Plant* would require approximately 100 workers during the peak construction period, lasting approximately 3 years. At any given time, approximately 50 percent of the workers would require specialized skills in management and supervision and tunnel boring and installation. These workers would likely come from outside the area. The remaining 50 percent of workers would be laborers and truck drivers that would likely be hired by the contractor from the communities within the primary study area. Total construction labor expenditures would be $122 million (Table 4-81) with direct regional job-years of 1,700 and total regional job-years of 2,560 (

Table 4-82). The average annual impact during construction on output, personal income, and employment these estimates represent are well below a 1 percent threshold for the impact indicators at the four-county regional level.

Table 4-81. *Alternative 2A – KDRPP East Shore Pumping Plant* Construction Expenditures

Expenditure Category	Total Expenditures (millions)
Labor	$121.86
Contractor Overhead & Capital Costs	$185.96
Noncontract Costs	$92.35
Total	**$400.17**

Table 4-82. *Alternative 2A – KDRPP East Shore Pumping Plant* Construction Impacts, by Type[1]

Region /Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$274.1	$30.6	$71.6	$376.4	1.37
Personal Income	$109.5	$9.5	$20.8	$139.8	1.28
Job Years	1,700	250	610	2,560	1.51
Rest of Washington					
Output	$121.4	$50.4	$82.7	$254.5	2.10
Personal Income	$39.2	$14.2	$24.6	$78.1	1.99
Job Years	820	280	600	1,700	2.07
Total Washington State					
Output	$395.6	$81.0	$154.3	$630.9	1.59
Personal Income	$148.7	$23.7	$45.5	$217.9	1.47
Job Years	2,520	530	1,210	4,260	1.69

[1] Shown in millions of dollars

Bull Trout Enhancement

Construction associated with the BTE actions at Gold Creek and Cold Creek is estimated to involve approximately $7 million in labor expenditures, and 120 total job-years in impacts within the four-county region (Table 4-83 and Table 4-84). These estimates may change as the design of these actions progresses.

Table 4-83. BTE Construction Impacts Construction Expenditures

Expenditure Category	Total Expenditures (millions)
Labor	$6.91
Contractor Overhead & Capital Costs	$10.54
Noncontract Costs	$2.30
Total	**$19.75**

Table 4-84. BTE Construction Impacts, by Type[1]

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$13.4	$1.3	$3.2	$17.9	1.34
Personal income	$5.1	$0.4	$0.9	$6.4	1.27
Job Years	80	10	30	120	1.50
Rest of Washington					
Output	$6.3	$2.5	$4.3	$13.2	2.09
Personal income	$2.0	$0.7	$1.3	$4.0	2.00
Job Years	40	10	30	80	2.00
Total Washington State					
Output	$19.6	$3.9	$7.6	$31.1	1.58
Personal income	$7.1	$1.1	$2.2	$10.4	1.48
Job Years	120	20	60	200	1.67

[1] Reported in millions of dollars

Operation

The long-term operation and maintenance of *Alternative 2A – KDRPP East Shore Pumping Plant* would require labor in addition to the ongoing management of the existing facilities. Typical annual labor expenditures would total $212,000 (Table 4-85), with 10 direct jobs and 25 total jobs annually (Table 4-86). The average annual impact during operation on output, personal income, and employment these estimates represent are well below a 1 percent threshold for the impact indicators at the four-county regional level.

Table 4-85. *Alternative 2A – KDRPP East Shore Pumping Plant* Operating Expenditures

Expenditure Category	Total Expenditures of Average Year
Labor	$212,400
Materials and equipment	$1,785,000
Total	**$1,997,400**

Table 4-86. *Alternative 2A – KDRPP East Shore Pumping Plant* Operating Impacts, by Type

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$1,670,150	$1,084,100	$782,760	$3,537,020	2.12
Personal income	$672,720	$534,660	$227,900	$1,435,290	2.13
Job years	10.4	8.1	6.7	25.2	2.42
Rest of Washington					
Output	$0	$436,590	$186,590	$623,180	-
Personal income	$0	$134,090	$51,690	$185,780	-
Job years	0.0	2.5	1.3	3.8	-
Total Washington State					
Output	$1,670,150	$1,520,690	$969,350	$4,160,200	2.49
Personal income	$672,720	$668,760	$279,590	$1,621,070	2.41
Job years	10.4	10.6	8.0	29.0	2.78

4.21.4.2 Temporary Lodging Supply and Demand

Construction

At the peak of construction, *Alternative 2A – KDRPP East Shore Pumping Plant* would increase demand for temporary lodging requirements in the primary study area. Approximately 50 workers would need temporary lodging for some period of time during the 3-year construction period. If each of these workers sought rental housing in Cle Elum, they would exceed the available supply of rental housing in the community. If this occurs, some workers would have to rent housing elsewhere in Kittitas County, where over 700 units of rental housing were available in 2012, or choose other temporary lodging options.

It is unlikely that all 50 workers would seek rental housing; many would work for shorter periods of time and likely stay in hotels, motels, RV parks, and campgrounds near the construction site. There are 10 hotels or motels in Cle Elum, and 29 RV parks and campgrounds. During the summer season when vacancy rates are low in hotels, motels and camping facilities, workers would either displace customary users or need to seek lodging further from the construction site, such as Ellensburg or Yakima. If workers occupied some of the rooms and campsites nearest to the construction site and displaced recreation visitors during the summer season, this alternative would adversely impact recreation visitors. To the extent that project-related construction activities temporarily reduce the area’s supply of recreational opportunities and cause recreation users to go elsewhere, construction workers would partially offset the lost business to establishments that traditionally serve recreation customers. The infusion of project-related demand for temporary lodging is expected to be well below the available capacity of rental housing, hotels and motels in the area, with vacancy rates that range from 25 percent in the summer to as high as 85 percent the remainder of the year. Because the temporary housing demand is not expected to exceed capacity, *Alternative 2A* would not significantly impact temporary lodging conditions. During the time of the year when vacancy rates are high for hotels, motels and the year-round camping facilities, workers would likely rent rooms and sites that otherwise would be vacant. This would have a positive induced impact on the businesses since workers would pay for temporary lodging services that might otherwise remain vacant.

Operation

Operation of *Alternative 2A – KDRPP East Shore Pumping Plant* would require minimal additional workforce and would not significantly affect the population in the study area or change the demand for temporary lodging or permanent housing. This alternative also would not affect the supply of available temporary lodging or permanent housing in the long term. Thus, operating *Alternative 2A – KDRPP East Shore Pumping Plant* would have no impact on temporary lodging or housing in the long term.

4.21.4.3 Property Values

It is difficult to establish specific impact indicators for impacts on property values, because a number of factors contribute to these values. The potential for property values to be affected by the changes in reservoir elevation was raised during EIS scoping, so this discussion is included here, in general terms. Property value effects are not only borne by property owners, but also local jurisdictions as property tax revenue could eventually change as well. While effects on property value would be most directly borne by property owners, the wider community could experience effects as well.

Construction

While construction is likely to disrupt some access and use of property, the disruption would be minimized to the extent possible, and temporary. No impacts on property values are likely from construction.

Operation

Alternative 2A – KDRPP East Shore Pumping Plant would increase the frequency, magnitude, and duration of lower pool elevations relative to baseline conditions. These lower pool elevations would modify the shoreline, increase the distance between recreational facilities and the water, and create less desirable views than current reservoir operations. Reclamation currently manages the reservoir such that the reservoir level fluctuations throughout the year; however, the proposed fluctuations would be greater than occur under current operations. Comments received during scoping for this EIS indicate that residents of areas near Kachess Reservoir are concerned about potential impacts on property values. Property values are affected by numerous factors, many of which are based on the potential buyer’s preferences, and it is difficult to project potential changes with accuracy. Reclamation has managed Kachess Reservoir for water supply for nearly a hundred years and water levels have fluctuated to meet irrigation demands during that period. Residential development along the lake shoreline has been subject to fluctuating water levels since development has occurred.

Hydrologic modeling results suggest that the *Alternative 2A* pool elevation in Kachess Reservoir would be lower than under *Alternative 1-No Action* during approximately half of the modeled years for an average duration of 314 days. This represents conditions that have not occurred at Kachess Reservoir before, and may be of concern to property owners. Refer to Section 4.3 for additional discussion of modeling results and predicted reservoir levels. Kachess Reservoir levels would be lower than *Alternative 1* levels both during drought years and in the years following droughts when the reservoir is refilling to its normal operating levels. During multi-year drought conditions, the reservoir level would be drawn down to as much as 80 feet below the existing minimum pool level, and could take 2 to 5 years to recover. Less severe drought years would result in levels between 40 and 50 feet lower.

The exact decrease in pool levels that could trigger changes in property values for the private parcels surrounding Kachess Reservoir is uncertain. Fluctuations within the current low-water threshold are unlikely to have an effect, but transactions that occur in years during and following when pool levels drop below historical lows could result in lower prices or slower sales. Studies of the changes in property values at other reservoirs subsequent to changes in pool levels suggest lake levels do influence property values (Lansford and Jones, 1995; Hanson and Hatch, 1998; Hanson et al., 2002), and sustained or significant decreases in water levels have negative effects. In addition to views, numerous factors affect property values, such as the size and condition of structures on the site, improvements, amenities, size of the property, the condition of the economy and housing market, and other considerations. Ultimately, the value of a property is determined by the purchaser in terms of the price he or she is willing to pay.

The reservoir has been, and would continue to experience fluctuations in water levels that are managed to address Reclamation’s needs for water supply. Property values may fall during periods when water levels fall below the current low-water threshold, but the frequency and duration of these drops cannot be predicted. The drops are unlikely to be sustained over time, and would likely fall within the normal range of fluctuations in value resulting from other market factors

Groundwater fluctuations that adversely affect domestic wells may also impact property values. Reservoir drawdowns that persist over several years could affect about 46 wells that are drilled in shallow sedimentary aquifers. Reclamation would monitor well levels and develop appropriate mitigation if monitoring shows that well levels are impacted.

4.21.4.4 Irrigation Impacts

Alternative 2A – KDRPP East Shore Pumping Plant would increase the water supply for proratable irrigation districts during drought years up to 23 percent. Although the increased water supply does not fully meet the 70 percent goal, it represents a significant increase in water supply compared to *Alternative 1 – No Action*. With the improved water supply, *Alternative 2A – KDRPP East Shore Pumping Plant* would increase agricultural output during drought years, relative to *Alternative 1 – No Action*. To model the economic impacts of changes in agricultural output during severe drought years, the analysis includes estimates of the alternative's effect on gross farm earnings, distribution across the appropriate types of crops, and allocation to the corresponding agricultural industry sectors in the IMPLAN model. Note that the model does not incorporate any conservation or water trading activity beyond what is already occurring in the basin.

Table 4-87 summarizes the economic impacts associated with the change in agricultural production attributed to the additional water provided by this alternative. Since the entirety of the change in agricultural production occurs within the four-county study area, by definition, all direct economic impacts would also occur within this area. Direct output represents the difference between gross farm earnings during an average drought year with this alternative and gross farm earnings without it. Modeling of agriculture production accounted for allocation of water supply among proratable users during droughts, accounting for differences in marginal effects dependent upon drought severity. Model runs accounted for the range of drought frequency and severity, and developed a composite, weighted set of drought impacts for input to IMPLAN. See the technical economic reports for more detail (Reclamation and Ecology, 2014c and 2014d). Changes in direct output for each affected industry sector were input into IMPLAN, and the model provided estimates of the associated changes in direct personal income and jobs.

The drought conditions and resulting amounts of water supply available differ depending on the assumption of historical climate conditions (observed over the last century), or estimated adverse climate change conditions, as described in Section 4.3. The following analysis of alternative impacts is provided for both sets of conditions.

Table 4-87. Summary of Economic Impacts, by Type, from Agricultural Production Associated with *Alternative 2A*[1]

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$99,139,604	$35,089,664	$37,365,977	$171,595,246	1.73
Personal income	$16,886,013	$16,686,677	$10,463,142	$44,035,832	2.61
Jobs	497	490	305	1,293	2.61
Rest of Washington					
Output	$0	$7,530,230	$4,252,054	$11,782,284	-
Personal income	$0	$1,303,769	$1,044,547	$2,348,316	-
Jobs	0	34	25	59	-
Total Washington State					
Output	$99,139,604	$42,619,894	$41,618,031	$183,377,530	1.85
Personal income	$16,886,013	$17,990,446	$11,507,689	$46,384,148	2.75
Jobs	497	524	331	1,351	2.73

[1] Model assumes historical climate conditions as opposed to adverse climate change
Note: Calculated using the spreadsheet model of direct irrigation benefits and 2012 IMPLAN base data. Based upon measurement relative to baseline conditions, and the net present value of 100 years of operation.

To calculate the indirect and induced impacts of this change in agricultural production, the direct impacts were run through IMPLAN. The impacts in the table do not include downstream impacts tied to agricultural production, such as food processing, transportation, and restaurant sales. In total, the *Alternative 2A – KDRPP East Shore Pumping Plant* impact on agricultural production during an average (weighted) drought year would generate about $172 million in output within the four-county study area. Of that output, about $44 million would go toward personal income that supports 1,293 job-years. Any given year under historical conditions would have a 16.7 percent probability of experiencing a drought.

Table 4-88 shows how these impacts (direct, indirect, and induced) in the four-county study area during drought years would be distributed across different industry sectors. Most of the increase in agriculture production would stay in the agricultural sector, and roughly 65 percent of the total change in output, 66 percent of the increase in personal income, and 69 percent of jobs created would be concentrated in this sector. The transportation, information and utilities sector would be the second most impacted by the increase in agricultural production, and roughly 20 percent of the total increase in output, personal incomes and jobs is observed in this sector.

Table 4-88. Distribution of Economic Impacts Associated with *Alternative 2A*, by Industry Sector, 4-County Study Area[1]

Aggregate Industry Sector	Output	Personal Income	Jobs	Average Wage	Output/Job
Agriculture	$110,944,303	$28,983,472	893	$32,634	$124,036
Utilities	$1,426,945	$485,823	10	$48,803	$143,292
Construction	$3,063,769	$1,232,950	21	$58,873	$145,968
Manufacturing	$8,277,910	$625,753	10	$60,079	$783,441
Transportation, information, utilities	$34,173,803	$8,810,623	251	$35,028	$135,585
Trade	$8,910,489	$2,940,377	84	$34,773	$105,308
Service	$2,406,137	$788,991	21	$37,487	$113,945
Government	$2,391,891	$167,843	2	$74,101	$1,056,168
Total	**$171,595,246**	**$44,035,832**	**1,293**	**$34,061**	**$132,727**

[1] Model assumes historical climate conditions as opposed to adverse climate change

Note: Calculated using the spreadsheet model of direct irrigation benefits and 2012 IMPLAN base data.

Under the assumption of adverse climate change impacts, *Alternative 2A – KDRPP East Shore Pumping Plant* would increase the amount of water available to proratable irrigators during drought years, which are expected to be more frequent and severe. The average drought year impacts would be less than without climate change, but drought years would be more frequent (Table 4-89 and Table 4-90). Any given year under the modeled adverse climate change conditions would have a 49 percent probability of experiencing a drought.

Table 4-89. Summary of Economic Impacts, by Type, from Agricultural Production Associated with *Alternative 2A*[1]

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$93,676,790	$33,130,960	$35,391,382	$162,199,132	1.73
Personal income	$15,964,642	$15,786,344	$9,910,213	$41,661,199	2.61
Jobs	470	464	289	1,223	2.61
Rest of Washington					
Output	$0	$7,081,187	$4,021,204	$11,102,390	-
Personal income	$0	$1,228,743	$987,540	$2,216,283	-
Jobs	0	32	24	55	-
Total Washington State					
Output	$93,676,790	$40,212,147	$39,412,585	$173,301,523	1.85
Personal income	$15,964,642	$17,015,087	$10,897,753	$43,877,481	2.75
Jobs	470	495	313	1,278	2.73

[1] Modeled with adverse climate change conditions

Note: Calculated using the spreadsheet model of direct irrigation benefits and 2012 IMPLAN base data.

Table 4-90. Distribution of Economic Impacts Associated with Increased Agricultural Production, by Industry Sector, 4-County Study Area[1]

Aggregate Industry Sector	Output	Personal Income	Jobs	Average Wage	Output/Job
Agriculture	$104,849,930	$27,420,024	844	$32,641	$124,032
Utilities	$1,351,884	$460,288	9	$48,804	$143,290
Construction	$2,893,445	$1,164,829	20	$58,864	$145,934
Manufacturing	$7,815,157	$592,176	10	$60,070	$783,000
Transportation, information, utilities	$32,327,013	$8,337,444	238	$35,028	$135,576
Trade	$8,431,512	$2,782,643	80	$34,772	$105,302
Service	$2,271,578	$745,304	20	$37,483	$113,924
Government	$2,258,613	$158,489	2	$74,104	$1,056,207
Total	**$162,199,132**	**$41,661,199**	**1,223**	**$34,073**	**$132,654**

[1] Modeled with climate change

Note: Calculated using the spreadsheet model of direct irrigation benefits and 2012 IMPLAN base data.

4.21.5 Alternative 2B – KDRPP South Pumping Plant

4.21.5.1 Income and Employment

Construction

KDRPP South Pumping Plant Facilities

Impacts from construction on economic output, income and employment under *Alternative 2B – KDRPP South Pumping Plant* would be similar in nature and timing to *Alternative 2A – KDRPP East Shore Pumping Plant,* but lesser in magnitude. Construction would generate 2,350 total regional job-years under *Alternative 2B* in total across the four-county region (Table 4-91 and Table 4-92). The average annual impact during construction on output, personal income, and employment these estimates represent are well below a 1 percent threshold for the impact indicators at the four-county regional level.

Table 4-91. *Alternative 2B* Construction Expenditures

Expenditure Category	Total Expenditures (millions)
Labor	$107.17
Contractor overhead & capital costs	$163.54
Noncontract costs	$81.21
Total	**$351.92**

Table 4-92. *Alternative 2B* Construction Impacts, by Type[1]

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$236.3	$31.2	$73.1	$340.7	1.44
Personal income	$101.4	$9.7	$21.3	$132.4	1.31
Job years	1,470	250	630	2,350	1.60
Rest of Washington					
Output	$124.0	$51.5	$84.4	$259.8	2.10
Personal income	$40.0	$14.5	$25.2	$79.7	1.99
Job Years	830	290	620	1,740	2.10
Total Washington State					
Output	$360.3	$82.7	$157.5	$600.5	1.67
Personal income	$141.4	$24.2	$46.4	$212.1	1.50
Job years	2,300	540	1,250	4,090	1.78

[1] Shown in millions of dollars

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.21.4.1).

Operation

Long-term impacts on water supply, income and employment of KDRPP operation under *Alternative 2B* would be similar to *Alternative 2A*. Typical annual total job impacts in the four-county region would be approximately 26, 10 of which are direct jobs (Table 4-93 and Table 4-94). This includes $1.4 million in total annual personal income. The average annual impact during operation on output, personal income, and employment these estimates represent are well below a 1 percent threshold for the impact indicators at the four-county regional level.

Table 4-93. *Alternative 2B* Operating Expenditures

Expenditure Category	Total Expenditures of Average Year
Labor	$212,400
Materials and equipment	1,551,000
Total	**$1,763,400**

Table 4-94. *Alternative 2B* Operating Impacts, by Type, Rounded

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$1,484,290	$1,084,100	$712,220	$3,280,610	2.21
Personal income	$611,960	$487,580	$207,370	$1,306,910	2.14
Job years	10.4	8.7	6.9	26.1	2.50
Rest of Washington					
Output	$0	$381,750	$165,240	$547,000	-
Personal income	$0	$134,040	$51,570	$185,610	-
Job years	0.0	2.5	1.3	3.8	-
Total Washington State					
Output	$1,484,290	$1,465,850	$877,470	$3,827,610	2.58
Personal income	$611,960	$621,620	$258,940	$1,492,520	2.44
Job years	10.4	11.2	8.2	29.9	2.87

4.21.5.2 Temporary Lodging Supply and Demand

Impacts on lodging under *Alternative 2B – KDRPP South Pumping Plant* would be similar in nature and timing to *Alternative 2A – KDRPP East Shore Pumping Plant.* See section 4.21.4.2 for discussion.

4.21.5.3 Property Values

Impacts on property values under *Alternative 2B – KDRPP South Pumping Plant* would be similar in nature and timing to *Alternative 2A – KDRPP East Shore Pumping Plant.* See section 4.21.4.3 for discussion.

4.21.5.4 Irrigation Impacts

Effects on irrigation and the resulting economic impacts under *Alternative 2B – KDRPP South Pumping Plant* would be similar in nature and timing to *Alternative 2A – KDRPP East Shore Pumping Plant.* See section 4.21.4.4 for discussion.

4.21.6 Alternative 3A – KKC North Tunnel Alignment

4.21.6.1 Income and Employment

Construction

KKC North Tunnel Alignment Facilities

Construction of *Alternative 3A – KKC North Tunnel Alignment* would require an average of 30 workers over the construction period of approximately 3 years. At the peak of labor demand, there would be a total of 40 workers. At any given time, approximately 50 percent of the workers would require specialized skills in management and supervision and tunnel boring and installation. These workers would likely come from outside the area. The remaining 50 percent of workers would be laborers and truck drivers who would likely be hired by the contractor from the communities within the primary study area.

Total employment in the four-county region would be approximately1,150 job years, 890 of which based upon direct impacts (Table 4-95). The average annual impact during construction on output, personal income, and employment these estimates represent are well below a 1 percent threshold for the impact indicators at the four-county regional level.

Table 4-95. *Alternative 3A* with Option B Construction Impacts, by Type[1]

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$144.1	$16.1	$15.5	$175.7	1.22
Personal income	$57.5	$5.0	$4.5	$67.0	1.16
Job years	890	130	130	1,150	1.29
Rest of Washington					
Output	$63.8	$26.5	$26.6	$117.0	1.83
Personal income	$20.6	$7.5	$8.0	$36.1	1.75
Job years	430	150	200	780	1.81
Total Washington State					
Output	$207.9	$42.6	$42.1	$292.6	1.41
Personal income	$78.2	$12.5	$12.5	$103.1	1.32
Job years	1,320	280	330	1,930	1.46

[1] Shown in millions of dollars

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.21.4.1).

Operation

The long-term operation and maintenance of *Alternative 3A – KKC North Tunnel Alignment* would require minimal labor over the ongoing management of the existing facilities. Average annual direct jobs would be less than two, and in total less than three (Table 4-96). The average annual impact during operation on output, personal income, and employment these estimates represent are well below a 1 percent threshold for the impact indicators at the four-county regional level.

Table 4-96. *Alternative 3A* with Option B Average Annual Operating Impacts, by Type, Rounded

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$198,180	$50,690	$93,920	$342,790	1.73
Personal income	$138,270	$17,920	$27,350	$183,530	1.33
Job years	1.5	0.4	0.8	2.6	1.79
Rest of Washington					
Output	$0	$23,790	$14,060	$37,850	-
Personal income	$0	$7,140	$3,680	$10,820	-
Job years	0.0	0.1	0.1	0.2	-
Total Washington State					
Output	$198,180	$74,480	$107,980	$380,640	1.92
Personal income	$138,270	$25,050	$31,030	$194,350	1.41
Job years	1.5	0.5	0.9	2.9	1.94

4.21.6.2 Temporary Lodging Supply and Demand

Construction

Impacts would be generally the same as those described for *Alternative 2A- KDRPP East Shore Pumping Plant*; however, the specific numbers of workers would be less, reducing the demand on temporary lodging. At the peak of construction, *Alternative 3A – KKC North Tunnel Alignment* would increase demand for temporary lodging requirements in the primary study area. Approximately 20 workers would need temporary lodging at the peak of the approximately 3-year construction period. It is unlikely that this number of workers would displace customary users, though still possible if the maximum number of workers were needed on weekends during peak summer visitation when lodging facilities often have no vacancy. During other times, this impact would not be expected to consistently exceed the available capacity of hotels and motels, which average a 25 percent vacancy rate in the summer, and up to 80 percent during the rest of the year. Because this level of temporary housing demand is not expected to exceed capacity, *Alternative 3A – KKC North Tunnel Alignment* would not significantly impact temporary lodging conditions.

Operation

Because the long-term operation of *Alternative 3A – KKC North Tunnel Alignment* would require minimal workforce increase, it would not affect the population in the primary study area and it would not change the demand for temporary lodging or permanent housing. This alternative also would not affect the supply of available temporary lodging or permanent housing in the long term. Thus, *Alternative 3A – KKC North Tunnel Alignment* would not have an impact on temporary lodging or housing in the long term.

4.21.6.3 Property Values

Construction

Impacts would be similar to those described for *Alternative 2A – KDRPP East Shore Pumping Plant* in Section 4.21.4.3. Some construction-related disruption (noise, dust) may occur to properties along Kachess Lake Road, but because the construction-related disruption would be temporary, impacts on property values are not expected.

Operation

Alternative 3A – KKC North Tunnel Alignment would not change reservoir levels relative to *Alternative 1- No Action* enough to have a potential adverse impact on property values.

4.21.6.4 Irrigation Impacts

Alternative 3A – KKC North Tunnel Alignment would not significantly increase the overall water supply from the baseline for prorationed irrigators, and therefore would not alter irrigation availability or agricultural practices. There could be some minor benefit during drought conditions under adverse climate change assumptions; this minor change would not result in a 1 percent change in output, personal income, or employment.

4.21.7 Alternative 3B – KKC South Tunnel Alignment

4.21.7.1 Income and Employment

Construction

KKC South Tunnel Alignment Facilities

Construction of *Alternative 3B – KKC South Tunnel Alignment* would require an average of 38 workers over the construction period of 3 years and 3 months. At the peak of labor demand, there would be a total of 50 workers. At any given time, approximately 50 percent of the workers would require specialized skills in management and supervision and tunnel boring and installation, and would likely come from outside the area. The remaining 50 percent of workers would be laborers and truck drivers who would likely be hired by the contractor from the communities within the primary study area.

Total employment in the four-county region would be approximately 1,340 job years, 1,040 of which would be based upon direct impacts (Table 4-97). The average annual impact during construction based on output, personal income, and employment these estimates represent are well below a 1 percent threshold for the impact indicators at the four-county regional level.

Table 4-97. *Alternative 3B* Construction Impacts, by Type[1]

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$167.2	$18.7	$18.0	$203.9	1.22
Personal income	$66.8	$5.8	$5.2	$77.8	1.16
Job years	1,040	150	150	1,340	1.29
Rest of Washington					
Output	$74.1	$30.8	$30.9	$135.8	1.83
Personal income	$23.9	$8.7	$9.3	$41.9	1.75
Job years	500	170	230	900	1.80
Total Washington State					
Output	$241.3	$49.4	$48.9	$339.6	1.41
Personal income	$90.7	$14.5	$14.5	$119.7	1.32
Job years	1,540	320	380	2,240	1.45

[1] Shown in millions of dollars

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.21.4.1).

Operation

Like Alternative 3A, *Alternative 3B – KKC South Tunnel Alignment* would have small long-term impacts on income and employment. Average annual direct jobs would be less than two, and in total less than three (Table 4-98). The average annual impact during operation on output, personal income, and employment these estimates represent are well below a 1 percent threshold for the impact indicators at the four-county regional level.

Table 4-98. *Alternative 3B* Average Annual Operating Impacts, by Type,

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$198,180	$56,580	$96,070	$350,820	1.77
Personal income	$138,270	$21,360	$27,970	$187,610	1.36
Job Years	1.5	0.4	0.8	2.7	1.84
Rest of Washington					
Output	$0	$24,090	$14,300	$38,390	-
Personal income	$0	$7,210	$3,740	$10,950	-
Job years	0.0	0.1	0.1	0.2	-
Total Washington State					
Output	$198,180	$80,660	$110,370	$389,220	1.96
Personal income	$138,270	$28,580	$31,710	$198,560	1.44
Job years	1.5	0.5	0.9	2.9	1.99

4.21.7.2 Temporary Lodging Supply and Demand

Construction
Impacts would be generally the same as those described for *Alternative 2A- KDRPP East Shore Pumping Plant*; however, the specific numbers of workers would be less, reducing the demand on temporary lodging. At the peak of construction, *Alternative 3B – KKC South Tunnel Alignment* would increase demand for temporary lodging requirements in the primary study area. Approximately 25 workers would need temporary lodging at the peak of the approximately 3-year construction period. It is unlikely that this number of workers would displace customary users, though still possible if the maximum number of workers were needed during peak summer visitation on weekends when lodging facilities often have no vacancy. During other times, this impact would not be expected to consistently exceed the available capacity of hotels and motels, which average a 25 percent vacancy rate in the summer, and up to 80 percent during the rest of the year.

Operation
Like Alternative 3A, *Alternative 3B – KKC South Tunnel Alignment* would have no impact on temporary lodging or housing in the long term.

4.21.7.3 Property Values

Construction
Impacts would be the same as those described for *Alternative 3A – KKC North Tunnel Alignment*.

Operation
Impacts would be the same as those described for *Alternative 3A – KKC North Tunnel Alignment*.

4.21.7.4 Irrigation Impacts

The expected irrigation impacts from *Alternative 3B – KKC South Tunnel Alignment* would not substantially differ from the *Alternative 1 – No Action*. There could be some minor benefit during drought conditions under adverse climate change assumptions; this minor change would not result in a 1 percent change in output, personal income, or employment.

4.21.8 Alternative 4 – Combined KDRPP and KKC

4.21.8.1 Income and Employment

Construction
KDRPP and KKC Facilities
Assuming that the peak labor demand for both KDRPP and KKC would occur simultaneously, and *Alternative 3B – KKC South Tunnel Alignment* was selected, *Alternative 4 – Combined KDRPP and KKC* would provide simultaneous employment for 150 workers for some period of time. The average employment would be less than this during the 3-year

construction period. At any given time, approximately 50 percent of the workers would require specialized skills in management and supervision and tunnel boring and installation and would likely come from outside the area. The remaining 50 percent of workers would be laborers and truck drivers who would likely be hired by the contractor from the communities within the primary study area.

Total labor expenditures for construction of *Alternative 4 – Combined KDRPP and KKC* would be $196 million, involving 3,900 total job-years over the 4-year construction period (Table 4-99 and Table 4-100). Divided equally over 4 years, this equates to approximately 0.35 percent of total employment in the four-county region. The average annual impact during construction on output, personal income, and employment these estimates represent are below a 1 percent threshold for the impact indicators at the four-county regional level.

Table 4-99. *Alternative 4* Construction Expenditures

Expenditure Category	Total Expenditures (millions)
Labor	$196.21
Contractor overhead & capital costs	$299.41
Noncontract costs	$148.69
Total	**$644.31**

Table 4-100. *Alternative 4* Construction Impacts, by Type[1]

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$441.34	$49.31	$89.64	$580.29	2.59
Personal income	$176.26	$15.28	$26.05	$217.59	2.44
Job years	2,740	400	760	3,900	2.80
Rest of Washington					
Output	$195.53	$81.21	$113.57	$390.31	3.93
Personal income	$63.12	$22.95	$33.94	$120.01	3.74
Job years	1,320	450	830	2,600	3.87
Total Washington State					
Output	$636.87	$130.42	$203.21	$970.49	3.00
Personal income	$239.39	$38.23	$59.99	$337.60	2.79
Job years	4,060	850	1,590	6,500	3.14

[1] Shown in millions of dollars

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as those described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.21.4.1).

Operation

The average annual operation of *Alternative 4 – Combined KDRPP and KKC* would involve $327,000 in annual labor expenditures, with the addition of 28 total jobs, 12 of which are direct impacts, within the four-county region (Tables 4-101 and 4-102). The average annual impact during operation on output, personal income, and employment these estimates represent are well below a 1 percent threshold for the impact indicators at the four-county regional level.

Table 4-101. *Alternative 4* Operating Expenditures

Expenditure Category	Total Expenditures of Average Year
Labor	$327,600
Materials and equipment	$2,009,000
Total	**$2,336,600**

Table 4-102. *Alternative 4* Operating Impacts, by Type, Rounded

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$1,868,330	$1,140,680	$878,830	$3,887,840	3.89
Personal income	$810,990	$556,020	$255,870	$1,622,900	3.49
Job years	11.9	8.5	7.5	27.9	4.26
Rest of Washington					
Output	$0	$460,680	$200,890	$661,570	-
Personal income	$0	$141,300	$55,430	$196,730	-
Job years	0	2.6	1.4	4.0	-
Total Washington State					
Output	$1,868,330	$1,601,350	$1,079,720	$4,549,420	4.45
Personal income	$810,990	$697,340	$311,300	$1,819,630	3.85
Job years	11.9	11.1	8.9	31.9	4.77

4.21.8.2 Temporary Lodging Supply and Demand

Construction

Impacts would be generally the same as those described for *Alternative 2A- KDRPP East Shore Pumping Plant*; however, the specific numbers of workers would be higher, increasing the demand on temporary lodging. At the peak of construction, *Alternative 4 – Combined KDRPP and KKC* would increase demand for temporary lodging requirements in the primary study area. Approximately 75 workers would need temporary lodging for some period of time during the construction period. If each of these workers sought rental housing options in Cle Elum, they would exceed the available supply of rental housing in the community. If this occurs, some workers would have to rent housing elsewhere in Kittitas County, or choose other temporary lodging options. As noted for *Alternative 2A*, it is expected that the workers would seek a mix of temporary housing options, including hotels, motels, RV parks and other options near the construction site. During the summer season when vacancy rates are low in both hotels/motels and camping facilities, workers would either displace customary users or need to seek lodging further from the construction site, in Ellensburg or Yakima. If workers occupied some of the rooms and campsites nearest to the construction site and displaced customary visitors during the summer season, this alternative would adversely impact customary visitors. To the extent that project-related construction activities temporarily reduce the area's supply of recreational opportunities and cause customary recreation users to go elsewhere, construction workers would partially offset the lost business to establishments that traditionally serve recreation customers.

Operation

Because the long-term operation of this alternative would not require additional workers and would not affect the population in the primary study area, it would not change the demand for temporary lodging or permanent housing. This alternative also would not affect the supply of available temporary lodging or permanent housing in the long term. Thus, *Alternative 4 – Combined KDRPP and KKC* would have no impact on temporary lodging or housing in the long term.

4.21.8.3 Property Values

Construction

Impacts on properties along the Kachess Reservoir shoreline would be the same as those described under *Alternative 2A – KDRPP East Shore Pumping Plant* in Section 4.21.4.3.

Operation

Impacts would be the same as those described under *Alternative 2A – KDRPP East Shore Pumping Plant* in Section 4.21.4.3.

4.21.8.4 Irrigation Impacts

Alternative 4 – Combined KDRPP and KKC would increase water supply to proratable irrigation districts during drought years, improving deliveries up to about 67 percent of their full entitlement during single drought years. *Alternative 4* would increase water supply reliability more than the individual effects of KDRPP or KKC alone.

With more water available during severe drought years, this alternative would increase agricultural production and market value during drought years, relative to *Alternative 1- No Action*. To model the economic impacts of changes in agricultural output during drought years, the analysis includes estimates of the alternative's effect on gross farm earnings, distribution across the appropriate types of crops, and allocation to the corresponding agricultural industry sectors in the IMPLAN model. Note that the model does not incorporate any conservation or water trading activity beyond what is already occurring in the basin. See the discussion of *Alternative 2A – KDRPP East Shore Pumping Plant* for more detail on methods.

Table 4-103 summarizes the economic impacts associated with the change in agricultural production attributed to the additional water provided by this alternative. Since the entirety of the change in agricultural production occurs within the four-county study area, by definition, all direct economic impacts would also occur within this area. Direct output represents the difference between gross farm earnings during a drought year with *Alternative 4 – Combined KDRPP and KKC* and gross farm earnings without it. Changes in direct output for each affected agricultural sector were fed into IMPLAN, and the model estimated the associated changes in direct personal income and jobs.

The drought conditions and resulting amounts of water supply available differ depending on the assumption of historical climate conditions (observed over the last century), or estimated adverse climate change conditions, as described in Section 4.3. The following analyses of impacts are provided for both sets of conditions.

Table 4-103. Summary of Economic Impacts, by Type, from Agricultural Production Associated with *Alternative 4*[1]

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$115,501,726	$40,910,428	$43,430,895	$199,843,048	1.73
Personal income	$19,661,853	$19,418,068	$12,161,437	$51,241,359	2.61
Jobs	580	570	355	1,505	2.61
Rest of Washington					
Output	$0	$8,813,258	$4,949,589	$13,762,847	-
Personal income	$0	$1,522,710	$1,216,257	$2,738,967	-
Jobs	0	39	29	68	-
Total Washington State					
Output	$115,501,726	$49,723,685	$48,380,484	$213,605,895	1.85
Personal income	$19,661,853	$20,940,778	$13,377,695	$53,980,326	2.75
Jobs	580	610	384	1,573	2.73

[1] Model assumes historical climate conditions as opposed to adverse climate change

Note: Calculated using the spreadsheet model of direct irrigation benefits and 2012 IMPLAN base data.

To calculate the indirect and induced impacts of this change in agricultural production, the direct impacts were run through IMPLAN. The impacts in the table do not include downstream impacts tied to agricultural production, such as food processing, transportation, and restaurant sales. Any given year under historical conditions would have approximately a 17 percent probability of experiencing a drought. In total, the alternative's impact on agricultural production during a drought year would generate on average about $200 million in output within the four-county study area. Of that output, about $51 million would go toward personal incomes that support about 1,505 jobs. This represents about 0.5 percent of total employment in the four-county region.

Table 4-104 shows how all of these impacts (direct, indirect, and induced) in the four-county study area during a severe drought year would be distributed across different industry sectors. Most of the increase in agriculture production stays in the agricultural sector, and roughly 65 percent of the total change in output, 66 percent of the increase in personal income, and 69 percent of jobs created are concentrated in this sector. The transportation, information and utilities sector would be the second most impacted by the increase in agricultural production, and roughly 20 percent of the total increase in output, personal incomes and jobs is observed in this sector.

Table 4-104. Distribution of Economic Impacts Associated with *Alternative 4* by Industry Sector, 4-County Study Area[1]

Aggregate Industry Sector	Output	Personal Income	Jobs	Average Wage	Output/Job
Agriculture	$129,232,154	$33,727,114	1,039	$32,630	$124,044
Utilities	$1,658,715	$564,726	12	$48,803	$143,292
Construction	$3,570,276	$1,436,347	24	$58,879	$145,993
Manufacturing	$9,652,474	$727,984	12	$60,090	$783,889
Transportation, information, utilities	$39,769,997	$10,249,787	293	$35,028	$135,593
Trade	$10,366,299	$3,420,398	98	$34,774	$105,315
Service	$2,805,309	$919,369	24	$37,491	$113,969
Government	$2,787,823	$195,634	3	$74,101	$1,056,156
Total	**$199,843,048**	**$51,241,359**	**1,505**	**$34,049**	**$132,794**

[1] Modeled without climate change

Note: Calculated using the spreadsheet model of direct irrigation benefits and 2012 IMPLAN base data.

Under the assumption of adverse climate change impacts, *Alternative 4 – Combined KDRPP and KKC* would increase the amount of water available to proratable irrigators during severe drought years, on average, from 26 percent to 43 percent of their full entitlement. More constrained water availability would lead to decreased agricultural production and diminished economic impacts (Table 4-105 and Table 4-106), relative to the scenarios without climate change impacts. Total output would increase by approximately $208 million and 1,563 jobs during an average drought year. Any given year under adverse climate change conditions would have a 49.4 percent probability of experiencing a drought. This represents about 0.6 percent of total employment in the four-county region, below the 1 percent threshold for the region.

Table 4-105. Summary of Economic Impacts, by Type, from Agricultural Production Associated under *Alternative 4*[1]

Region/Impact Measure	Direct	Indirect	Induced	Total	Multiplier
4 County Region					
Output	$120,157,006	$42,611,209	$44,992,723	$207,760,938	1.73
Personal income	$20,437,457	$20,157,472	$12,598,795	$53,193,723	2.61
Jobs	604	592	368	1,563	2.61
Rest of Washington					
Output	$0	$9,242,739	$5,141,309	$14,384,048	-
Personal income	$0	$1,591,040	$1,264,030	$2,855,070	-
Jobs	0	41	30	71	-
Total Washington State					
Output	$120,157,006	$51,853,948	$50,134,031	$222,144,985	1.85
Personal income	$20,437,457	$21,748,512	$13,862,825	$56,048,793	2.75
Jobs	604	633	398	1,635	2.73

[1] Modeled with adverse climate change conditions

Note: Calculated using the spreadsheet model of direct irrigation benefits and 2012 IMPLAN base data.

Table 4-106. Distribution of *Alternative 4* Economic Impacts Associated with Increased Agricultural Production, by Industry Sector, 4-County Study Area[1]

Aggregate Industry Sector	Output	Personal Income	Jobs	Average Wage	Output/Job
Agriculture	$134,398,358	$35,015,446	1,080	$32,632	$124,054
Utilities	$1,719,516	$585,439	12	$48,804	$143,291
Construction	$3,714,396	$1,493,622	25	$58,881	$145,998
Manufacturing	$10,057,697	$755,497	12	$60,097	$784,172
Transportation, information, utilities	$41,291,242	$10,635,044	304	$35,028	$135,598
Trade	$10,756,594	$3,548,472	102	$34,776	$105,321
Service	$2,921,716	$956,578	25	$37,494	$113,987
Government	$2,901,419	$203,625	3	$74,103	$1,056,183
Total	**$207,760,938**	**$53,193,723**	**1,563**	**$34,029**	**$132,910**

[1] Modeled with climate change

Note: Calculated using the spreadsheet model of direct irrigation benefits and 2012 IMPLAN base data.

4.21.9 Mitigation Measures

The Proposed Action would not cause negative socioeconomic impacts; therefore, no mitigation measures are proposed.

4.22 Environmental Justice

4.22.1 Methods and Impact Indicators

Methods. Reclamation analyzed census data to determine the demographic makeup of residents of the primary study area (see Section 3.22 for more information). This information was used to determine if KDRPP and KKC would disproportionally impact minority or low-income populations residing in the primary study area. The analysis also considered whether minority or low-income populations recreating in the area would be disproportionally impacted.

Impact Indicators. Table 4-107 shows the environmental justice impact indicators and criteria for determining impact significance. Reclamation assessed all criteria relative to the *Alternative 1 - No Action*.

Table 4-107. Impact Indicators and Significance Criteria for Environmental Justice

Impact Indicator	Significance Criteria
Are minority or low-income populations in the area disproportionally subject to adverse environmental, human health, or economic impacts?	Construction is adjacent to minority or low-income populations Private property or easements are disproportionately acquired from minority or low-income populations The resources impacted by the Proposed Action support subsistence living

4.22.2 Summary of Impacts

Members of the Yakama Nation and other Tribes currently use natural resources in the Kachess Reservoir area and would be expected to do so in the future. They may use these resources disproportionately to the total population. The subsistence use of renewable natural resources (such as fish, wildlife, and vegetation) by Tribes or other populations in the reservoir area and downstream has not been quantified. As described in Section 4.6.2, impacts to fish in Kachess Reservoir are largely negative. Therefore, implementation of KDRPP under *Alternatives 2* and *4* could decrease the potential for subsistence use of these resources and the impact could be substantial. Flow improvements in the Keechelus Reach of the Yakima River under *Alternatives 3* and *4* would improve habitat conditions for anadromous fish and potentially increase the subsistence use of these resources.

Because there are no environmental justice populations living in the primary study area, construction activities and property acquisitions would not disproportionately impact minority or low-income populations.

The BTE actions would be implemented as part of all the action alternatives; similarly, no disproportionate impacts on minority of low-income populations are anticipated. Table 4-108 summarizes the potential impacts.

Table 4-108. Summary of Impacts for Environmental Justice

Impact Indicator	Summary of Impact
Are minority or low-income populations in the area disproportionally subject to adverse environmental, human health, or economic impacts?	No significant impacts from construction. Impacts to fish species in Kachess Reservoir from *Alternatives 2A, 2B*, and *4* could cause a significant impact to subsistence living.

4.22.3 Alternative 1 – No Action Alternative

Alternative 1 - No Action would not cause direct impacts on environmental justice. Barriers to bull trout passage at both reservoirs and high flows in the Keechelus Reach of the Yakima River would continue to negatively impact fish populations, which could cause indirect impacts through reduced opportunity for subsistence fishing.

4.22.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.22.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

Construction impacts from *Alternative 2A - KDRPP East Shore Pumping Plant* would relate to earth resources, construction noise and emissions, and transportation. Construction would have no disproportionate impact to minority and low-income populations; the project would affect everyone in the area equally. Since construction would not be adjacent to minority or low-income populations, the impact would not be significant.

Bull Trout Enhancement

Similar to the east shore pumping plant facilities, the BTE is not anticipated to have significant environmental justice impacts because construction would have no disproportionate impact to minority and low-income populations; the project would affect everyone in the area equally.

4.22.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

The immediate geographic area potentially affected by *Alternative 2A - KDRPP East Shore Pumping Plant* has lower percentages of minority and low-income populations than the Yakima River basin counties or the State of Washington. The project would affect everyone in the areas. Therefore, the project would have no disproportionate adverse impact to those populations and the impact would not be significant.

The project could require the acquisition of private land at the pumping plant site. The property is currently undeveloped and it is not yet known if the property would be acquired from minority or low-income populations. Reclamation would follow the requirements of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 USC 4601) and the procedures described in the Reclamation Manual Directives and Standards (LND 06-01, 2003) for any property or easement acquisition.

Members of the Yakama Nation and other Tribes currently use natural resources in the Kachess Reservoir area and would be expected to do so in the future. They may use these resources disproportionately to the total population. The subsistence use of renewable natural resources (such as fish, wildlife, and vegetation) by Tribes or other populations in the reservoir area and downstream has not been quantified. As described in Section 4.6.2, impacts to fish in Kachess Reservoir are largely negative. Therefore, implementation of Alternative 2A could decrease the potential for subsistence use of these resources and the impact could be substantial.

Bull Trout Enhancement
Similar to the east shore pumping plant facilities, the BTE is not anticipated to have environmental justice impacts because the project would have no disproportionate adverse impact to environmental justice populations; it would affect everyone in the area equally. Improvements in fish abundance from improved habitat conditions may increase the potential for subsistence use of fish resources.

4.22.5 Alternative 2B – KDRPP South Pumping Plant

4.22.5.1 Construction

KDRPP South Pumping Plant Facilities
Impacts would be the same as for *Alternative 2A - KDRPP East Shore Pumping Plant* (Section 4.22.4.1).

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.22.4.1).

4.22.5.2 Operation

KDRPP South Pumping Plant Facilities
Impacts would be the same as for *Alternative 2A - KDRPP East Shore Pumping Plant* (Section 4.22.4.2).

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.22.4.2).

4.22.6 Alternative 3A – KKC North Tunnel Alignment

4.22.6.1 Construction

KKC North Tunnel Alignment Facilities

Construction impacts from *Alternative 3A - KKC North Tunnel Alignment* would relate to earth resources, construction noise and emissions, and transportation impacts. Construction activities would affect everyone in the area equally. Therefore, construction would have no disproportionate impact to minority and low-income populations and the impact would not be significant.

Bull Trout Enhancement

Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.22.4.1).

4.22.6.2 Operation

KKC North Tunnel Alignment Facilities

The immediate geographic area potentially affected by *Alternative 3A - KKC North Tunnel Alignment* has lower percentages of minority and low-income populations than the Yakima River basin counties or the State of Washington. Operation impacts would affect everyone in the area equally. Therefore, *Alternative 3A* would have no disproportionate adverse impact to minority and low-income populations and the impact would not be significant.

As described for *Alternative 2A - KDRPP East Shore Pumping Plant* (Section 4.22.4.2), members of the Yakama Nation and other Tribes may currently use natural resources in the Keechelus and Kachess reservoirs area and would be expected to do so in the future. Long-term impacts of *Alternative 3A - KKC North Tunnel Alignment* include improved rearing conditions in the Yakima River and improved bull trout migration from Kachess Reservoir to tributary streams. Improvements in fish abundance from improved habitat conditions downstream of the dam may increase the potential for subsistence use of these resources.

Bull Trout Enhancement

Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.22.4.2).

4.22.7 Alternative 3B – KKC South Tunnel Alignment

4.22.7.1 Construction

KKC South Tunnel Alignment Facilities

Impacts would be the same as for *Alternative 3A - KKC North Tunnel Alignment* (Section 4.22.6.1).

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.22.4.1).

4.22.7.2 Operation

KKC South Tunnel Alignment Facilities
Impacts would be the same as for *Alternative 3A - KKC North Tunnel Alignment* (Section 4.22.6.2).

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.22.4.2).

4.22.8 Alternative 4 – Combined KDRPP and KKC

4.22.8.1 Construction

KDRPP and KKC Facilities
Impacts would be the same as for KDRPP (Section 4.22.4.1) and KKC (Section 4.22.6.1).

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.22.4.1).

4.22.8.2 Operation

KDRPP and KKC Facilities
Impacts would be the same as for KDRPP (Section 4.22.4.2) and KKC (Section 4.22.6.2).

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.22.4.2).

4.22.9 Mitigation Measures

Implementation of *Alternatives 2A, 2B,* or *4* could have a significant impact on subsistence use of fish resources in Kachess Reservoir. Reclamation would implement the mitigation measures in Section 4.6.9 to minimize the impacts to fish species.

4.23 Environmental Health and Safety

4.23.1 Methods and Impact Indicators

Reclamation compared potential impacts from the action alternatives to existing conditions and the No Action Alternative. Table 4-109 lists the impact indicators and significance criteria.

Table 4-109. Impact Indicators and Significance Criteria for Environmental Health and Safety

Impact Indicator	Significance Criteria
Hazardous sites	Disturbance of hazardous material that creates exposure to the public. Spill of fuel or hazardous materials during construction that could affect the public.
Public safety hazards, including those associated with boating, access to reservoir bed during drawdown, construction equipment, and construction traffic	Exposure of slopes greater than 20 degrees in areas accessible to the public, such as developed and undeveloped recreation sites, or private access points. Exposure of slopes susceptible to erosion (as described in Section 3.2 Earth) in areas accessible to the public.

Methods. Reclamation conducted database surveys to identify known hazardous sites. They also analyzed aerial photography and bathymetry to determine potential safety hazards.

Impact Indicators. Impact indicators for environmental health and safety relate to whether construction activities or operation would disturb hazardous sites or expose the public to safety hazards.

4.23.2 Summary of Impacts

Reclamation anticipates an increased safety risk associated with steep slopes around the Kachess Reservoir from *Alternatives 2A, 2B,* and *4*. The BTE actions would be implemented as part of all the action alternatives; no construction or operation impacts are anticipated. Table 4-110 summarizes the potential impacts.

Table 4-110. Summary of Impacts for Environmental Health and Safety

Impact Indicator	Summary of Impacts
Hazardous sites	There would be no impacts from hazardous sites under any of the alternatives.
Public safety hazards, including those associated with boating, access to reservoir bed during drawdown, construction equipment, and construction traffic	With *Alternatives 2A, 2B* and *4*, full drawdown would expose areas with slopes greater than 20 degrees around Kachess Reservoir, which would present a safety hazard to people accessing the reservoir. Exposure of formerly submerged boating hazards is not considered significant because boat launches would be above the reservoir pool elevation making access to the reservoir by boat difficult during low water periods.

4.23.3 Alternative 1 – No Action Alternative

Under existing conditions, there would be no environmental health and safety impacts. A risk of hazardous material spill is present during construction of projects occurring under the No Action Alternative as described in Section 2.3. Around the reservoirs, the public is currently exposed to existing safety hazards such as steep slopes to access to the reservoir bed, and submerged hazards for boaters. These potential impacts are not considered significant. Completion of the I-90 Phase 2A project would result in more traffic volume through the area, which could increase safety hazards on I-90 and other local roads, but increased risks are not expected to be significant.

4.23.4 Alternative 2A – KDRPP East Shore Pumping Plant

4.23.4.1 Construction

KDRPP East Shore Pumping Plant Facilities

There are no known NPL sites in the primary study area (EPA, 2014b). The hazardous materials site located within the extended study area would not be disturbed by the proposed activities. If Reclamation acquires any properties as part of the Proposed Action, Reclamation would conduct an environmental site survey after the preferred alternative is selected but before construction starts (Reclamation, 2014c).

Construction may release fuels, oils, solvents, or other potentially hazardous materials. Construction best management practices would be implemented to minimize this risk. If a release were to occur, measures would be taken to avoid contamination of surface waters. If sites containing hazardous materials are identified, procedures would be taken during site planning and construction to avoid further contamination.

Although unlikely, injury or death is possible from encounters with large machinery or access to construction sites by the public and by construction workers. To minimize these risks, safety plans would be implemented in accordance with all applicable requirements, including public access restrictions to the construction areas, notification of construction activities, and other construction site safety practices.

Bull Trout Enhancement

Construction is not expected to disturb the UST near Gold Creek (described in Section 3.23). Construction BMPs would be implemented to minimize the risk of fuel, oil, solvent, and other potentially hazardous material releases. If a release were to occur, measures would be taken to avoid contamination of surface waters. Additional analysis of potential environmental health and safety impacts will be developed as the design of these actions progresses. If sites containing hazardous materials are identified during design, procedures would be taken during site planning and construction to avoid further contamination.

4.23.4.2 Operation

KDRPP East Shore Pumping Plant Facilities

The vertical distance from the Kachess Reservoir shoreline to the water could increase substantially over current conditions. This change could create a risk to the general public accessing the reservoir, particularly in areas near developed or undeveloped recreational sites, existing residences, and other accessible areas. This hazard may last as long as 5 years after drought years, until the reservoir has refilled. Under existing conditions, near the Kachess Campground and boat launches it is relatively flat; however, with full drawdown the additional 150 to 200 feet of exposed reservoir bed would be steep, with slopes greater than 20 degrees. Further south, near the Kachess Ridge residential area, the areas exposed by full drawdown would be relatively flat, and thus not pose a hazard to the public. On the east side of the reservoir, near the East Kachess Group Site and undeveloped areas, much of the newly exposed reservoir bed would have slopes between 20 and 40 degrees, with up to 60 degrees in some areas. Slopes of greater than 20 degrees would be a significant safety hazard to the public.

Keechelus Reservoir levels would be up to 15 feet lower than existing conditions in years following a drought while Kachess refills. Keechelus Reservoir thus would experience drawdown in the years following a drought and would have more area of steep slopes than under present conditions. The increased risk associated with steep slopes is less at Keechelus Reservoir because the decrease in the reservoir level is much less.

In some areas the reservoir bed exposed by the full drawdown would be relative flat. In these areas, the public may access the reservoir bed in their vehicles and drive recklessly. Near the Kachess Ridge Residential area, the newly exposed bed would be relatively flat. This increased safety hazard would not be considered significant because the reservoir bed is composed primarily glacial deposits, which have relatively high strength. Furthermore, under existing conditions, there are large flat areas of the reservoir bed already exposed. The increase in flat areas from full drawdown, relative to existing conditions, would be not considered significant.

The lower pool elevation on both Kachess and Keechelus reservoirs may increase the risk to boaters on the lake. When compared with current conditions, there may be more submerged or formerly submerged hazards (such as rocks, tree stumps, and shoals). However, the drawdown in drought years would make the boat launches inaccessible during the lowest drawdown periods, which would reduce or eliminate boating on the reservoir. Thus, boaters would be unlikely to be exposed to these hazards and the potential impact is not considered significant.

Bull Trout Enhancement
After construction of BTE actions, hazards in the area would be no greater than they are under existing conditions. No long-term impacts from BTE actions are expected.

4.23.5 Alternative 2B – KDRPP South Pumping Plant

4.23.5.1 Construction

KDRPP South Pumping Plant Facilities
There are no known hazardous materials sites or NPL sites within the primary study area for *Alternative 2B - KDRPP South Pumping Plant*. Construction impacts would be the same as for *Alternative 2A - KDRPP East Shore Pumping Plant* (Section 4.23.4.1).

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.23.4.1).

4.23.5.2 Operation

KDRPP South Pumping Plant Facilities
Long-term impacts would be the same as for *Alternative 2A - KDRPP East Shore Pumping Plant* (Section 4.23.4.2) because the reservoirs would experience the same level of drawdown.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.23.4.2).

4.23.6 Alternative 3A – KKC North Tunnel Alignment

4.23.6.1 Construction

KKC North Tunnel Alignment Facilities
There are no known hazardous materials sites or NPL sites within the primary study area for *Alternative 3A - KKC North Tunnel Alignment*. Construction impacts would be the same as for *Alternative 2A - KDRPP East Shore Pumping Plant* (Section 4.23.4.1).

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.23.4.1).

4.23.6.2 Operation

KKC North Tunnel Alignment Facilities
All facilities associated with KKC would be fenced or otherwise inaccessible to the public. Therefore, the public would not be exposed to safety hazards from operations.

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.23.4.2).

4.23.7 Alternative 3B – KKC South Tunnel Alignment

4.23.7.1 Construction

KKC South Tunnel Alignment Facilities
There are no known hazardous materials sites or NPL sites within the primary study area for *Alternative 3B - KKC South Tunnel Alignment*. Construction impacts would be the same as those for *Alternative 2A - KDRPP East Shore Pumping Plant* (Section 4.23.4.1).

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.23.4.1).

4.23.7.2 Operation

KKC South Tunnel Alignment Facilities
Operation impacts would be the same as those for *Alternative 3A - KKC South Tunnel Alignment* (Section 4.23.4.2).

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.23.4.2).

4.23.8 Alternative 4 – Combined KDRPP and KKC

4.23.8.1 Construction

KDRPP and KKC Facilities
Construction impacts would be the same as those for *Alternative 2A - KDRPP East Shore Pumping Plant* (Section 4.23.4.1).

Bull Trout Enhancement
Construction impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.23.4.1).

4.23.8.2 Operation

KDRPP and KKC Facilities
Long-term impacts would be the same as those for *Alternative 2A - KDRPP East Shore Pumping Plant* and *Alternative 3A - KKC South Tunnel Alignment* (Section 4.23.4.2).

Bull Trout Enhancement
Operation impacts associated with the BTE actions would be the same as described for *Alternative 2A – KDRPP East Shore Pumping Plant* (Section 4.23.4.2).

4.23.9 Mitigation Measures

Signage would be installed and notices posted to ensure that the public understands potential safety issues, including steep slopes along the reservoir and boating hazards. Signage and notices would also provide information about new conditions to be expected. BMPs would be followed to reduce the risk of spills.

4.24 Relationship of the Proposed Action to the Integrated Plan

This section is included for SEPA purposes to summarize how the KDRPP and KKC proposals meet the goals of the Integrated Plan and the State authorization (Section 1.9.2). As described in Chapter 1, Reclamation and Ecology identified the KDRPP and KKC as projects necessary to help address water needs in the Yakima River basin.

KDRPP and KKC support the goals of the Integrated Plan by providing additional storage and improving instream flows to benefit fisheries. The KDRPP would allow Reclamation to access additional water from Kachess Reservoir during drought years. The additional water would increase water supplies to proratable irrigation districts, increasing prorationing percentage close to the 70 percent goal of the Integrated Plan. With the KKC, Reclamation could reduce the artificially high flows in the Keechelus Reach of the Yakima River by diverting water directly from Keechelus Reservoir to Kachess Reservoir. This would improve habitat for salmonids, including the ESA listed bull trout and MCR steelhead. The Bull Trout Enhancement improvements at Gold and Cold creeks, which are incorporated as part of all the action alternatives, further improves habitat and offsets impacts of the projects on bull trout access to tributaries.

Listed below are the specific goals of the Integrated Plan that the Proposed Action supports:

- Provide opportunities for comprehensive watershed protection, ecological restoration, and enhancement, addressing instream flows, aquatic habitat, and fish passage
- Improve water supply reliability during drought years for agricultural and municipal needs
- Improve the ability of water managers to respond and adapt to potential effects of climate change
- Contribute to the vitality of the regional economy and sustain the riverine environment

KDRPP would improve water supply to proratable irrigators from 19 to 23 percent in drought years, raising the proration percentage to about 64 percent of entitlement (see Section 4.3.4.2, Surface Water). This would be a significant benefit to water supply.

KKC is an important component of the Integrated Plan's goals to meet reach-specific target flows for fish recommended by fish biologists and agency representatives (see Section 5.3.2.1 of the Integrated Plan PEIS). The Integrated Plan includes recommended instream flows for specific reaches of rivers and streams affected by operation of the Yakima Project. Reducing the artificially high summer flows in the Keechelus Reach is a high priority. With KKC, summer flow targets in the Keechelus Reach would be met in most years and would significantly increase the productivity and abundance of spring Chinook and other anadromous fish (see Section 4.6.4.2, Fish).

The BTE habitat improvements, included as a component of all action alternatives, would improve streamflow in Gold Creek and Cold Creek during late summer and fall, when Keechelus and Kachess reservoirs are at their lowest levels. The enhancements would provide a surface water connection from the streams to the reservoir pools, providing better seasonal passage conditions for bull trout and significantly benefiting fish passage and riparian habitat.

The 200,000 acre-feet of additional water accessible from Kachess Reservoir during drought years would help meet the Water Supply Facility Permit and Funding Milestone (Section 1.9.2). If the Milestone is met, the Teanaway Community Forest would continue to be managed to meet the goals of the Integrated Plan, including habitat protection and restoration.

4.25 Cumulative Impacts

Cumulative impacts are the effects that may result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7). "Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7). This analysis looks at whether the impacts of KDRPP and KKC could have additive or interactive effects in combination with other projects in the area within the defined analysis area. For cumulative effects, Reclamation and Ecology generally define the analysis area as the Yakima River basin, but defines more specific analysis areas for some resources as defined in the impacts discussions.

The analysis first looks briefly at the cumulative impacts of past actions related to agricultural development in the Yakima River basin. It then looks at cumulative impacts of present actions, defined as construction associated with phases of WSDOT's I-90 Snoqualmie Pass East Project. The last section of this cumulative impacts analysis describes the impacts of reasonably foreseeable projects, defined by Reclamation and Ecology as the Cle Elum Pool Raise Project. Because construction of I-90 near the reservoirs would continue into the future, those projects are included in the discussion of cumulative construction impacts.

4.25.1 Past Actions

For the purpose of this discussion, the analysis area encompasses the Yakima River basin. The descriptions of resources in Affected Environment (Chapter 3) include the cumulative impacts of these past actions as the baseline condition.

4.25.1.1 Land Use Practices

Agricultural development in the Yakima River basin over the past 150 years, including Reclamation's Yakima Project, has caused impacts to surface water, water quality, fish, vegetation and wetlands, wildlife, and cultural resources (Sections 1.3 and 1.6 of the Integrated Plan PEIS (Reclamation and Ecology, 2012)). Agricultural development has contributed to the economy of the Yakima River basin as described in Section 3.21.

Timber harvest, mining, transportation, and residential and commercial development have further altered environmental conditions in the basin. Impacts from these past actions include altered streamflows and stream channels, degraded water quality, blocked fish passage, degraded riparian and floodplain habitat, reduced forest and shrub-steppe habitat, and declined fish and wildlife populations. The impacts that have degraded fish and wildlife habitat have led to listing of species such as the northern spotted owl, MCR steelhead, and bull trout as threatened species under the Endangered Species Act.

4.25.1.2 Water Management Practices

Past water management actions have caused cumulative impacts at the Kachess and Keechelus reservoir areas that have affected surface water, fish, vegetation, wildlife, and cultural resources. Construction of Kachess and Keechelus dams blocked fish passage to glacial lakes at Kachess and Keechelus and their tributaries. Water storage and releases from the dams altered streamflows below the dams, which in turn altered the stream channels. Reclamation's Yakima River Project has enabled the production of high-value orchard crops, wine grapes, and hops in addition to grains, vegetables and dairy products. Residential, commercial, and recreational development have altered the reservoir shorelines and disturbed wildlife habitat. The dams created reservoirs larger than the historic lakes and flooded forest areas. The reservoir also inundated traditional Native American hunting, fishing, and gathering areas that had been located on the historic lake shorelines.

4.25.2 Present Actions

Reclamation and Ecology have characterized present actions as those that are currently ongoing within the Yakima River basin that could have additive or interactive effects in relation to the Proposed Action. There is one current, major activity that could contribute to cumulative impacts within or near the Proposed Action area—ongoing construction activity along I-90 related to WSDOT's I-90 Snoqualmie Pass East Project.

The intent of WSDOT's I-90 Snoqualmie Pass East Project is to reduce congestion and improve safety and reliability along the 15-mile corridor of I-90 between Hyak to Easton. The project would widen the highway to six lanes and includes stabilizing slopes, replacing deteriorating pavement, adding vehicle capacity, and improving wildlife connectivity by replacing bridges and culverts. The project would also reduce road closures due to avalanches. WSDOT has planned the I-90 Snoqualmie Pass East Project in three phases. Phase 1 started in 2009 with scheduled completion in 2018. Phase 1 construction could overlap with construction associated with all of the reasonably foreseeable projects, depending on their start time. With Phase 1, WSDOT has widened the first few miles of highway to six lanes, replaced the existing bridges over Gold Creek with much longer bridges to allow wildlife passage, excavated 250,000 cy of material from Keechelus Reservoir; and removed the snowshed. WSDOT is currently constructing two avalanche bridges and continuing the highway widening to Keechelus Dam.

Phase 2 of the project, from Keechelus Dam to the Cabin Creek Interchange, is scheduled to begin in 2015 and continue until 2020. Phase 2 includes phases 2A and 2B. The primary feature for Phase 2A is a wildlife crossing over I-90 at Price and Noble Creeks. Phase 2B consists of 2.5 miles of improvements between the Stampede Pass and Cabin Creek interchanges, and currently only has funding for design. Reclamation and Ecology have included the Phase 2A project as part of *Alternative 1 – No Action* because some of the proposed construction would overlap with that of KDRPP and KKC. Chapter 4 summarizes potential impacts of Phase 2A. Phase 3, from Cabin Creek Interchange to the Easton vicinity, has currently only been funded for scoping and planning. Because there is no defined start time, this project is not included in the cumulative impacts analysis.

Construction associated with the I-90 Phase 1 project would increase, noise, vehicle, emissions and dust to the area. Construction activities have created traffic delays including closures of I-90 lasting at least an hour for rock blasting, lane closures in both directions, and rolling slowdowns that have caused traffic delays of up to 20 minutes.

KDRPP and KKC would also have major construction impacts, which would create cumulative impacts in combination with construction of I-90 Phase 1. Construction noise from both the I-90 project and the Proposed Action could impact noise-sensitive wildlife in the area. Construction vehicles for KDRPP and KKC would add to overall construction-related traffic delays (Section 4.17); however, the increased traffic on I-90 and adjacent roads would be below the 50-peak period vehicle threshold for impact significance and the vehicle trips are expected to cause minor additional traffic delays. Reclamation and Ecology do not anticipate significant cumulative impacts associated with construction of the I-90 Phase 1.

4.25.3 Reasonably Foreseeable Future Actions

4.25.3.1 Projects Included in the Analysis

Reclamation and Ecology have used the following criteria to identify reasonably foreseeable projects for this cumulative impact analysis. They include projects that:

- Occur within the defined boundary
- Have some level of design, planning, and are being actively pursued
- Have additive or interactive effects in relation to the Proposed Action

Reasonably foreseeable future projects identified in the Kachess and Keechelus reservoir areas include two projects in the Integrated Plan Initial Development Phase—the Cle Elum Pool Raise Project. The Initial Development Phase of the Integrated Plan is the period from the State’s authorizing legislation for the Integrated Plan in 2013 through the year 2023. Projects included in the Initial Development Phase are those identified by Reclamation and Ecology that would quickly achieve tangible improvements in streamflow, habitat, and fish passage, as well as provide increased security of existing out-of-stream water supplies. This project meets the criteria for inclusion as reasonably foreseeable projects for this cumulative impact analysis because it occurs within the defined boundary where construction and operation impacts of the Proposed Action would occur, it is undergoing design, and Reclamation and Ecology are actively pursuing the project. The Cle Elum Pool Raise Project also has the potential for additive or interactive effects with the Proposed Action.

Reclamation and Ecology have included other projects in the Integrated Plan Initial Development Phase, but those water conservation and stream restoration projects would occur further downstream in the Yakima River basin and are considered outside the defined boundary for cumulative impacts. These projects would not have additive or interactive effects with KDRPP or KKC. Reclamation and Ecology do not consider these projects part of this cumulative impact analysis because they do not meet the criteria listed above.

4.25.3.2 Evaluation of Cumulative Impacts of Reasonably Foreseeable Actions

The following sections describe the potential cumulative impacts of the identified reasonably foreseeable projects. Section 4.25.3.3 is a summary of the potential cumulative impacts. The cumulative impacts of the individual projects are described in Section 4.25.3.4.

If the Proposed Action would have no direct or indirect effect on a resource, then it could not cause or contribute to potential cumulative effects on that resource, and the cumulative impacts analysis does not include them. Reclamation and Ecology have identified the Cle Elum Pool Raise Project as reasonably foreseeable.

Reclamation and Ecology are evaluated the potential impacts associated with the Cle Elum Pool Raise Project in a DEIS released in September 2014 (Reclamation and Ecology, 2014a). The FEIS will be completed in spring 2015. One purpose of the Cle Elum Pool Raise Project is to improve aquatic resources for fish habitat, rearing, and migration in the Cle Elum and upper Yakima rivers. The project provides additional storage in the water that would be used to improve instream flows downstream from the dam and meet this purpose. The project would contribute to improving aquatic resources in the Yakima River basin.

4.25.3.3 Cumulative Impacts of Reasonably Foreseeable Projects

The proposed KDRPP and KKC are intended to improve water supply for proratable irrigators in the Yakima River basin and to improve habitat conditions for ESA listed species. These projects, including the BTE habitat improvements at Gold and Cold creeks, would address some of the issues associated with past actions by providing improved aquatic habitat and improved instream flows downstream. KDRPP and KKC would not exacerbate the negative cumulative impacts of past actions, but Reclamation and Ecology expect the Proposed Action to provide benefits to fish and streamflow conditions that would be beneficial at a basin-wide level when implemented with other proposed projects, including improved instream flows from the Cle Elum Pool Raise Project.

KDRPP and KKC in combination with other reasonably foreseeable projects would contribute to regional trends toward reduced habitat. However, the habitat losses would be small. The projects would add cumulatively to impacts to historic and cultural resources. Reclamation would work closely with all affected parties and implement a Cultural Resource Management Plan to minimize these impacts.

The major cumulative impact associated with KDRPP and KKC would be construction impacts. KDRPP, KKC, and the Cle Elum Pool Raise Project are planned to have a similar construction schedule, although implementation is dependent on future congressional authorization and funding which may delay the start of construction. Construction traffic for all projects would travel on I-90. Dust, noise, and overall traffic would be additive, although these impacts would be limited to the period of construction. While the impact on traffic of the individual projects would not be significant, the impacts, combined with the ongoing construction on the I-90 Snoqualmie Pass East Project Phase 1, would cause additive impacts. These cumulative impacts would create a nuisance for people traveling on I-90 as well as residents and recreationists in the Proposed Action areas and on the I-90 corridor.

The following sections provide more details about potential cumulative impacts of KDRPP and KKC.

4.25.3.4 Cumulative Impacts of KDRPP and KKC

KDRPP Potential Cumulative Impacts

The purpose of KDRPP is to improve water supply to proratable irrigators by accessing stored water that is currently not accessible from the existing gravity outlet. KDRPP would contribute to improving water supply in the Yakima River basin. KDRPP includes implementation of BTE habitat improvements at Gold and Cold Creek, which would improve fish passage between the creeks and Keechelus Reservoir.

The project would cause short-term construction impacts, including increased noise, vehicle emissions, fugitive dust, and traffic delays. If the reasonably foreseeable future projects create similar impacts, impacts of the KDRPP could contribute to potential cumulative impacts of those projects. The major operation impact identified for KDRPP relates to increased reservoir drawdown, which would have adverse effects on reservoir slope stability, water quality, groundwater levels, fish in the reservoir, bull trout access to tributary streams, visual quality, recreation use of the reservoir and shoreline facilities, cultural resource sites and possibly Traditional Cultural Properties. Implementation of the BTE habitat improvements would improve fish passage and habitat conditions for bull trout.

Construction

The analysis boundary for construction was the area around Kachess Reservoir that would experience construction noise and dust, and local roadways and I-90 where construction traffic would occur. Construction of KDRPP facilities would last approximately 3 years and would cause increased noise, vehicle emissions, and fugitive dust. Traffic on local roadways and I-90 would increase and delays in travel are expected. Construction is not likely to happen concurrently with I-90 projects, but could follow shortly. Access would be maintained to residences and recreation facilities during construction. Portions of the reservoir near the facilities would be closed during construction and off-limits to recreation. All of these impacts are expected to be temporary and minor, but cumulatively would create a nuisance for residents and recreationists for the length of the construction period. This could add to overall “construction fatigue” when added to the I-90, KKC, and Cle Elum Pool Raise Project.

Operation

Earth. The analysis boundary was the Kachess Reservoir shoreline and reservoir bed. KDRPP would expose large areas of reservoir bed during drought years when the reservoir is drawn down up to an additional 80 feet. Steep slopes in some exposed areas would be subject to erosion and incision at stream channels. This could cause turbidity plumes in the reservoir and affect water quality. This increased erosion would be additive to erosion that would otherwise be occurring within the reservoir, but the increase is expected to be minor. Erosion would be confined to small areas of the reservoir and would not contribute significantly to cumulative impacts in combination with the other reasonably foreseeable projects.

Surface Water. The analysis boundary includes the Kachess Reservoir, Kachess River, and Yakima River downstream to the Parker gage. KDRPP would withdraw up to an additional 200,000 acre-feet of stored water from Kachess Reservoir that is currently inaccessible from the gravity outlet. This would improve irrigation supply to proratable irrigation districts by up to 67 percent during drought years and would contribute significantly to improving water supply in the Yakima River basin. The improvement in irrigation supply would add cumulatively to the benefits of other water supply projects, including the Cle Elum Pool Raise Project, if Reclamation used the additional storage from that project to supply proratable irrigation districts.

Water Quality. The analysis area includes Kachess Reservoir, the Kachess River downstream of the reservoir, and the Yakima River downstream of the Kachess River. During drought years when the reservoir is drawn down, water quality may decrease because of increased heating and increased residence time in the reservoir. This may cause lower dissolved oxygen (DO) concentrations and higher water temperatures that would adversely affect aquatic organisms. As noted above, increased erosion on the exposed reservoir bed could increase turbidity in the reservoir. These water quality impacts could result in inconsistency with water quality standards and could be significant. Impacts would be localized and mostly confined to the reservoir. Water released from the reservoir may cause a small increase water temperature downstream in the Kachess River, but DO would not degrade and impacts would not be significant. KDRPP is not expected to add cumulatively to water quality problems in the Yakima River in combination with other reasonably foreseeable projects.

Groundwater. The analysis area includes the aquifers adjacent to Kachess Reservoir and aquifers downstream in the Yakima River basin. Water levels in wells adjacent to the reservoir could be lowered during drawdown. The extent of this impact is unknown and

Reclamation would develop appropriate mitigation for any affected residences. Therefore, the impact to water supply is not expected to be significant. The increased water supply for irrigation could increase groundwater recharge downstream in the basin during drought years because more water would be available for seepage to groundwater. The increased water supply to proratable irrigators may also reduce the use of drought relief wells downstream in the Yakima River basin. No cumulative impacts to groundwater are anticipated.

Fish. Kachess Reservoir and the Kachess and Yakima rivers downstream from the reservoir were included in the analysis area. The additional drawdown of Kachess Reservoir would further impede fish passage to reservoir tributaries and between the Kachess basin and Little Kachess basin. Reclamation would provide mitigation for passage problems; therefore, impacts are not expected to be significant. Fish in the reservoir could be negatively impacted by increased water temperature, decreased water quality, decreased food prey, and increased temperatures. This could decrease the abundance and productivity of fish, but the impacts would be confined to fish in the reservoir. The BTE habitat improvements at Gold and Cold creeks would improve conditions for fish in Keechelus Reservoir. No cumulative impacts to fish are anticipated in combination with other reasonably foreseeable projects.

Vegetation and Wildlife. The analysis boundary is the Kachess Reservoir watershed. Construction of the KDRPP facilities would impact one small wetland and cause permanent loss of some upland and riparian vegetation. These losses would not be significant because wetland impacts would be mitigated and the loss of vegetation is small (less than 20 acres) relative to the overall availability of similar vegetation in the watershed. Localized wildlife species with small home ranges would be impacted by the loss of habitat. The Cle Elum Pool Raise Project would also cause relatively small losses in wetlands and vegetation. These impacts, while not expected to be significant, contribute to an overall trend of reduced habitat within the Yakima River basin, and could exacerbate stresses on species using shoreline habitats and result in cumulative impacts to vegetation and wildlife.

Threatened and Endangered Species. The analysis area includes Keechelus and Kachess reservoir and their tributaries, the Yakima and Kachess rivers, and the land surrounding the reservoir that provides habitat for terrestrial species. Northern spotted owls could be significantly impacted by construction noise that exceeds the noise-only disturbance threshold for the species and a significant loss of habitat that supports the spotted owl. Degraded habitat conditions in the reservoir described for fish would also negatively affect bull trout. Lower reservoir levels would prevent bull trout access to Kachess Reservoir tributaries and to the Little Kachess pool, exacerbating existing access problems. The proposed mitigation for KDRPP includes installing measures to improve tributary access, which is expected to offset the impacts to bull trout passage and could be an improvement over existing conditions. The BTE habitat improvements at Gold and Cold creeks would improve conditions for bull trout in Keechelus Reservoir. KDRPP is expected to provide a cumulative benefit to bull trout, but could pose cumulative impacts to the northern spotted owl by adding to the loss of habitat in combination with other reasonably foreseeable projects.

Recreation. The analysis boundary is Kachess Reservoir and recreation areas adjacent to it. KDRPP would cause significant impacts to recreation at Kachess Reservoir during the additional reservoir draw down during drought years and years when the reservoir is refilling. The increased reservoir draw down would prevent use of boat launches, decrease fishing opportunities on the reservoir, increase the distance from the shore to water, and reduce the aesthetic quality of the reservoir. These impacts are considered significant and would likely cause recreationists to avoid the area. The loss of recreation facilities at Kachess Reservoir when the reservoir is drawn down could cause recreationists to seek similar recreation opportunities at other reservoirs, such as Keechelus and Cle Elum, which currently exceed capacity during peak periods. This increased use and crowding would be a cumulative impact to recreation in the reservoir areas.

Cultural Resources. Reclamation has established a study area for KDRPP, which includes Kachess Reservoir and areas where construction and installation of new facilities would occur. Reclamation has not fully completed cultural resource surveys for KDRPP. Preliminary surveys identified one eligible archaeological resource, which is inundated by the existing reservoir. The reservoir drawdown could expose additional cultural resources and make them more vulnerable to erosion and vandalism. Impacts to cultural resources at Kachess Reservoir would add cumulatively to impacts to cultural resources in the Yakima River basin, including impacts at Cle Elum Reservoir area from the Cle Elum Pool Raise Project. Reclamation does not expect these impacts to be significant with the implementation of a Cultural Resource Management Plan as described in Section 4.18.9.

KKC Project Cumulative Impacts

KKC would transfer water from Keechelus Reservoir to Kachess Reservoir in all years in order to reduce streamflows in the Keechelus Reach of the Yakima River. KKC would provide a minimal benefit to irrigation water supply and would help refill Kachess Reservoir more quickly.

The major impacts associated with KKC include construction, surface water, surface water quality, fish, threatened and endangered species, and cultural resources. KKC would also cause minor impacts to groundwater, vegetation and wetlands, and wildlife.

Construction

Construction of the KKC facilities would last approximately 3 years. It would cause increased noise, vehicle emissions, and fugitive dust. Traffic on local roadways and I-90 would increase and delays in travel are expected, but increased traffic would be below the 50-peak period vehicle threshold for impact significance. Portions of the reservoir near the facilities would be closed during construction and off-limits to recreation. All of these impacts are expected to be minor individually, but cumulatively would create a nuisance for residents, recreationists, and travelers on I-90 for the length of the construction period. Construction for KKC and KDRPP could occur at the same time, which would cumulatively increase construction impacts. Although construction for the Cle Elum Pool Raise Project would not occur simultaneously with KKC and KDRPP, there could be some overlap and the continued construction in the area, combined with the I-90 construction, would add to overall "construction fatigue."

Operation

Surface Water. The analysis boundary is Keechelus Reservoir, Kachess Reservoir, the Kachess River, and the Yakima River downstream to the Parker gage. KKC would reduce streamflows in the Keechelus Reach and provide a significant benefit to instream flow conditions. Reduced streamflows in the Keechelus Reach would add cumulatively to streamflow benefits from KDRPP and the Cle Elum Pool Raise Project. KKC would provide a small improvement to water supply for proratable irrigators in drought years (less than 1 percent). Although the improved water supply in drought years is minimal, cumulatively, it would contribute to improvements in water supply in the Yakima River basin.

Surface Water Quality. The analysis boundary is Keechelus Reservoir, Kachess Reservoir and the Yakima and Kachess rivers. PCB and dieldrin contamination has been identified in Keechelus. Transferring this water to Kachess Reservoir could degrade water quality in Kachess Reservoir. The significance of the impact is not yet known, but Reclamation and Ecology would establish a monitoring program for changes in water quality and would develop appropriate mitigation as warranted. If contaminated water is transferred to Kachess Reservoir, it would add to water quality problems in the reservoir. No cumulative water quality impacts are anticipated in combination with the reasonably foreseeable projects because water quality impacts would be confined to the reservoirs.

Fish. The analysis boundary is the Yakima River basin, but focuses on Keechelus Reservoir, Kachess Reservoir, and the Yakima and Kachess rivers. Decreased high flows in the Keechelus Reach would be a significant benefit to habitat for fish species. Decreased flows would significantly improve productivity of spring Chinook and other anadromous fish. The improved streamflows would contribute to basin-wide improvements in fish productivity. The Gold and Cold Creek habitat improvements would improve habitat and passage for fish. These benefits would add cumulatively to improved habitat and fish conditions in the Yakima River basin when combined with improvements from the Cle Elum Pool Raise Project.

Vegetation, Wetlands and Wildlife. The analysis boundary is the area round Keechelus and Kachess reservoir where facilities would be installed, as well as the areas around the reservoir, which would be affected by noise and disturbance from the project. KKC would cause a small loss of riparian and upland vegetation that could affect species with small home ranges. The impacts would not be significant, but combined with impacts to habitat and wildlife from the other reasonably foreseeable projects, would contribute to the overall decline in habitat and wildlife in the basin. The BTE habitat improvements at Gold and Cold creeks combined with WSDOT's I-90 wildlife migration projects and property acquisition, would help offset the impacts to vegetation, wetlands, and wildlife.

Threatened and Endangered Species. The analysis area includes Keechelus and Kachess reservoir and their tributaries, the Yakima and Kachess rivers, and the land surrounding the reservoir that provides habitat for terrestrial species. Construction noise that exceeds the noise-only disturbance threshold for the species and a significant loss of habitat could significantly impact northern spotted owls. These impacts, combined with other stresses to the species could negatively affect the northern spotted owl. KKC would provide a significant benefit to MCR steelhead and bull trout by reducing the artificially high flows in Keechelus Reach. The BTE habitat improvements at Gold and Cold creeks would improve passage and habitat for bull trout. Cumulative benefits would occur to MCR steelhead and bull trout when combined with the benefits from the KDRPP and the Cle Elum Pool Raise Project.

Cultural Resources. The analysis boundary is the area tributary to Keechelus and Kachess Reservoir, including the alignment for the KKC tunnel. Reclamation has established a study area that includes Keechelus Reservoir and the areas where construction and installation of new facilities may have the potential to cause effects. Reclamation has not yet fully completed cultural resource surveys for KKC. Preliminary surveys indicate the project would impact an eligible archaeological resource. Impacts to cultural resources in the KKC construction areas would add cumulatively to impacts to cultural resources in the Yakima River basin. Reclamation does not expect significant cultural resource impacts with the implementation of a Cultural Resource Management Plan as described in Section 4.18.9.

4.26 Unavoidable Adverse Impacts

Unavoidable adverse impacts are defined as environmental consequences of an action that cannot be avoided, either by changing the nature of the action or through mitigation if the action were undertaken. The proposed project design features, BMPs, and compensatory mitigation would avoid or minimize many of the potential adverse effects associated with the proposed alternatives. However, it would not be possible to avoid all adverse effects, nor would mitigation be 100 percent effective in remediating all impacts. There would be at least a minimal amount of unavoidable impact to most resources in the Kachess and Keechelus reservoirs area for at least a short time, due to the presence of equipment and humans in the area and the time necessary for restoration to be effective.

Unavoidable adverse impacts associated with KDRPP include the following:

- Drawdown of Kachess Reservoir by as much as 80 feet below existing low pool conditions in drought years. The time for Kachess Reservoir to refill to normal operating levels would be 2 to 5 years. Reservoir levels would be below those under the No Action Alternative in 51 percent of years.

- Reduced reservoir elevations in Kachess Reservoir are likely to reduce the abundance of food prey and reduce habitat complexity. Increased drawdown would prevent access to tributary streams at both reservoirs and to Little Kachess basin. Higher Kachess reservoir temperatures may reduce the survival and productivity of native salmonids.
- Removal of approximately 75 acres of vegetation, most of which is forest habitat that supports northern spotted owl.
- Permanent loss of less than 1 acre of wetland near Kachess Dam.
- Reduction of boat access, fishing access, and quality and accessibility of developed and undeveloped recreation at Kachess Reservoir during drawdown in drought years and for 2 to 5 years after drought years as the reservoir refills. Significant impacts to recreation at Kachess Reservoir would increase recreational pressure at other recreation sites, particularly nearby Cle Elum Reservoir.
- Visual changes in the overall landscape character and desirability at Kachess Reservoir during drought years and as the reservoir refills.
- Potential property acquisition for the east shore pumping plant and Gold and Heli’s pond improvements.
- Increased steep slope hazard at Kachess Reservoir during extended drawdown.

Unavoidable adverse impacts associated with KKC include the following:

- Removal of approximately 13 acres of vegetation, most of which is forest habitat that supports northern spotted owls.
- Potential acquisition of easements on private property, including for Gold and Heli’s pond habitat improvements.

4.27 Relationship between Short-Term Uses and Long-Term Productivity

NEPA requires considering “the relationship between short-term uses of man’s environment and the maintenance and enhancement of long-term productivity” (40 CFR 1502.16). This occurs when an agency counterbalances short-term negative effects by a long-term positive effect (and vice-versa). The construction of the project would produce short-term effects to soil, water quality, vegetation, habitat, threatened and endangered species, and fish while providing long-term benefits to instream flows and fish habitat.

4.28 Irreversible and Irretrievable Commitments of Resources

Irreversible commitments are decisions affecting resources, such as wetlands and vegetation, where the resource is lost and replacement can only occur over a long period of time, or at great expense, or cannot be replaced at all (for example, minerals). Irretrievable commitments refer to loss of production or use of resources because of a decision, such as removal of trees, which eliminates another harvest until a new stand grows. They represent opportunities foregone for the period of time that a resource is not useable.

While there would be some temporary and permanent removal of vegetation with this project, overall the irreversible and irretrievable resources associated with that removal are minor relative to the amount of resources available in the basin. There would be an irreversible and irretrievable commitment of the energy used during the manufacture and mining of proposed project components and materials as well as during construction and operation of the project.

4.29 Energy and Depletable Resources

NEPA requires consideration of energy requirements and conservation potential for each EIS alternative (40 CFR 1502.16(e) and Executive Order 13514).

The action alternatives would require expenditures of energy, including natural and depletable resources, during construction of project components; however, the energy use would be short-term and have negligible impacts to energy resources. Each alternative would have similar energy expenditures and impacts.

Operation of the pumping plant under *Alternative 2A*, *2B* or *4* would require construction of a power supply substation and a transmission line connecting the new substation to the Easton Substation to operate KDRPP. The pumping plant would consume additional electricity when in operation during drought years. The anticipated increase falls within normal ratings for bulk electrical systems under normal operating conditions and would not be a significant impact on energy (Reclamation and Ecology, 2014n).

4.30 Environmental Commitments

Environmental commitments are measures or practices adopted by a project proponent to reduce or avoid adverse effects that could result from project operations. Chapter 4 describes specific mitigation measures for project impacts for each resource. The following summarizes major environmental commitments for the project. Reclamation and Ecology share the responsibility to ensure obligations to protect natural resources are fulfilled.

- Obtain all applicable Federal, State and local permits.
- Prior to construction, conduct site-specific geotechnical studies to identify subsurface issues, unstable slopes, and other local factors that could contribute to slope instability and increase erosion potential.
- Conduct continued monitoring of site conditions and erosion potential.
- Develop a surface water quality monitoring program in cooperation with Ecology to monitor changes in water quality associated with the project.
- Monitor wells near Kachess Reservoir to determine if the additional reservoir drawdown lowers groundwater levels. Develop appropriate mitigation strategies if water levels are impacted.
- Enter into a Memorandum of Understanding (MOU) (Appendix A) with Ecology, the Yakama Nation, Service, and WDFW. The MOU provides a framework in which to coordinate and facilitate cooperation among the parties to develop and implement improvements to bull trout habitat within the Yakima River basin as described in the Bull Trout Enhancement Report in Appendix C and consistent with environmental commitments in this section.
- Support a study to examine reservoir productivity and food web impacts from future use of Kachess Reservoir inactive storage.
- Provide bull trout passage between Box Canyon Creek and Kachess Reservoir and between the Little Kachess and Kachess basins to offset impacts of additional draw down at Kachess Reservoir. Conduct general passage improvement activities within Kachess and Keechelus reservoirs.
- Prior to construction, conduct wetland surveys using current wetland delineation methodology. Design projects to avoid wetland impacts. If wetland impacts occur, comply with mitigation measures established in permit conditions to ensure no net loss.
- Prior to construction, coordinate with USFS to determine the presence of any Sensitive or Survey and Manage species and take steps to minimize impacts to those species.

- Monitor for infestations of invasive plant species associated with project ground disturbances and periods of prolonged drawdown of the reservoirs and implement suppression strategies to control invasive plant populations.
- If feasible, extend boat ramps at Kachess Reservoir when the reservoir is drawn down during drought years.
- Implement a public communication strategy to prepare recreation users for the significant impacts on recreation at Kachess Reservoir.
- Implement a construction traffic management plan with specific traffic management measures and procedures for construction contractors.
- Prior to construction, conduct cultural resource studies of all areas that would be disturbed by construction.
- In consultation with DAHP and affected Indian Tribes, develop a treatment plan for all cultural resources directly impacted by the project.
- Develop a Cultural Resource Management Plan to address ongoing and future operational and land management implications of the proposed project.
- Prior to construction, survey utilities in construction areas and take appropriate measures to minimize conflicts with any identified utilities.
- Install signage and post notices to ensure that the general public understands potential safety issues associated with steep slopes along the reservoir.

Reclamation would implement current BMPs when appropriate, to enhance resource protection and avoid additional potential affects to surface and groundwater quality, earth resources, fish, wildlife, and their habitats.

- Haul oils or chemicals to an approved site for disposal and use vegetable-based lubricants in machinery when working in or near water to prevent petroleum products from entering surface or groundwater.
- Develop and implement a Stormwater Pollution Prevention Plan (SWPPP) per Ecology’s rules and regulations. The plan would include erosion control methods, stockpiling, site containment, shoreline protection methods, equipment storage, fueling, maintenance, washing, and methods to secure a construction site under circumstances of an unexpected high water or rain event.
- Equip all construction equipment with environmental spill kits to contain petroleum products in the event of a leak.
- Require all contractors to have a Spill Prevention Plan and a Toxics Containment and Storage Plan.

- Develop and implement a spill plan to implement containment of construction materials such as treated woods, contaminated soils, concrete, concrete leachate, grout, and other substances that may be deleterious or toxic to fish and other aquatic organisms.
- Develop a plan for safe handling and storage of potentially toxic construction materials, fuels, and solvents for staging sites in close proximity to receiving waters and riparian areas.
- Place stockpiles of earthen materials to minimize runoff into nearby receiving waters.
- Require all contractors to inventory noxious weed populations by marking with temporary fencing to avoid spreading weeds to other areas in accordance with Federal, State and local weed control requirements.
- Continue with ongoing weed control efforts on disturbed lands following construction and revegetation in accordance with Federal, State and local requirements.

CHAPTER 5 - PUBLIC INVOLVEMENT, CONSULTATION, AND COORDINATION

Chapter 5 Public Involvement, Consultation, and Coordination

5.1 Introduction

This chapter describes the public involvement, consultation, and coordination activities undertaken by Reclamation and Ecology to date, plus future actions that would occur during the processing of this document. Public information activities would continue through future development of this project.

5.2 Public Involvement

Public involvement is a process where agencies consult and include interested and affected individuals, organizations, agencies, and governmental entities in the decisionmaking process. In addition to providing information to the public regarding this DEIS, Reclamation and Ecology solicited responses regarding the public's needs, values, and evaluations of the proposed alternatives. Both formal and informal input were encouraged and used.

5.2.1 Scoping Process

Reclamation and Ecology sought comments from the interested public, including individuals, organizations, and governmental agencies. The process of seeking comments and public information is called "scoping." Scoping is a term used for an early and open process to determine the scope of issues to be addressed in the EIS and to identify the significant issues related to a proposal.

On October 30, 2013, Reclamation published a Notice of Intent (NOI) to prepare an EIS in the Federal Register. Reclamation and Ecology issued a joint press release to Washington State media on November 6, 2013, announcing the dates and locations of scoping meetings and request for comments. Reclamation mailed meeting notices to interested individuals, Tribes, interest groups, and governmental agencies. Reclamation also posted the notice on its Integrated Plan website and associated pages describing the project, requesting comments, and providing information about the public scoping meetings.

On November 4, 2013, Ecology published its SEPA Determination of Significance (DS) and public notices in area newspapers requesting comments on the scope of the EIS. Ecology also notified by email all those registered on its Yakima Integrated Plan list-serve and posted the notice on its Office of Columbia River website.

On November 20, 2013, Reclamation and Ecology held two public open houses/scoping meetings at the Yakima Arboretum in Yakima, Washington—one in the afternoon and one in the evening. Twenty-three individuals attended the two meetings. At the meetings, Reclamation described the KDRPP and KKC Projects proposal and gave attendees the opportunity to discuss the proposal with Reclamation and Ecology staff as well as comment on the scope of the EIS, the EIS process, and resources to be evaluated in the EIS.

On November 21, 2013, Reclamation and Ecology held two public open houses/scoping meetings at the USFS headquarters in Cle Elum, Washington - one in the afternoon and one in the evening. Thirty-three individuals attended the two meetings. The meeting format followed that of the Yakima meetings.

5.2.2 Comments Received from the Public

The scoping period began October 30, 2013, and concluded December 16, 2013, during which time the agencies received 39 comment letters. The comments covered a wide range of topics. One of the major concerns was the effect of the additional drawdown of Kachess Reservoir and its ability to refill following the drawdown. Comments expressed concerns about the effects of the drawdown on fish, recreation access, groundwater wells, aesthetics, and property values. Concerns about the KKC proposal related to whether the project could benefit flows and fish in the upper Yakima River and the impacts on aquatic species from the transfer of water from one reservoir to another. Other concerns included impacts of a tunnel on groundwater flow and transportation corridors, coordination of the project with other projects in the area such as the I-90 Snoqualmie East Project, and construction impacts.

Reclamation and Ecology prepared a Scoping Summary Report that summarizes the comments received (Reclamation and Ecology, 2014i). The report is available from Reclamation upon request or can be accessed from the Yakima River Basin Water Enhancement Project (YRBWEP) 2011 Integrated Plan website: http://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html.

5.2.3 Comments on this DEIS

The public comment period for this DEIS will begin on January 9, 2015, and extend to March 10, 2015. Reclamation and Ecology will conduct public hearings for this DEIS on February 3 and 5 in Ellensburg and Cle Elum, Washington, respectively. Reclamation will accept written comments from the public and will compile a transcript of public comments provided at the public hearings. Reclamation and Ecology will consider all public comments in the development of the Final EIS (FEIS). The FEIS will include all the public comments, responses to those comments, and modifications to the FEIS made in response to those comments.

5.3 Consultation and Coordination

The Council on Environmental Quality regulations (40 CFR 1501.6) emphasize agency cooperation early in the NEPA process and allow a lead agency (in this instance, Reclamation) to request the assistance of other agencies that either have jurisdiction by law or have special expertise regarding issues considered in an EIS. Reclamation requested that the BPA, NMFS, USFS, U.S. Fish and Wildlife Service, and the Yakama Nation participate as cooperating agencies in the EIS. The BPA and Yakama Nation both responded that they would participate as cooperating agencies due to their special expertise regarding issues considered in the EIS. USFS also responded that they would participate as cooperating agencies based on their jurisdictional responsibilities under the National Forest Management Act, as well as their special expertise regarding issues considered in the EIS. The Service requested that its participation in the EIS be accomplished through the Fish and Wildlife Coordination Act instead of acting as a cooperating agency. The Service's request was agreed to by Reclamation. NMFS declined to be a cooperating agency.

5.4 Tribal Consultation and Coordination

Reclamation and Ecology have determined that the project area lies within the ceded territory of the Yakama Nation. The Yakama Nation is a major partner in the overall Integrated Plan and has been involved in all aspects of the Integrated Plan, including the KDRPP and KKC projects. Additionally, the Yakama Nation is conducting Historic Resource surveys to assist Reclamation and Ecology with compliance activities associated with the NHPA and Washington State preservation laws.

Reclamation is consulting with the Colville Confederated Tribes under the NHPA. The Confederated Colville Tribes will receive copies of the draft EIS and the final EIS.

Reclamation sent a letter on July 24, 2014, requesting Government-to-Government consultation with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Reclamation will schedule meetings to discuss the project. The CTUIR will also receive copies of the DEIS and the FEIS.

5.4.1 Native American Graves Protection and Repatriation Act

The 1990 NAGPRA regulates Tribal consultation procedures in the event of discoveries of Native American graves and other NAGPRA "cultural items." NAGPRA requires consultation with Tribes during Federal project planning if graves and other NAGPRA cultural items are discovered. NAGPRA details procedures for repatriation of human skeletal remains and other cultural items to appropriate Tribes. Reclamation will comply with NAGPRA regulations (43 CFR Part 10) if any graves or other NAGPRA cultural items are discovered.

5.4.2 Executive Order 13175: Consultation and Coordination with Tribal Governments

Executive Order 13175 instructs Federal agencies to consult, to the greatest extent practicable and to the extent permitted by law, with Tribal governments prior to taking actions that affect federally recognized Tribes. Each agency assesses the impact of Federal Government plans, projects, programs, and activities on Tribal trust resources and assures consideration of government rights and concerns during the development of such plans, projects, programs, and activities. As described in Sections 5.3 and 5.4, Reclamation has consulted with the Yakama Nation, Colville Tribes, and CTUIR. This DEIS evaluated potential impacts to cultural resources (Section 4.18), Indian sacred sites (Section 4.19) and Indian Trust Assets (Section 4.20).

5.4.3 Executive Order 13007: Indian Sacred Sites

Executive Order 13007 (May 24, 1996) instructs Federal agencies to promote accommodation of access to and protect the physical integrity of American Indian sacred sites. A "sacred site" is a specific, discrete, and narrowly delineated location on Federal land. An Indian Tribe or an Indian individual determined to be an appropriately authoritative representative of an Indian religion must identify a site as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion. However, the EO includes the proviso that the Tribe or authoritative representative has to inform the agency of the existence of such a site. As described in Section 4.19, Reclamation has determined the project would not impact Indian sacred sites because none are identified in the project area. Reclamation will continue to coordinate with affected Tribes and, if any Indian sacred sites are identified in the future, Reclamation will consult with affected Tribes to determine how to protect the sacred sites.

5.4.4 Secretarial Order 3175: Department Responsibilities for Indian Trust Assets

ITAs are legal interests in property held in trust by the United States for federally recognized Indian Tribes or individual Indians. ITAs may include land, minerals, federally reserved hunting and fishing rights, federally reserved water rights, and instream flows associated with trust land. The United States allotted some Tribes land under the General Allotment Act of 1887, while the United States allotted others land through treaty or specific legislation until 1934, when Congress prohibited further allotments. These allotments are ITAs.

Federally recognized Indian Tribes with trust land are beneficiaries of the Indian trust relationship. The United States acts as trustee. By definition, no one can sell, lease, or otherwise encumber ITAs without approval of the U.S. Government.

Reclamation contacted the BIA Yakima Office to identify the presence of ITAs or trust land (allotments) in the project area. BIA personnel indicated that there are no allotments in the Kachess or Keechelus Reservoir area. Reclamation also contacted the BIA Colville Tribes Office who also indicated that there is no trust land in the project area (Wolf, 2014).

Reclamation has determined that the project area does not include land held in trust by the United States for Tribes or individual allottees, nor does the project area include trust land or allotments. However, some Tribes have stated in the past that habitat for fishing, hunting, and gathering located on federally owned land may constitute an ITA. While this is not Reclamation's position, the Government respects and acknowledges this Tribal perspective.

5.5 Compliance with Federal and State Laws and Executive Orders

In addition to the agency and Tribal coordination and consultation laws, Executive orders, and regulations described above, Reclamation will comply with the following laws and Executive orders on the KDRPP and KKC Projects.

5.5.1 Endangered Species Act

The ESA requires all Federal agencies to ensure that their actions do not jeopardize the continued existence of ESA-listed species, or destroy or adversely modify their critical habitat. As part of the ESA's Section 7 process, an agency must request a list of species from the Service and the NMFS that identifies threatened and endangered species within or near the action area. The agency then must evaluate impacts to those species. If the action may impact any ESA-listed species, the agency must consult with the Service or NMFS, or both.

Reclamation will initiate consultation with the Service and NMFS on the KDRPP and KKC projects through preparation of a Biological Assessment (BA). Following review of the BA, the Service and NMFS would be expected to issue a determination that addresses the effect of the projects on listed species. Additional information on the ESA consultation process will be included when consultation is complete.

5.5.2 Fish and Wildlife Coordination Act

The FWCA provides for equal consideration of wildlife conservation in coordination with other features of programs on water resource development. The FWCA requires that any plans to impound, divert, control, or modify any stream or other body of water must be coordinated with the Service and State wildlife agency through consultation directed toward prevention of fish and wildlife losses and development or enhancement of these resources.

Reclamation consulted with the Service regarding the Integrated Plan. The Service completed the *Final Fish and Wildlife Coordination Act Report for the Integrated Plan* in February 2012; Reclamation posted it on the Yakima River Basin Water Enhancement Project Integrated Plan website at http://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html. Reclamation consulted with the Service regarding the need for further FWCA consultation for KDRPP and KKC. The Service determined that all impacts for KDRPP and KKC were considered in the *Final Fish and Wildlife Coordination Act Report for the Integrated Plan* and that FWCA consultation was complete for the projects.

5.5.3 National Historic Preservation Act

The NHPA of 1966, as amended, requires that Federal agencies consider the effects that their projects have on properties eligible for or on the National Register of Historic Places (the Register). The 36 CFR 800 regulations provide procedures that Federal agencies must follow to comply with the NHPA. For any undertaking, Federal agencies must determine if there are properties of National Register quality in the project area, the effects of the project on those properties, and the appropriate mitigation for adverse effects. In making these determinations, Federal agencies are required to consult with the SHPO, Native American Tribes with a traditional or culturally-significant religious interest in the study area, the interested public, and the Advisory Council on Historic Preservation (in certain cases).

Reclamation has determined that the Proposed Action could impact identified archaeological sites (Section 4.18). Reclamation has initiated consultation with the SHPO and with Native American Tribes (Section 5.4). Reclamation will conduct additional cultural resource surveys of Proposed Action areas prior to construction. Reclamation will continue consultation regarding impacts to historic and cultural resources and will develop and implement a treatment plan and a Cultural Resources Management Plan to define appropriate impact avoidance and mitigation. Reclamation would execute a Memorandum of Agreement to resolve any adverse effects to historic properties.

5.5.4 Clean Water Act

Section 404 of the CWA regulates the discharge of dredged or fill materials into waters of the United States, including wetlands. The Corps evaluates applications for Section 404 permits. Permit review and issuance follows a sequence process that encourages avoidance of impacts, followed by minimizing impacts and, finally, requires mitigation for unavoidable impacts to the aquatic environment. The guidelines at Section 404(b)(1) of the CWA describe this sequence.

Section 4.4 describes potential impacts to water quality. Reclamation will implement best management practices and other techniques to minimize the potential for erosion and sedimentation during construction, the most likely impact to water quality. Reclamation will coordinate with Ecology to develop an appropriate monitoring program and will develop mitigation for any detected water quality impacts. Reclamation will consult with the Corps regarding impacts to water quality and will comply with permit conditions.

As described in Section 4.7, Reclamation will survey all construction areas prior to construction to determine the presence of wetlands. Reclamation will design shoreline protection measures to avoid or minimize impacts to wetlands and will locate construction staging areas, roads and other facilities outside wetlands to the extent possible. If wetland impacts are unavoidable, Reclamation will consult with the Corps and will comply with mitigation measures established by permit conditions.

5.5.5 Executive Order 11990: Protection of Wetlands

Executive Order 11990 (May 24, 1977) directs Federal agencies to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial value of wetlands in carrying out programs affecting land use. Reclamation's actions to comply with this Executive order are described in Section 5.5.4.

5.5.6 Executive Order 12898: Environmental Justice

Executive Order 12898 (February 11, 1994) instructs Federal agencies, to the greatest extent practicable and permitted by law, to make achieving environmental justice part of its mission by addressing, as appropriate, disproportionately high and adverse human health or environmental effects on minority populations and low income populations. Environmental justice means the fair treatment of people of all races, income, and cultures with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no person or group of people should shoulder a disproportionate share of negative environmental impacts resulting from the execution of environmental programs. As described in Section 4.22, Reclamation does not expect the project to cause impacts to environmental justice populations.

5.5.7 Executive Order 11988: Floodplain Management

Executive Order 11988 (May 24, 1977) instructs Federal agencies to determine to the greatest extent practicable whether the Proposed Action will occur in a floodplain prior to taking an action, and if so, to consider alternatives to avoid adverse effects. If the only feasible alternatives occur within a floodplain, the agency shall take action to design or modify its action to minimize potential harm to or within the floodplain consistent with regulations accompanying this Executive Order.

The shoreline of Keechelus Reservoir, the Yakima River downstream of the reservoir, and Gold and Coal creeks upstream of the reservoir are within the mapped 100-year floodplain. Kachess Reservoir and the Kachess River both upstream and downstream from the reservoir are within the mapped 100-year floodplain as well. The proposed projects would not cause additional flooding in the reservoirs because they would cause reduced reservoir levels. The projects would not cause flooding downstream because Reclamation would continue its flood control operations and the additional flows from the reservoirs would be released during low flow periods in the river.

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Yakima Herald Republic, Yakima

GLOSSARY

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acre-foot	The volume of water that could cover 1 acre to a depth of 1 foot. Equivalent to 43,560 cubic feet or 325,851 gallons.
active capacity	The reservoir capacity or quantity of water, which lies above the inactive reservoir capacity and normally is usable for storage and regulation of reservoir inflow to meet established reservoir operating requirements.
adfluvial	Fish that spawn in tributary streams where the young rear from 1 to 4 years before migrating to a lake system, where they grow to maturity.
alluvial	Composed of clay, silt, sand, gravel, or similar material deposited by running water.
alluvium	Is loose, unconsolidated (not cemented together into a solid rock) soil or sediments, which has been eroded, reshaped by water in some form, and redeposited in a non-marine setting.
anadromous	Fish that hatch and develop to adolescence in rivers and migrate to saltwater to feed, then migrate from saltwater to freshwater to spawn.
benthic	Relating to the bottom of a sea or lake or to the organisms that live there.
cfs	Flow rate in cubic feet per second.
colluvium	A general name for loose, unconsolidated sediments that have been deposited at the base of hillslopes. It is typically composed of a heterogeneous range of rock types and sediments ranging from silt to rock fragments of various sizes.
cumulative effect	For NEPA purposes, these are impacts to the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such action.
emergence	Refers to the fry lifestage of the salmon when they swim up through the substrate from their incubation nest (red) to live along the stream edge.
emergent	Wetland class characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens.

endangered species	Under the Endangered Species Act, a species that is in danger of extinction throughout all or a significant portion of its range. To term a run of salmon “endangered” is to say that particular run is in danger of extinction.
Environmental Justice	The fair treatment of people of all races and incomes with respect to actions affecting the environment. Fair treatment implies that there is equity of the distribution of benefits and risks associated with a proposed project and that one group does not suffer disproportionate adverse effects.
epilimnion	The top-most layer of water in a thermally stratified lake (reservoir), occurring above the deeper hypolimnion.
eutrophication	The process by which a body of water becomes enriched in dissolved nutrients that stimulate the growth of aquatic plant life, usually resulting in the depletion of dissolved oxygen.
feasibility study	Detailed investigation specifically authorized by the Congress to determine the desirability of seeking congressional authorization for implementation of a preferred alternative, normally the NED Alternative, which reasonably maximized net national economic development benefits.
flip-flop	An operational action in the upper Yakima River basin in late summer to encourage anadromous salmon to spawn at lower river state levels so that the flows required to keep the redds watered and protected during the subsequent incubation period are minimized.
flow	The volume of water passing a given point per unit of time.
flow objectives	The desired monthly streamflow used to guide RiverWare model operation criteria. Also used to evaluate alternative performance in terms of how closely they meet the desired monthly streamflow.
fry	The life stage of fish between the egg and fingerling stages. Depending on the fish species, fry can measure from a few millimeters to a few centimeters in length (see also fingerling and smolt).

glacial till	An unsorted glacial sediment.
habitat	The combination of resources and the environmental conditions that promotes occupancy by individuals of a given species and allows those individuals to survive and reproduce.
historic property	Any building, site, district, structure, or object (that has archeological or cultural significance) included in, or eligible for inclusion in, the National Register.
hydraulic conductivity	The rate at which the water can move through an aquifer.
hypolimnion	The dense, bottom layer of water in a thermally-stratified lake (reservoir). It is located below the epilimnion.
inactive capacity	The reservoir capacity or quantity of water, which lies beneath the active reservoir capacity and is normally unavailable for withdrawal because of operating agreements or physical constraints.
Indian Sacred Site	A specific, discrete, narrowly delineated location on Federal land that is identified by an Indian Tribe or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion.
Indian Trust Assets	Legal interests in property held in trust by the United States for Indian Tribes or individuals. They are rights that were reserved by or granted to American Indian Tribes or Indian individuals by treaties, statutes, and Executive orders. These rights are sometimes further interpreted through court decisions and regulations.
instream flows	Waterflows for designated uses within a defined stream channel, such as minimum flows for fish, wildlife, recreation, or aesthetics.
junior water rights	Proratable water rights that, in water-short years, receive less than their full right on a prorated basis.
lacustrine wetland	A freshwater lake wetland; as deep water habitat that exceeds 20 acres in size and lacks trees, shrubs, or emergent vegetation.
littoral	The part of a lake that is closest to the shoreline.
megavolt ampere	The unit used for the apparent power in an electrical circuit. Apparent power is the product of the root-mean-square of voltage and current, used only for alternating current (AC).

metamorphic rock	Refers to rocks that have changed in form from their original rock type (sedimentary or igneous) in response to extreme changes in temperature, pressure, or chemical environment (i.e. limestone into marble).
moraine	Any glacially formed accumulation of unconsolidated glacial debris (soil and rock) that occurs in currently glaciated and formerly glaciated regions.
natural flow	Riverflow that originates from a source other than reservoir storage.
nonproratable water rights	Pre-Yakima Project senior water rights related to natural flows that are served first and cannot be reduced until all the proratable rights are regulated to zero.
oligotrophic	Lacking plant nutrients and usually containing plentiful amounts of dissolved oxygen without stratification.
ogee-crest	A type of spillway that over-tops a dam.
palustrine wetland	A freshwater wetland dominated by vascular and nonvascular plants, although some palustrine wetlands may also lack vegetation.
parr	Juvenile anadromous salmonids actively feeding and rearing in freshwater.
pipe jacking	Pipe jacking is a trenchless method for installing steel pipelines. Hydraulic jacks are used to push specially designed pipes through the ground behind a shield, at the same time as excavation is taking place in front. Spoils are directed to within the pipe.
proratable water rights	Newer junior water rights related to storage water that, in water-short years, receive less than their full right on a prorated basis.
prorationing	The process of equally reducing the amount of water delivered to junior (i.e., “proratable”) water right holders in water-deficient years.
reach	Any length of a stream between any two points.
redd	The nest that a spawning female salmon digs in gravel to deposit her eggs.
riparian	Relating to, living in, or located on a water course.
River Mile	Measure of distance in miles along a river measured from the mouth of the river upstream.

salmonid	A family of soft-finned fishes of cold and temperate waters that includes salmon, trout, chars, freshwater whitefishes and graylings.
sediment	Any very finely divided organic or mineral matter deposited by water in nonturbulent areas.
senior water rights	Nonproratable water rights that are served first and cannot be reduced until all the proratable rights are regulated to zero.
shotcrete	A construction method in which concrete is projected at high velocity onto a surface using a hose.
smolt	Adolescent salmon or steelhead, usually 3 to 7 inches long, that are undergoing changes preparatory for living in saltwater (see also fry and fingerling).
stock	The fish spawning in a particular lake or stream(s) (or portion of it) at a particular season, which to a substantial degree, do not interbreed with any group spawning in a different place, or in the same place at a different season.
target flows	Flows quantified in Title XII of the Act of October 31, 1994, for two points in the Yakima River basin (Sunnyside and Prosser Diversion Dams).
terrestrial	Of or relating to land as distinct from air or water.
thermocline	In lakes, transition layer between the mixed layer at the surface and the deep water layer. In the thermocline, temperature decreases rapidly from the mixed layer to the colder deep-water layer.
threatened species	Under the Endangered Species Act, a species that is likely to become endangered within the foreseeable future.
Title XII target flows	Specific instream target flows established for Yakima Project operations at Sunnyside and Prosser Diversion Dams by Title XII of the Act of October 31, 1994 (Public Law 103–464).
total water supply available (TWSA)	The total water supply available for the Yakima River basin above the Parker gage for the period April through September.
ungulate	A four-legged, hoofed animal.
unregulated flow	The flow regime of a stream as it would occur under completely natural conditions; that is, not subjected to modification by reservoirs, diversions, or other human works.
waterway	A channel for conveying or discharging excess water.

water year	The 12-month period from October through September. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. For example, the year ending September 30, 1992, is called the “1992 water year.”
watershed	The total land area draining to any point in a stream.
wetland	Generally, an area characterized by periodic inundation or saturation, hydric soils, and vegetation adapted for life in saturated soil conditions.

Appendix A

DRAFT BULL TROUT ENHANCEMENT MEMORANDUM OF UNDERSTANDING

DRAFT

MEMORANDUM OF UNDERSTANDING
between
Confederated Tribes and Bands of the Yakama Nation
and
U.S. Fish and Wildlife Service
and
U.S. Forest Service
and
State of Washington Department of Ecology
and
State of Washington Department of Fish and Wildlife
and
United States Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office

This Memorandum of Understanding (MOU) is entered into by Bureau of Reclamation, Pacific Northwest Region, Columbia-Cascades Area Office, (Reclamation), State of Washington Department of Fish and Wildlife (WDFW), State of Washington Department of Ecology (Ecology), United States Fish and Wildlife Service (USFWS), United State Forest Service and the Confederated Tribes and Bands of the Yakama Nation (YN), (collectively, "the parties"), pursuant to the Reclamation Act of June 17, 1902 (32 Stat. 388), and acts amendatory thereof or supplementary thereto. This MOU identifies the parties respective roles in the development and the implementation of the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan), specifically, to implement bull trout recovery actions and/or projects within the Yakima River basin to achieve self-sustainable, healthy, harvestable populations of native bull trout (*Salvelinus confluentus*) which are currently listed with the USFWS as a threatened species pursuant to the Endangered Species Act of 1973, as amended (Act) (64 FR 58910; November 1, 1998).

1. Background

Reclamation and Ecology share authority for developing the Integrated Plan. Federal authority is through the Yakima River Basin Water Enhancement Project[1] and State authority is through the 2013 Yakima Policy Bill and State Capital budget.[2] The Integrated Plan identifies a comprehensive approach to water resources and ecosystem restoration improvements in the Yakima River basin.

[1] Yakima River Basin Water Enhancement Project (YRBWEP) was authorized on December 28, 1979 (93 Stat. 1241, Public Law 96-162, Feasibility Study—Yakima River Basin Water Enhancement Project and Title XII, Yakima River YRBWEP, of the Yavapai-Prescott Indian Tribe Water Rights Settlement Act of 1994 (Public Law 103-434).
[2] Chapter 90.38 RCW, the Yakima River Basin Water Resource Management legislation approved by the Washington State Legislature in 2013.

The Integrated Plan includes seven elements: (1) reservoir fish passage; (2) structural and operational changes to existing facilities; (3) surface water storage; (4) groundwater storage; (5) habitat/watershed protection and enhancement; (6) enhanced water conservation; and (7) market reallocation. The Integrated Plan was developed to address a variety of water resource and ecosystem problems affecting fish passage, fish habitat, and water supplies for agriculture, municipalities, and domestic use.

The Integrated Plan Workgroup is primarily made up of representatives of statutorily created organizations. This includes State and Federal agencies, the Yakama Nation, local government, irrigation districts and environmental groups. The Integrated Plan is not intended to supersede, enhance, or impair any organizations' responsibilities, contracts, rights or authorities. It is the intent of Reclamation and Ecology to ensure Integrated Plan projects are implemented in such a way to provide a balanced approach to meeting out-of-of stream and fisheries protection and restoration demands.

Bull trout were listed as threatened in 1998. The historic abundance of bull trout in the basin is not well defined but the historic distribution was likely broader than currently exists with many distinct populations. The basin was recently designated as critical bull trout habitat, and there is a need to restore year-round connectivity of bull trout habitat between lakes and mainstem rivers, including the Yakima and Naches Rivers.

As a stated long-term goal within the Final Integrated Plan Programmatic Environmental Impact Statement (PEIS) (March 2012), the parties acknowledge that bull trout recovery efforts should be developed and implemented to achieve self-sustainable, healthy, harvestable populations of native bull trout within the Yakima River Basin. The parties recognize that water is a valuable resource in Washington State and as demand increases, ensuring that bull trout have "cold, clean, complex, and connected habitat"[3] is vital to attain and surpass the Endangered Species Act (ESA) recovery threshold in the basin.

2. Purpose

The purpose of this MOU is to provide a framework in which to coordinate and facilitate cooperation among the parties to develop and implement bull trout recovery actions within the Yakima River basin. Bull trout recovery actions are intended to support the fish passage, habitat restoration, and habitat/watershed protection elements within the Final PEIS, as well as subsequent project-level Environment Impact Statements (EIS). Objectives of this MOU include using Integrated Plan processes and committees to ensure proposed bull trout recovery actions are most effective at achieving bull trout recovery in the Yakima River basin. The Yakima Basin Bull Trout Action Plan (BTAP) and the USFWS Bull Trout Recovery Plan are examples of bull trout resource protection and enhancement plans that will be used to inform the Integrated Plan bull trout decisions.

Pursuant to this MOU, the parties agree that:

a. Development and implementation of Integrated Plan actions will continue to move forward through a collaborative process, in conjunction with bull trout recovery within the Yakima River basin;

[3] Draft Bull Trout Recovery Plan, USFWS (2014).

b. This MOU shall be referenced in the Environmental Commitments section and included as an appendix to the project-level EIS for the Kachess Drought Relief Pumping Plant/Keechelus Reservoir-to-Kachess Reservoir Conveyance, which includes the Bull Trout Enhancement (BTE);

c. WDFW, USFWS, and Yakama Nation each have legal authority for protection and restoration of the fish species of the Yakima River basin;

d. Reclamation and Ecology each have legal authority for water management in the Yakima River basin for a variety of instream and out-of-stream uses including fisheries protection and restoration;

e. Working together will ensure fisheries protection and recovery efforts are accomplished concurrently with out-of-stream needs within the Yakima River basin;

f. Recovery, for the purposes of this MOU and the Integrated Plan, is achieved when self-sustainable, healthy, harvestable populations of native salmonids occur throughout their natural range in the Yakima River basin;

g. Bull trout are a salmonid of the Yakima River basin currently listed as threatened through and protected by the ESA;

h. Bull trout populations are critically depressed or functionally extirpated in parts of the Yakima River basin and susceptible to injury by way of changes to reservoir operations, timing, short-term and long-term habitat response, predator-prey interactions, and risk factors such as barriers (physical and temporal), recreation, and climate change;

i. Implementation of Integrated Plan and BTE projects shall result in a net gain to fish resources and their habitat and in the long run will help lead bull trout recovery in the Yakima River basin; and

j. No project shall result in a net harm to bull trout, at all life stages, or bull trout critical habitat, and pursuant to this MOU and the intent of the Integrated Plan to consistently support the recovery of bull trout throughout the Yakima River basin.

3. Implementing Actions

The parties will work cooperatively through the Integrated Plan Workgroup and its subcommittees to provide oversight and direction for bull trout recovery actions related to the Integrated Plan. The parties, working through the Integrated Plan processes and committees, will continue to develop bull trout recovery actions concurrent with development, construction, and operation of the Cle Elum Pool Raise, the Kachess Drought Relief Pumping Plant, and the Keechelus-to-Kachess Pipeline.

The parties agree to work together and within the Integrated Plan process to:

a. Implement Phase 1 BTE projects and evaluations identified in the project-level EIS for the Kachess Drought Relief Pumping Plant/Keechelus-to-Kachess Conveyance in the first 5 years; implement Phase 2 actions identified and designed based on Phase 1 assessments and evaluations in years 5 through 10; project implementation is contingent on Kachess Drought Relief Pumping Plant/Keechelus-to-Kachess Conveyance authorization and funding; implement additional bull trout recovery actions as Integrated Plan water enhancement projects are developed and implemented contingent on authorization and funding;

b. To provide guidance on how to operate the Kachess Drought Relief Pumping and Keechelus-to-Kachess Conveyance projects as part of the Yakima River Basin system to maintain environmental conditions needed to ensure existing bull trout populations remain viable

c. Evaluate/conduct: a) the feasibility for wild bull trout population enhancement (e.g. supplementation and translocation) in the Yakima River basin; b) habitat assessments and/or limiting factor analyses, c) fish passage for juvenile and adult fishes; d) interaction with nonnative species; e) monitoring, evaluation, and adaptive management; f) primary and secondary productivity assessment(s) (prey base and limiting factors); and g) climate change resiliency planning;

d. Support Reclamation and Ecology through subsequent project-level environmental compliance development, permitting processes, and project-level scientific and technical review and assistance;

e. Provide scientific review and recommendations, as necessary, regarding future Integrated Plan actions and potential impacts and/or benefits to bull trout and bull trout critical habitat;

f. Support recommended bull trout recovery and enhancement actions and/or projects through the Integrated Plan that support Reclamation and Ecology's Integrated Plan obligations;

g. Ensure water supply projects are accompanied with a set of fish/habitat enhancement projects that improve conditions for native fish species of the Yakima River basin, specifically, projects that provide measureable benefits to bull trout at all life stages and bull trout critical habitat; and

h. Develop and implement a long-term monitoring and evaluation plan to assess bull trout populations at all life stages and bull trout critical habitat changes, associated with implementing actions pursuant to this MOU.

The parties agree that, working cooperatively, the following activities shall be accomplished by Reclamation, Ecology, WDFW, USFWS and the Yakama Nation:

i. BTE projects are intended to be incorporated in all relevant State and Federal permits;

ii. Assist with securing short-term and long-term funding from local, State, and Federal entities to execute bull trout recovery actions and/or projects and activities necessary to accomplish the purposes of this MOU;

iii. Actively participate in the Integrated Plan habitat subcommittee to support bull trout recovery actions and/or projects within the Yakima River basin as a nondiscretionary element of on-going Integrated Plan activities;

iv. Support coordination and use of previous bull trout recovery work including utilizing the BTAP and USFWS Bull Trout Recovery Report;

v. Ensure participation of individuals with local bull trout expertise to ensure that recovery actions associated with the Integrated Plan are the most biologically effective and cost effective actions possible; and

vi. Continually explore opportunities to implement priority bull trout recovery actions and/or projects that maximize State and Federal investment dollars by partnering with other entities and leveraging other fisheries recovery funds to fulfill an array of bull trout recovery goals and objectives.

4. Period of Performance

This MOU shall become effective on the date of last signature hereto and through the initial phase of the Integrated Plan. The initial phase of the Integrated Plan is estimated to be 10 years. All Implementing Actions shall commence simultaneously, with or before, construction of the Cle Elum Pool Raise, Kachess Drought Relief Pumping Plant Project, and the Keechelus-to-Kachess Conveyance Project pending authorization and funding. The MOU shall terminate 10 years from when it was signed by the parties to align with the initial phases of the Integrated Plan.

5. Modifications

All parties to this MOU may formally request modifications to this MOU. Modifications shall be made by mutual consent by the issuance of a written modification to this MOU, signed and dated by all parties prior to any changes being performed.

6. Principal Contacts

The principal contacts for this MOU are:

Reclamation	Ecology	WDFW
Dawn Wiedmeier 1917 Marsh Road Yakima WA 98902	Derek I. Sandison 15 W. Yakima Ave, Ste 200 Yakima WA 98902	Mike Livingston 1701 S. 24th Ave Yakima WA 98902
USFWS	**USFS**	**Yakama Nation**
Jim Craig Mid-Columbia River FRO 7501 Icicle Road Leavenworth WA 98826	Patty Garvey-Darda Cle Elum Ranger District 803 W. 2nd Street Cle Elum WA 98922	Phil Rigdon PO Box 151 Toppenish WA 98948

7. General Provisions

a. **This MOU is neither a fiscal nor a funds obligating document.** Any endeavor or transfer of anything of value involving reimbursement or contribution of funds between the parties of this MOU will be handled in accordance with applicable laws, regulations, and procedures including those for Government procurement and printing. Such endeavors will be outlined in separate agreements that shall be made in writing by representatives of the parties and shall be independently authorized by appropriate statutory authority. This MOU does not provide such authority. Specifically, this MOU does not establish authority for noncompetitive award to the parties of any contract, other agreement or commitment of funds.

b. No member of or delegate to Congress, or resident Commissioner, shall be admitted to any share or part of the MOU or to any benefit that may arise out of it.

c. All parties to this MOU agree to comply with all Federal statutes relating to nondiscrimination, including but not limited to: Title VII of the Civil Rights Act of 1964, as amended, which prohibits discrimination on the basis of race, color, religion, sex, or national origin; Title IX of the Education amendments of 1972, as amended, which prohibits discrimination of the basis of sex; the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act of 1990, as amended, which prohibit discrimination on the basis of disability; the Age Discrimination in Employment Act of 1967, as amended, which prohibits discrimination based on age against those who are at least 40 years of age; and the Equal Pay Act of 1963.

d. Any information furnished to Reclamation, under this MOU, is subject to the Freedom of Information Act (5 U.S.C. 552).

8. Signatures

IN WITNESS WHEREOF, the parties hereto have executed this MOU as of the last date written below.

____________________________________ ________________
Date

Confederated Tribes and Bands of the Yakama Nation

____________________________________ ________________
Date

United States Fish and Wildlife Service

____________________________________ ________________
Date

United States Forest Service

__________________________________ _______________

Date

State of Washington Department of Ecology

__________________________________ _______________

Date

State of Washington Department of Fish and Wildlife

__________________________________ _______________

Date

Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office

~~ End of Document ~~

Appendix B

NOTICE OF ADOPTION

NOTICE OF ADOPTION OF EXISTING ENVIRONMENTAL DOCUMENT

Description of current proposal: Kachess Drought Relief Pumping Plant and Keechelus to Kachess Conveyance Projects Environmental Impact Statement (EIS)

Proponent: Washington State Department of Ecology

Location of current proposal: Kittitas County, State of Washington

Title of documents being adopted:

> Yakima River Basin Integrated Water Resource Management Plan Final Programmatic Environmental Impact Statement (Reclamation and Ecology, 2012)

Date adopted documents were prepared: March 2012

Description of documents being adopted:

> The Yakima River Basin Integrated Water Resource Management Plan Programmatic EIS is a joint NEPA/SEPA document prepared by Reclamation and Ecology. The EIS evaluates the potential impacts of implementing the Integrated Plan, a comprehensive approach to water resources and ecosystem restoration improvements in the Yakima River basin. The Integrated Plan includes seven elements: reservoir fish passage, structural and operational changes to existing facilities, surface water storage, groundwater storage, habitat/watershed protection and enhancement, enhanced water conservation, and market reallocation. It is adopted to help document the potential impacts of the KDRPP and KKC projects, which are included as projects in the Integrated Plan and were evaluated at a programmatic level in the Integrated Plan EIS.

If the document being adopted has been challenged (WAC 197-11-630), please describe:

N/A

The document is available to be read at (place/time): The adopted document was distributed to agencies with jurisdiction, Tribes and other interested parties when they were released. The document may be viewed at Department of Ecology offices during normal business hours (8:00 a.m. to 5 p.m., Monday to Friday) at the following locations:

> Department of Ecology Headquarters
> 300 Desmond Drive
> Lacy, WA 98503
>
> Department of Ecology Central Regional Office
> 15 West Yakima Avenue, Suite 200
> Yakima, WA 98902-3452

The adopted document can be viewed on-line at the following location:

http://www.usbr.gov/pn/programs/yrbwep/reports/FPEIS/fpeis.pdf

EIS REQUIRED: The lead agency has determined the Kachess Drought Relief Pumping Plant and Keechelus to Kachess Conveyance Projects are likely to have significant adverse impact on the environment. To meet the requirements of RCW 43.21C.030(2)(c), the lead agency is adopting portions of the NEPA and SEPA documents described above, in addition to preparing a stand-alone NEPA/SEPA EIS for the proposal, to fulfill its requirements under SEPA.

The lead agency has determined that this document is appropriate for the proposal and will accompany the proposal to decision makers.

Nam of agency adoption document: Washington State Department of Ecology

Responsible Official: Derek I. Sandison

Position/title: Director, Office of Columbia River

Address: 303 S. Mission Street, Suite 200
Wenatchee, WA 98801

Phone: 509-662-0516

Date: October 16, 2014 **Signature:** ______________________

Appendix C

BULL TROUT ENHANCEMENT

Bull Trout Enhancement

Kachess Drought Relief Pumping Plant and Keechelus-To-Kachess Conveyance

Kittitas and Yakima Counties, Washington

A Component of the Yakima River Basin
Integrated Water Resource Management Plan

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office
Yakima, Washington

State of Washington
Department of Ecology
Office of Columbia River
Yakima, Washington

December 2014

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The mission of the Department of Ecology is to protect, preserve and enhance Washington's environment, and promote the wise management of our air, land and water for the benefit of current and future generations.

Acronyms and Abbreviations

Ecology	Washington State Department of Ecology
ESA	Endangered Species Act
KDRPP	Kachess Drought Relief Pumping Plant
KCT	Kittitas Conservation Trust
KDRPP	Kachess Drought Relief Pumping Plant
KKC	Keechelus-to-Kachess Conveyance
Reclamation	Bureau of Reclamation
Service	U.S. Fish and Wildlife Service
USFS	U.S. Forest Service
WDFW	Washington Department of Fish and Wildlife
YBTAP	*Yakima Bull Trout Action Plan*

Contents

CHAPTER 1: INTRODUCTION

As a component of both the Kachess Drought Relief Pumping Plant (KDRPP) and Keechelus-to-Kachess Conveyance (KKC) projects, the Bureau of Reclamation and Washington State Department of Ecology have identified bull trout enhancement projects to address a need for improving the resiliency of bull trout populations in Keechelus and Kachess watersheds. Individual projects were identified in conjunction with the U.S. Fish and Wildlife Service (Service), National Marine Fisheries Service (NMFS), Washington Department of Fish and Wildlife (WDFW), and the Yakama Nation. The Yakama Nation, Service, WDFW, Ecology, and Reclamation, have entered into a Memorandum of Understanding (MOU) to facilitate coordination and communication concerning bull trout enhancement projects.

In June 1998, the Service listed the Columbia River Basin "distinct population segment" of bull trout as threatened under the Endangered Species Act (ESA). The Service subsequently identified 15 local populations of bull trout in the Yakima Basin (Service 2014) and designated critical habitat in a number of reaches of the Yakima River and tributaries, including portions of the project areas for the KDRPP and KKC projects.

The enhancement projects (on-the-ground work projects) and actions (assessments and design work based on assessments) described herein are intended to complement other proposed measures and best management practices to avoid or reduce adverse effects on aquatic species as part of the KDRPP and KKC. The enhancements also are intended to support the objectives of the *Yakima River Basin Integrated Water Resource Management Plan* (Integrated Plan; Reclamation and Ecology, 2011) associated with the need to address problems with depleted populations and degraded aquatic habitat. This objective of the Enhancement Package is to improve aquatic conditions within the Keechelus and Kachess watersheds. Bull trout are the focal species for this effort, given both their threatened status under the ESA, and current local-population abundance in these areas. The specific needs of bull trout were therefore used to prioritize activities for inclusion in this plan.

This document summarizes current threats to bull trout in the reservoirs and tributaries of those watersheds and prioritizes specific actions expected to reduce the probability or magnitude of risk posed. The projects described in this document consider both habitat enhancements to improve the function and productivity of reservoir and tributary habitats as well as population enhancement efforts, such as translocation/and or supplementation of bull trout populations in the Yakima Basin. However, the projects described in this document are not intended to represent the full scope of potential restoration and enhancement activities within the upper Yakima Basin.

Phase 1 of the Bull Trout Enhancement Plan includes implementation of four enhancement projects—Gold Creek Passage and Habitat Improvements, Gold Creek U.S. Forest Service (USFS) Bridge Replacement, Cold Creek Passage Improvements, and nutrient enhancement using pathogen-treated fish carcasses. Project assessments (see Chapter 3) are also included in Phase 1 to better prioritize and direct efforts advanced under Phase 2.

Phase 2 of the Bull Trout Enhancement Plan includes project implementation based on the results of the assessments and designs prepared in Phase 1 (see Chapter 6).

CHAPTER 2: POPULATIONS

A key bull trout characterization is life history strategy. In the Yakima Basin, these strategies include: fluvial, adfluvial, and resident. All individuals, regardless of life history, spawn in cold and pristine headwater tributaries. Juvenile bull trout rear in these natal streams for 2 to 4 years. Resident fish continue to occupy headwater tributaries, but fluvial bull trout migrate downstream to larger rivers and adfluvial bull trout migrate to lakes to rear. These migratory fish live several years in larger rivers or lakes, where they grow to a much larger size than resident forms before returning to tributaries to spawn.

To successfully spawn and rear, bull trout have stringent habitat requirements for water quality, riparian and instream cover, channel stability, and spawning and rearing substrate (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Pratt 1992; Rieman and McIntyre 1993, 1995; Watson and Hillman 1997). These required characteristics are not necessarily present throughout watersheds, even in pristine habitats (Watson and Hillman 1997 and Rieman and McIntyre 1993) resulting in patchy bull trout distribution within a watershed (Rieman et al. 1997). Seasonal habitats for all bull trout life histories are linked through migratory corridors. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993; Rieman et al. 1997). Migrations also facilitate gene flow among local populations when individuals from different local populations interbreed, stray, or return to non-natal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants.

In the Yakima basin, 9 adfluvial, 4 fluvial, and 2 resident local bull trout populations have been identified (Reiss et al. 2012). All known adfluvial populations are or were located upstream of storage reservoirs. While a fluvial population has been assigned to the Upper Yakima River, there is no evidence that the few spawning fish observed in this area constitute a distinct and self-supporting population. With the potential extirpation of two adfluvial populations in the Cle Elum drainage and the resident population in the Teanaway watershed (Reiss et al. 2012), the three local populations located in the Kachess (Box Canyon and Kachess local populations) and Keechelus (Gold Creek local population) drainages are the only known populations remaining in the Upper Yakima watershed. Each of these populations have critically low abundances, with 10-year geometric means of 8, 11, and 13 redds, respectively (Eric Anderson, Personal Communication, 2014).

Non-natural barriers to passage have reduced or eliminated population movement and the potential for genetic exchange, as well as reducing habitat quality and quantity in migratory corridors (Reiss et al. 2012). According to a comprehensive genetic analysis, bull trout in the Yakima Basin appear to be losing genetic diversity in comparison to bull trout throughout the species' range in the United States (Small et al. 2009). Results of microsatellite analysis of 462 bull trout samples from the Yakima River Basin indicate limited and asymmetrical gene flow among populations. As population sizes decline, genetic diversity is lost, and the risk of inbreeding increases, and resilience in the face of catastrophic events declines. While there is evidence that small populations have persisted at low numbers for many generations (Whitesel et al. 2004), reduced genetic diversity, combined with current habitat threats are thought to threaten Yakima bull trout population's long-term viability.

2.1. Threats

Bull trout populations in Keechelus and Kachess reservoirs have chronically low abundance, reduced genetic diversity, and are isolated from other bull trout populations. The presence of reservoir dams has eliminated upstream access to the historic habitat and effectively eliminated opportunities for fluvial (river and stream) migrations and the interaction with other populations within the Yakima Basin. In recognition of this threat, the Integrated Plan includes the Reservoir Fish Passage Element (Reclamation and Ecology, 2011).

In addition, each population has specific threats that are unique to the geographic spawning and rearing habitats within the reservoirs (Tables 1 through 4). Climate change (e.g., Mastin, 2008) adds another layer of risk for Yakima Basin bull trout. The *Yakima Bull Trout Action Plan* (YBTAP) (Reiss et al. 2012) provides a comprehensive analysis of threats throughout the Yakima watershed).

Table 1. Gold Creek (Keechelus Reservoir) threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions and action priority identified in *Yakima Basin Bull Trout Action Plan* (Reiss, et al. 2012)

Threats	Rating	Actions	Priority
Dewatering	SIGNIFICANT	Hydrological assessment, floodplain restoration	HIGH
Low abundance	SIGNIFICANT	Evaluate supplementation	HIGH
Passage barriers	SIGNIFICANT	Passage at Keechelus Dam	HIGH
Angling	UNKNOWN SIGNIFICANT	Monitor; outreach	MEDIUM
Development	UNKNOWN SIGNIFICANT	Land acquisition; monitor bank stabilization projects	MEDIUM
Entrainment	UNKNOWN SIGNIFICANT	Passage at Keechelus Dam	MEDIUM
Prey base	UNKNOWN SIGNIFICANT	Carcass/analogs	MEDIUM
Introduced species	UNKNOWN	Monitor brook trout introgression	MEDIUM
Transportation	UNKNOWN LOW		LOW
Forest management	LOW		LOW
Recreation	LOW		LOW
Agriculture	NOT PRESENT		NA
Altered Flows	NOT PRESENT		NA
Grazing	NOT PRESENT		NA
Limited extent habitat	NOT PRESENT		NA
Mining	NOT PRESENT		NA

Table 2. Box Canyon Creek (Kachess Reservoir) threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions, and action priority identified in *Yakima Basin Bull Trout Action Plan* (Reiss, et al. 2012).

Threats	Rating	Actions	Priority
Low abundance	SIGNIFICANT	Monitor; Evaluate Supplementation	HIGH
Passage barriers	SIGNIFICANT	Passage at Kachess Dam, monitor passage at mouth	HIGH
Angling	UNKNOWN SIGNIFICANT	Outreach	MEDIUM
Entrainment	UNKNOWN SIGNIFICANT	Passage at Kachess Dam	MEDIUM
Limited extent habitat	UNKNOWN SIGNIFICANT	Passage at Peek-a-Boo Falls	MEDIUM
Prey base	UNKNOWN	Carcass/analog pilot study	MEDIUM
Recreation	UNKNOWN	Outreach	MEDIUM
Forest management	UNKNOWN	Riparian restoration	MEDIUM
Introduced species	UNKNOWN		MEDIUM
Agriculture	NOT PRESENT		NA
Altered flows	NOT PRESENT		NA
Development	NOT PRESENT		NA
Dewatering	NOT PRESENT		NA
Grazing	NOT PRESENT		NA
Transportation	NOT PRESENT		NA
Mining	NOT PRESENT		NA

Table 3. Kachess River (Kachess Reservoir) threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions, and action priority identified in *Yakima Basin Bull Trout Action Plan* (Reiss, et al. 2012).

Threats	Rating	Actions	Priority
Low abundance	SIGNIFICANT	Monitor; evaluate supplementation	HIGH
Passage barriers	SIGNIFICANT	Passage at Kachess Dam	HIGH
Dewatering	SIGNIFICANT[1]	Natural: no actions	HIGH
Angling	UNKNOWN SIGNIFICANT	Monitor; outreach	MEDIUM
Entrainment	UNKNOWN SIGNIFICANT	Passage at Kachess Dam	MEDIUM
Prey base	UNKNOWN SIGNIFICANT	Carcass/analogs	MEDIUM
Introduced species	UNKNOWN	Monitor brook trout introgression	MEDIUM
Limited extent habitat	UNKNOWN	No action	MEDIUM
Forest management	LOW		LOW
Recreation	LOW		LOW
Agriculture	NOT PRESENT		NA
Altered flows	NOT PRESENT		NA

[1] This cell was updated to "Significant" (E. Anderson, Personal Communication, August 22, 2014)

Threats	Rating	Actions	Priority
Development	NOT PRESENT		NA
Grazing	NOT PRESENT		NA
Transportation	NOT PRESENT		NA
Mining	NOT PRESENT		NA

Table 4. South Fork Tieton River threats, highest severity rating in any life stage/effect category, abbreviated list of associated actions, and action priority identified in *Yakima Basin Bull Trout Action Plan* (Reiss, et al. 2012).

Threats	Rating	Actions	Priority
Passage barriers	SIGNIFICANT	Passage at Tieton Dam & South Fork Tieton Falls	HIGH
Angling	UKNOWN SIGNIFICANT	Outreach	MEDIUM
Entrainment	UKNOWN SIGNIFICANT	Passage at Tieton Dam	MEDIUM
Prey base	UKNOWN	Carcass analogs	MEDIUM
Recreation	UKNOWN SIGNIFICANT	Close streamside campsites	MEDIUM
Grazing	UKNOWN SIGNIFICANT	Maintain cattle exclusion	MEDIUM
Forest management	UNKNOWN	Dry Forest Restoration Strategy; address problem roads	MEDIUM
Introduced species	UNKNOWN	Monitor brook trout introgression	MEDIUM
Low abundance	LOW		LOW
Agriculture	NOT PRESENT		NA
Altered flows	NOT PRESENT		NA
Development	NOT PRESENT		NA
Dewatering	NOT PRESENT		NA
Limited extent habitat	NOT PRESENT		NA
Transportation	NOT PRESENT		NA
Mining	NOT PRESENT		NA

2.1.1 Summary of Baseline Threats

The most common significant threats for all three populations in Keechelus and Kachess reservoirs include low abundance, passage barriers created by the storage dams and reservoir drawdown, and dewatering events that occur in tributaries where bull trout spawn and rear (Tables 1-3). The YBTAP considered these three threats to be the highest priority for Gold Creek and Kachess River populations and low abundance and passage barriers were considered to be highest priority for the Box Canyon Creek population. Angling, entrainment, prey base, introduced species, limited habitat, forest practices, and recreation were also indicated as unknown or significant threats for some or all of the three populations.

The highest severity threats to the South Fork Tieton population result from the presence of Tieton Dam which creates a passage barrier, entrains bull trout, and contributes to a reduced prey base (Table 4; Reiss, et al. 2012). The dam precludes anadromous fish passage and eliminates upstream gene flow from Naches River fluvial bull trout populations. In addition, habitat access is limited in the South Fork Tieton River by channel modification that occurred when Forest Service Road 1200 was constructed. The channel modification results in a passage barrier when Rimrock Reservoir is drawn down.

CHAPTER 3: ENHANCEMENT PROJECTS AND ACTIONS

The enhancement projects and actions described in this document are intended to benefit bull trout inhabiting Keechelus and Kachess reservoirs by addressing population threats in these habitats. Restoring passage into the South Fork Tieton will provide managers more options to manage flows for improved habitat and passage throughout the Yakima Basin and may provide additional flexibility to manage reservoir pool levels in the Upper Yakima to maintain bull trout passage (e.g. Kachess). Enhancing the South Fork Tieton bull trout population could also benefit Keechelus and Kachess reservoir populations by ensuring the stability of a possible “donor” population that could be used to increase the abundance and diversity of bull trout within the two reservoirs or in other locations in the basin.

Specifically, the enhancements address or assess low abundance, passage barriers above the reservoirs, degraded habitat, dewatering, and prey base threats for Keechelus and Kachess reservoirs and address a passage barrier threat for the South Fork Tieton population. Passage barriers within the Keechelus and Kachess reservoirs that are created by operational drawdowns are addressed through Reclamation’s mitigation responsibilities.

The proposed projects are consistent with recommendations in the YBTAP (Tables 1-4) and reflect input from regional biologists from WDFW, the Service, Yakama Nation, and Reclamation. Recognizing that low abundance and poorly functioning habitat are among the threats driving the decline of bull trout, the enhancement measures include projects to improve habitat function as well as directly increase the abundance of bull trout in the watersheds.

Phase 1 of the Bull Trout Enhancement includes five projects described below including: Gold Creek Passage and Habitat Improvements, Gold Creek USFS Bridge Replacement, Cold Creek Passage Improvement, Bull Trout Task Force Project, and Nutrient Enhancement. Several of the proposed projects have undergone initial assessments and preliminary design work. There are four other actions that comprise of assessment, evaluation, or design work that will guide development of future projects that will be advanced by Reclamation, Ecology, and participating agencies and entities through implementation of the Bull Trout Enhancement Phase 2, subject to further environmental review and permitting. Each of the projects and actions will require funding approval and the costs are estimated.

3.1. Gold Creek Passage and Habitat Improvements

This project would improve the connectivity of habitats within Gold Creek by addressing dewatering and passage barrier issues (Map 1). Gold Creek is the sole documented spawning tributary for the Keechelus Lake population (Reiss et al. 2012). During mid-July to late

September, channel dewatering that occurs in the lower 3.1 miles of this tributary impedes bull trout moving upstream in the late summer to spawn. Bull trout that have already initiated their upstream migration when the reach begins to be dewatered are vulnerable to predation or outright desiccation if they cannot find pool refugia. Stream dewatering also affects young bull trout rearing year-round in Gold Creek. In the 2013, field season, the maximum cumulative length of dewatered stream channel was 1.24 miles (Natural Systems Design 2013). While this tributary likely historically experienced dewatering during drought conditions, assessment work underway indicates that land management practices, including past timber harvest and gravel mining in the Gold Creek valley, have exacerbated the problem. The goal of this project is to restore and enhance channel hydraulic connectivity to provide better bull trout passage to spawning grounds, improve rearing habitat, and reduce stranding of fish. Project assessment and conceptual designs have been funded and work will be completed in the spring of 2015 (Kittitas Conservation Trust (KCT) is managing the assessment and conceptual design).

Preliminary assessment findings have identified two key mechanisms causing reach dewatering. First, Gold Creek Pond has modified the groundwater gradient, negatively affecting flow in sections of Gold Creek. Second, stream widening has increased loss of surface water-to-groundwater infiltration. Other contributing factors include a buried drainage line and a second, smaller, gravel borrow pit (Helis Pond). Restoration actions identified to address Gold Creek dewatering are described below.

3.1.1 Gold Creek Actions

- Narrow channel width along 1.0 to 2.3 miles of Gold Creek (Figures 1 and 2; lower range focus on just dewatered reach, upper range includes entire overwidened reach).
- Narrow channel down 100 to 200 feet, to a 50-to-125-foot-wide channel (based on 1944 aerial photo) (this may need to change based on hydraulics/flooding issues).
- Construct a stable low-flow channel utilizing wood and rock to aid in perennial flow and adding habitat along 1.0 to 2.3 miles of Gold Creek.
- Some of this work will be on private land so real property or easement acquisitions may be needed to facilitate this action.

3.1.2 Gold Creek Pond Actions

- Based on results of the KCT assessment, reconfigure the pond size and shape and pond outlet to reduce surface and groundwater draw from Gold Creek into the pond (e.g. partial filling of the pond, raising the pond surface elevation, etc.) (Figure 3).
- Regrading of berms surrounding pond (13-16 acres) (could be considered under complete or partial filling of pond).

Figure 1. Representative habitat in Lower Gold Creek where habitat function would be improved by narrowing the creek channel (Photo by William Meyer, WDFW)

Figure 2. Properly functioning consolidated, narrow channel in Upper Gold Creek (Photo by William Meyer, WDFW)

Figure 3. Gold Creek Pond (Photo by William Meyer, WDFW)

3.1.3 *Helis Pond Actions*

- Complete filling (approximately 2 acres) of Helis Pond and outlet channel.
- This work will be on private land so real property or easement acquisitions may be required to facilitate this action.

These activities would potentially require adding fill or the removal of creek bed materials. In addition, the placement of boulders, logs, or other engineered materials may be necessary to ensure that the constructed creek channel is stabilized until natural channel stabilization mechanisms are in place (e.g. native vegetation) to provide adequate cover for bull trout.

Channel restoration and filling would require in-water work and would result in increased levels of turbidity and noise that would temporarily disturb bull trout from construction areas downstream to the confluence with the reservoir. Flows may also need to be partially or completely diverted from the existing channel to allow construction access to bed materials and to prevent fish from encountering major construction activities. These impacts could be minimized if work is completed when the channel is dry.

In addition to in-water work, construction activities may require temporary access roads and heavy equipment operation in the riparian areas adjacent to the creek. The disturbance of riparian vegetation would be transient as temporary roads and other disturbed areas would be regraded and revegetated with appropriate native plant species immediately following construction. Erosion and sediment control plans would be implemented to reduce the risk of upland sediments entering the creek.

The timing of all in-water work would be subject to work windows that minimize the disturbance of bull trout and other aquatic and terrestrial species in the project area. The project would adhere to local, state and Federal regulatory requirements.

Real property and/or easement acquisition may be required where work would occur on privately owned lands. Acquisitions would be with willing landowners.

Design costs are expected to be approximately $250,000. The cost estimate for project implementation is $3 million.

3.2. Gold Creek USFS Bridge Replacement

The proposed project would involve construction of a new bridge on Forest Service Road 4832 (Figure 4) to restore the Gold Creek floodplain and enhance connectivity of bull trout habitat within Gold Creek and between Gold Creek and Keechelus Reservoir. The project site is located on the Okanogan-Wenatchee National Forest in Section 15, Township 22 North, Range 11 East, Willamette Meridian (Map 1).

Figure 4. Location of existing Forest Service Road 4832 bridge relative to Interstate-90 and Keechelus Reservoir.

Construction of Interstate-90 (I-90) and Forest Service Road 4832 altered the hydrology and structure of Gold Creek. The original roads were constructed on fill across most of the historical floodplain, and bridges confined Gold Creek to a single active channel (Figure 5). Borrow pits and staging areas were constructed on the floodplain along both sides of the highway. A large borrow pit upstream of Forest Service Road 4832 confined Gold Creek to the western margin of its historical floodplain. This created the Gold Creek Pond that is fed by seepage and discharges through an artificial outlet channel to Gold Creek. Reaches of Gold Creek upstream of the pond outlet often dewater by mid-summer. The existing Gold Creek USFS Bridge artificially constrains the floodplain and creek channel, resulting in scouring and sediment deposition patterns that prevent natural habitat processes from occurring (USDA, 2011). Interstate-90 has recently been reconstructed to span the Gold Creek floodplain, and the previous fill has been removed.

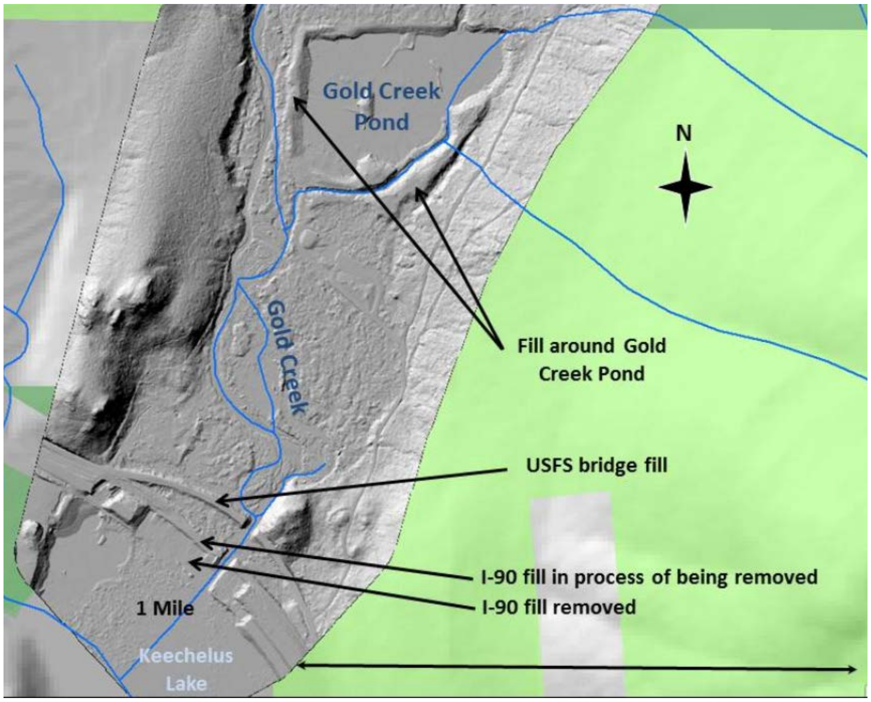


Figure 5. LiDAR Image of Gold Creek floodplain depicting areas of fill along Forest Service Road 4832 that constrict the channel migration zone and reduce floodplain functions (Figure provided by William Meyer, WDFW). All I-90 fill has now been removed.

The new Gold Creek USFS Bridge would span the floodplain of Gold Creek (approximately 725 feet wide) and would provide the following benefits: improved hydrologic connectivity, lower stream velocities, improved channel migration, floodplain restoration, restored capacity for sediment transport, reduced sediment and temperature, and improved groundwater flow (USDA, 2011).

Engineered designs developed by Sargent (2011) identify several options for replacing the bridge and provide a recommendation for a preferred design alternative (Figures 6 and 7). All of the replacement options considered would require the following construction activities (a comprehensive description is provided by Sargent [2011]):

- Placement of shafts or pilings to provide a foundation for the bridge structure. Installing pilings would require an impact hammer and shafts will require drilling machines.
- Installation of the bridge superstructure using cranes and other heavy equipment,
- Installation of a detour around the construction area,

- Construction of temporary roads,
- Clearing and grubbing,
- Removal of the existing bridge and approach roadway fills (approximately 50,000 cubic yards of material), and
- Construction of a new embankment (approximately 6,000 cubic yards of material).

In general, the bridge replacement project would require very large equipment. The construction of the shafts will require large drilling machines that occupy a very large area. This area is larger than the area provided by the existing road, so it is likely that the contractor would access the piers via the existing creek floodplain area. This would require the removal of existing vegetation and the placement of a working pad of rock (Sargent, 2011).

Construction would only occur in the months of April through October over a period of 2-3 years.

Bridge and foundation installation would require in-water work and would result in increased levels of turbidity and noise that would temporarily disturb bull trout in the construction area downstream to the confluence with the reservoir. Flows may also need to be partially or completely diverted from the existing channel to allow construction access to bed materials and to prevent fish from encountering major construction activities. Fish salvage and removal efforts would be conducted within the immediate project area to reduce the risk of injury or mortality during construction.

In addition to in-water work, construction activities would require temporary access roads, staging areas, and heavy equipment operation in the riparian areas adjacent to the creek. The disturbance of riparian vegetation would be transient as temporary roads and other disturbed areas would be regraded and revegetated with appropriate native plant species immediately following construction. Erosion and sediment control plans would be implemented to reduce the risk of upland sediments entering the creek.

The timing of all in-water work would be subject to work windows that minimize the disturbance of bull trout and other aquatic and terrestrial species in the project area. The project would adhere to local, state and Federal regulatory requirements.

The proposed project was evaluated in a NEPA Environmental Assessment (USDA, 2011). A Decision Notice and Finding of No Significant Impact were issued by the Cle Elum Ranger District on August 10, 2011 (USDA, 2011XXX). The project has undergone initial design review and preliminary costing (Sargent, 2011). The estimated project cost for the new Gold Creek Bridge and associated roadway construction activities is $5.6 million.

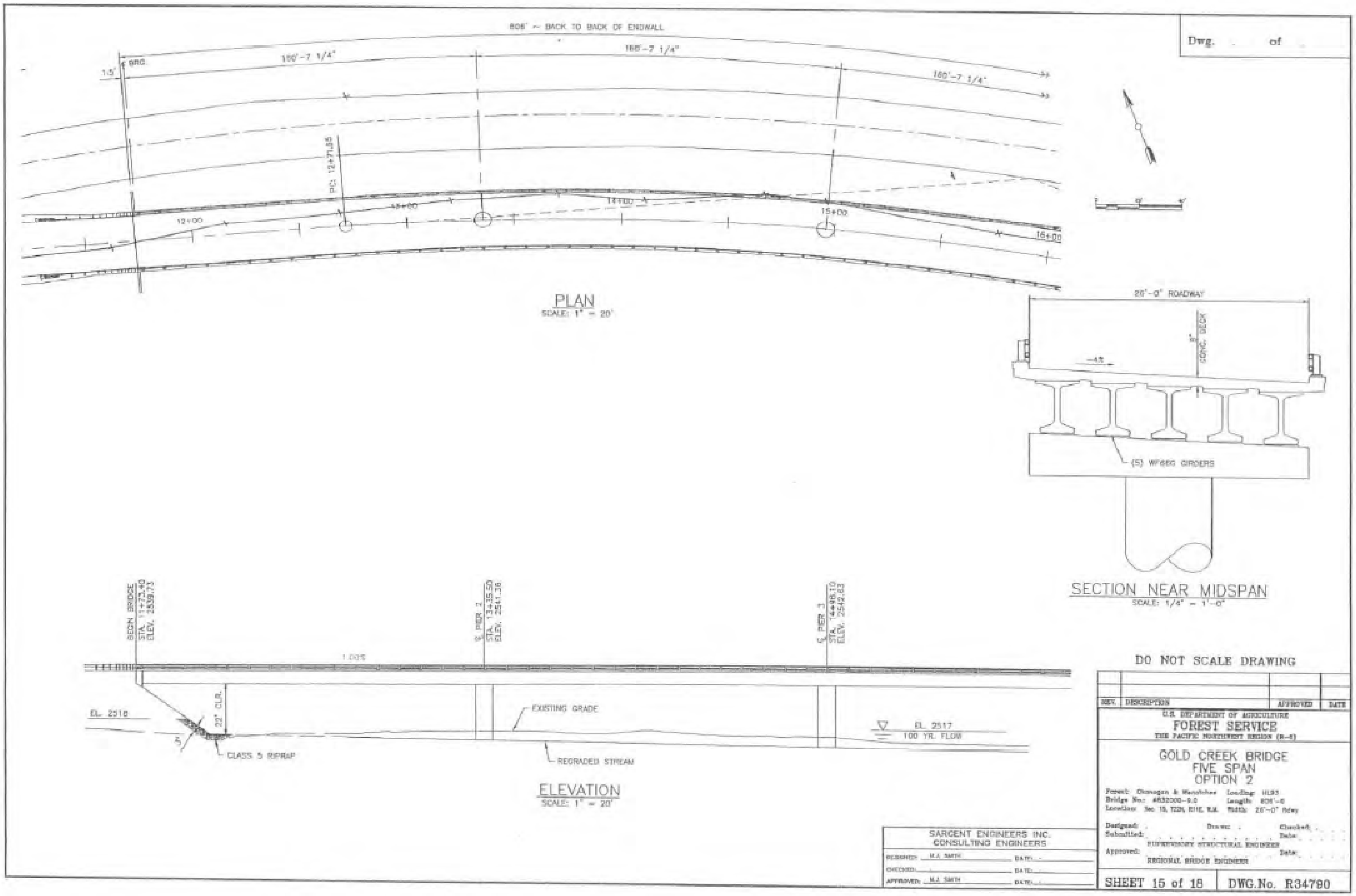


Figure 6. Recommended Gold Creek USFS bridge replacement Design Sheet 15 (Drawing obtained from Sargent, 2011)

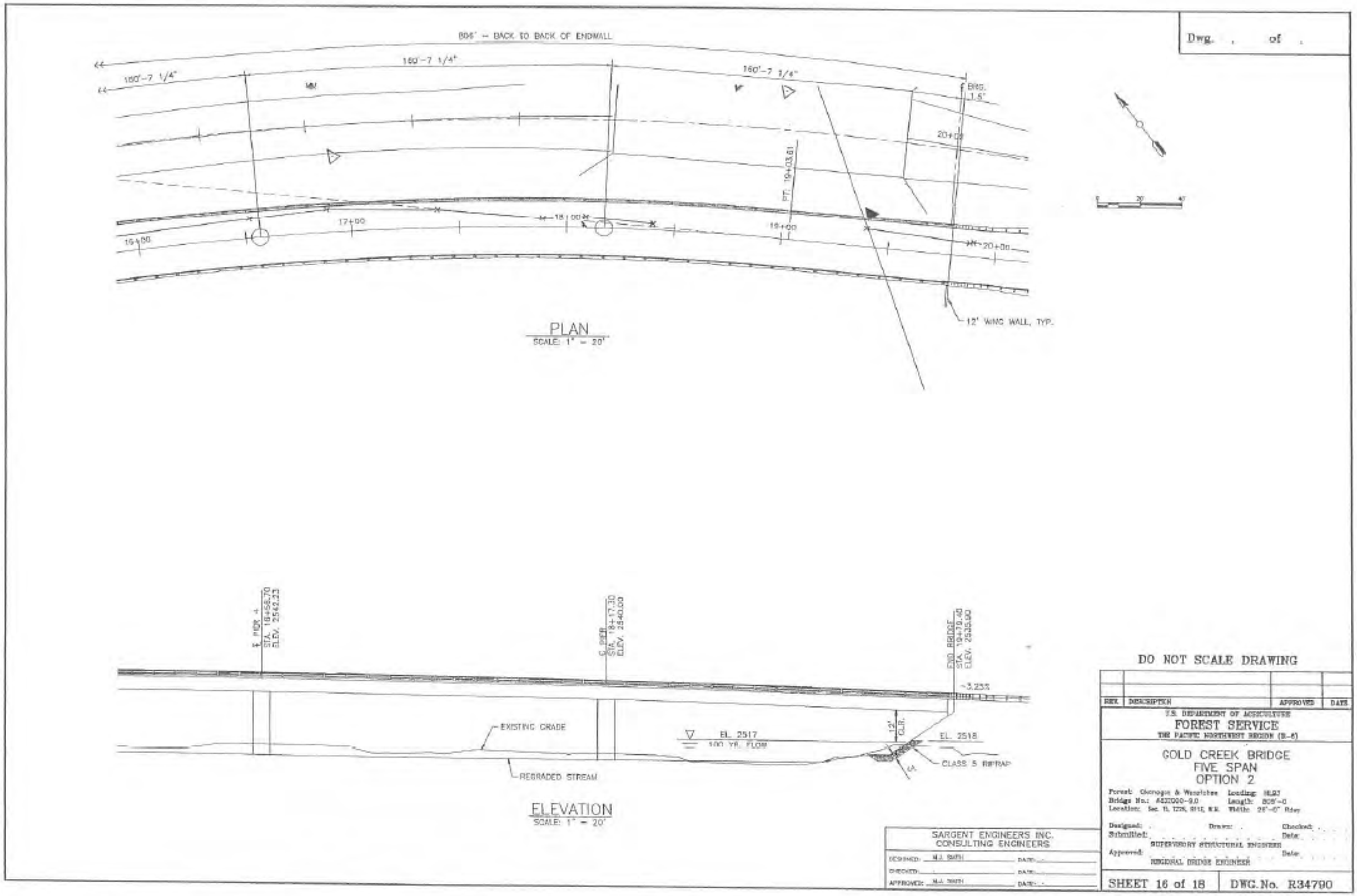


Figure 7. Recommended Gold Creek USFS bridge replacement Design Sheet 16 (Drawing obtained from Sargent, 2011)

3.3. Cold Creek Passage Improvement

This project would provide access to habitats within Cold Creek that are currently not accessible to bull trout because of passage issues at the lower reach of the creek. Cold Creek may provide a significant tributary habitat for Keechelus Reservoir bull trout (Map 2; Reiss et al. 2012) if access is provided. Cold Creek is a true headwater system that reaches to nearly 5,500 feet and whose forest is relatively intact, providing good stream complexity and cold, clean water that bull trout require (W. Meyer, Personal Communication, September 11, 2014).

Access to Cold Creek is prevented by a perched culvert and existing dewatered channel that occurs during low pool elevations (Figures 8 and 9). A previous attempt to create passage was unsuccessful as high water destroyed the constructed improvements (Reiss et al. 2012).

Figure 8. Existing Passage Barrier at Cold Creek Culvert

Figure 9. Existing Cold Creek Channel Condition Downstream of Culvert

The proposed project activities would include engineering, design, and installation of a bridge, removing the existing culvert, and improving channel conditions between the existing culvert and Keechelus Reservoir to provide passage to bull trout. The existing culvert crosses Cold Creek at the John Wayne Pioneer Trail and Iron Horse State Park.

The specific method of providing passage into Cold Creek has not been determined but a concept-level plan exists including the following elements (Tappel, 2012):

- Excavate the existing State Park trail (historic railroad grade) to an elevation approximately 55 feet below existing trail elevation, including removal of the existing concrete culvert.
- Build a new stream channel with 50-foot-wide bottom under the trail crossing with cross-section dimensions to more-or-less match undisturbed creek sections upstream. Use the existing creek's downstream control (plunge pool below culvert) for channel vertical control.
- Install a 120-foot-span x 14-foot-wide steel beam or prestressed concrete girder bridge for a new trail over Cold Creek about 35 feet lower than the existing trail crossing. Place the bridge superstructure on precast concrete footings protected by large armor rock (buried in stream banks).
- Gradually slope the trail at 6 percent on both sides of the new bridge, to intersect the existing John Wayne Pioneer Trail and Iron Horse State Park (old railroad grade) about 600 feet from the creek.
- Roughly excavate a 50-foot-wide channel at about 8-percent slope to 200 feet upstream of the new bridge. This channel would be excavated through existing bedload deposits (natural alluvial materials). High flows in Cold Creek would be expected to develop (headcut) an armored channel at about 5-percent slope to taper into existing creek channel reaches upstream.
- Excavated materials from the trail embankment excavation and from channel excavation would be used onsite to construct more natural bank extensions for Cold Creek downstream from the trail.
- The existing powerline along the trail has several galvanized steel cable braces and anchors would need to be replaced and reset for a lower trail grade. In addition, there may be buried fiber optic cables and other utilities adjacent to the trail that will need to be maintained or replaced.
- Reconstruction of more natural topography and ground contours downstream (south) of the trail would be followed with revegetation with native shrubs and trees to substantially improve upland resources within the project vicinity.

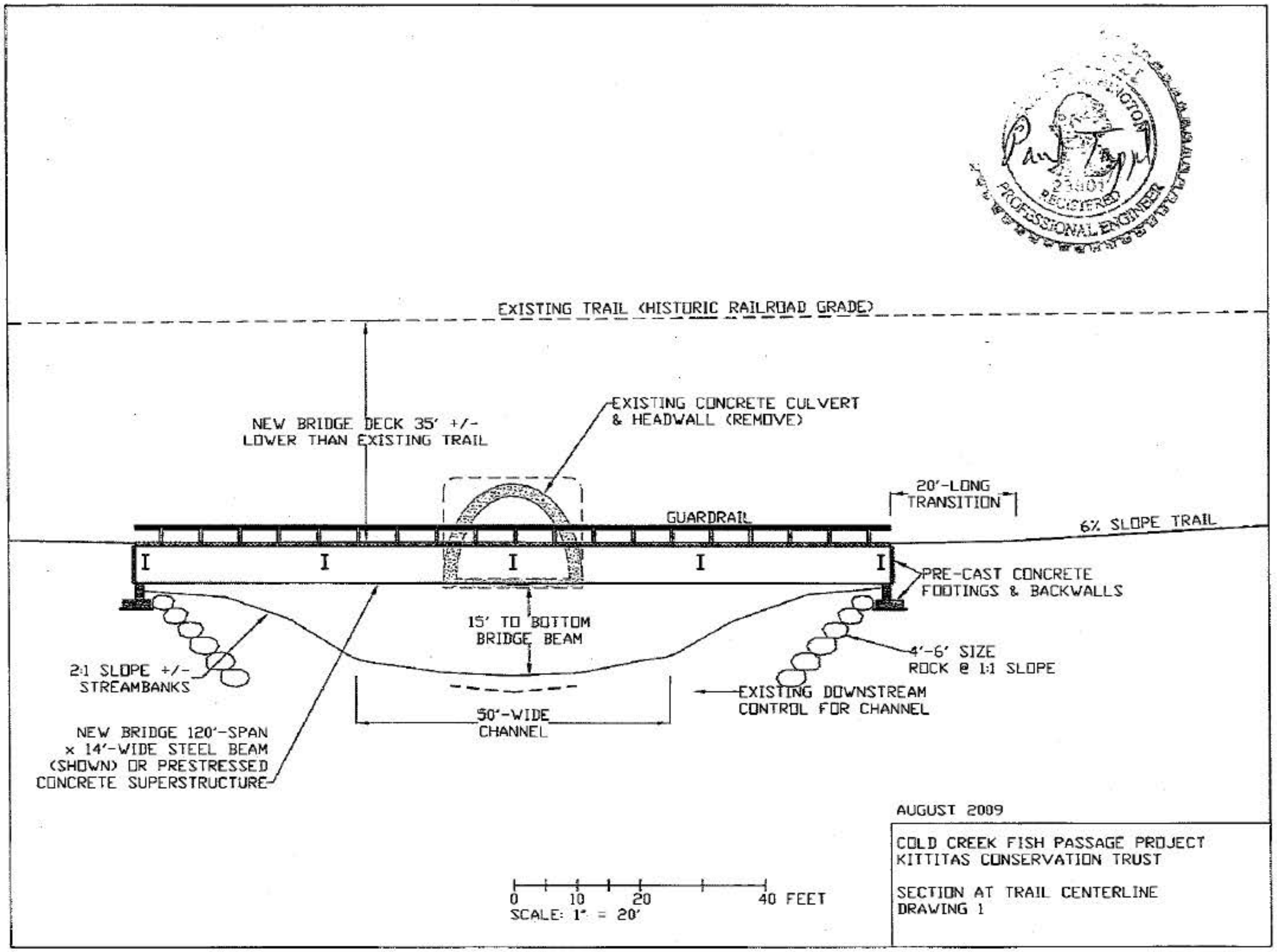


Figure 10. Conceptual Design for passage improvement at Cold Creek (Drawing obtained from Tappel, 2012)

These activities would potentially require adding fill or the removal of creekbed materials. In addition, the placement of boulders, logs, or other engineered materials may be necessary to ensure that the constructed creek channel is stabilized and provides adequate cover for bull trout.

Channel excavation and culvert removal would require in-water work and would likely result in increased levels of turbidity and noise that would temporarily disturb bull trout from construction area downstream to the confluence with the reservoir. Flows may also need to be partially or completely diverted from the existing channel to allow construction access to bed materials and to prevent fish from encountering major construction activities.

In addition to in-water work, construction activities may require temporary access roads and heavy equipment operation in the riparian areas adjacent to the creek. The disturbance of riparian vegetation would be transient as temporary roads and other disturbed areas would be regraded and revegetated with appropriate native plant species immediately following construction. Erosion and sediment control plans would be implemented to reduce the risk of upland sediments entering the creek.

The timing of all in-water work would be subject to work windows that minimize the disturbance of bull trout and other aquatic and terrestrial species in the project area. The project would adhere to local, state and Federal regulatory requirements.

The estimated cost of this project is expected to be $250,000 for engineering and up to $1.6 million for project implementation.

3.4. Bull Trout Task Force Project

The Bull Trout Task Force project is a combination project that includes on-the-ground work, data collection, and outreach. The Bull Trout Task Force (BTTF) is a collaborative effort between multiple organizations in the Yakima Basin to protect and restore bull trout populations through the prompt removal of recreational dams, direct outreach to anglers and recreationists, and population monitoring. The BTTF will work on threats that have been identified in the 2014 Draft Bull Trout Recovery Plan (Service 2014) and in the 2012 Yakima Bull Trout Action Plan (Reiss, et al. 2012). These threats include angling, threats associated with the building of swimming pools in creeks (i.e. recreation dams), riparian vegetation removal, harassment during spawning, streambank destruction, and poaching.

There are 15 identified local bull trout populations in the Yakima Basin that occupy a wide range of habitat, primarily foraging and overwintering in mainstem rivers and reservoirs, with spawning and rearing in headwater tributaries. These habitats are also where recreation is focused. Threats to bull trout by recreationists happen both intentionally and incidentally as a result of uneducated anglers and recreationists. A priority objective of the Bull Trout Task Force is identifying and removing recreation dams. A channel-spanning recreational dam can be constructed in an afternoon, and can block an entire year of spawning. The effects of that one dam will be experienced in the population over the long-term, particularly in the small, very vulnerable populations. The Bull Trout Task Force will educate recreationists about the unintended consequences of recreation dams and will post informational recreation dam signs in “problem” areas.

In addition to the removal of recreation dams, the BTTF will conduct direct outreach to anglers and recreationists regarding bull trout identification and conservation. Anglers will be given a bull trout versus brook trout identification card to keep in their tackle box. The BTTF will be deploying, maintaining and retrieving temperature data loggers in bull trout streams throughout the Yakima Basin. The BTTF temperature data collection will assist with a multiagency temperature monitoring network that will fill temperature data gaps throughout the Yakima Basin and help guide future restoration work.

The Bull Trout Task Force will work throughout the Yakima Basin and will focus much of their effort in the Keechelus and Kachess reservoirs to prevent direct take of bull trout and educate the public about species protection.

The estimated cost of this project is expected to be $33,000 a year. The proposal is to implement this project for 2 years for a total budget of $66,000.

3.5. Kachess River and Box Canyon Creek Assessment and Design

This assessment would identify opportunities to reduce or eliminate dewatering events in the Kachess River (Map 3) and Box Canyon Creek (Map 4). After assessments are complete, project designs will be developed for implementation in Phase 2 of the Bull Trout Enhancement Plan. Currently, the lower portions of these tributaries have experienced dewatering events that can prevent or delay bull trout from moving upstream into spawning grounds, and expose spawning adults or rearing juveniles to predation or desiccation.

Dewatering in the Kachess River occurs at two locations extending from the first 0.25-0.30 mile of the river above the reservoir low-pool elevation (i.e., “reservoir inundation reach”) and an additional reach 1.0 to 1.3 miles upstream of the high reservoir pool level (i.e., “upstream reach”) (Figure 11).

Within the reservoir inundation reach, there is typically adequate flow, but the unconsolidated braided channel distributes the flow over a wide area leading to shallow zones that may create a passage barrier for adults and trap for juveniles and fry. If the system loses flow due to a dry fall, these braids can go dry (Figure 12).

In the upstream reach, the valley bottom forest has been logged and the river channel is now destabilized. As a result, the channel has become too wide and sediments have been eroded and redistributed in a manner that contributes to shallow or subsurface flows and periodic dewatering (Figure 13).

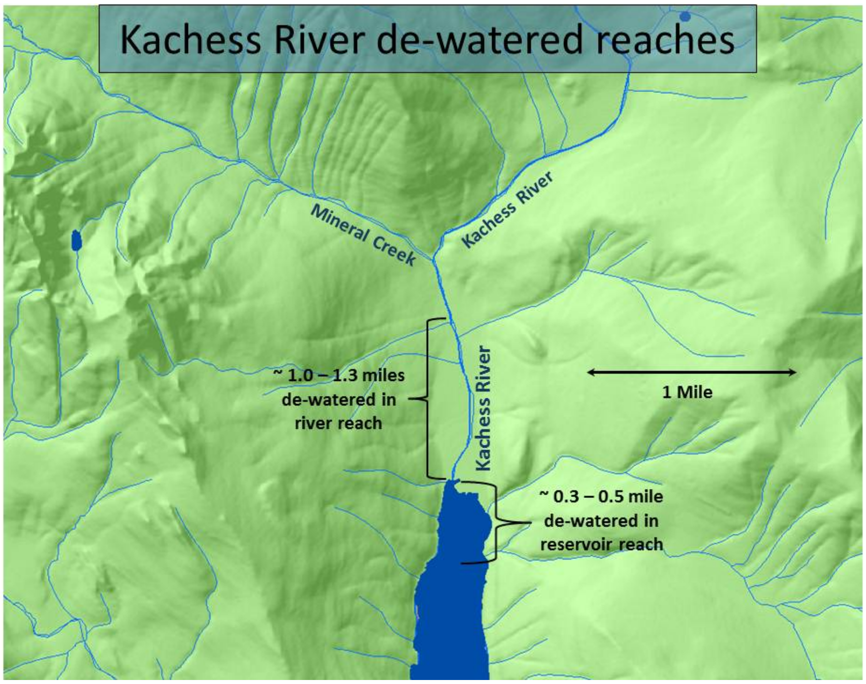


Figure 11. Kachess River reaches that experience dewatering (Figure Provided by William Meyer, WDFW)

Figure 12. Dewatered Reach of Lower Kachess River within the Reservoir Bed (Photo by William Meyer, WDFW)

Figure 13: Dewatered Section of Kachess River Upstream of Kachess Reservoir (Photo by William Meyer, WDFW)

The goal of the proposed assessments is to identify restoration actions that would improve hydrologic connectivity between reservoir and spawning grounds, improve rearing habitat, and reduce the chance of stranding fish in both streams. The current Gold Creek investigation being conducted by Natural Systems Design (2013) provides an example of this type of assessment. This assessment would examine changes in channel shape and form, floodplain vegetation, bank structure, sediment composition and budget, hydrology (surface and groundwater), and instream structure. The evaluation would also examine how land and water management has influenced any identified changes. The assessment would identify action(s) to reduce dewatering and provide project designs for subsequent construction. The estimated cost for the assessments and design work is $600,000.

Reclamation, Ecology, and participating agencies and entities intend to pursue and implement river channel/floodplain restoration projects to reduce dewatering and improve passage as guided by the results of the assessments and design process, subject to environmental review and permitting.

The specific approach for reducing dewatering events in the Kachess River and Box Canyon Creek has not yet been determined but once assessments are done, designs will be completed and project implementation will be part of Phase 2 of the Bull Trout Enhancement Plan. Channel reconstruction and the placement of large wood would require in-water work and would likely result in increased levels of turbidity and noise that would temporarily disturb bull trout from the upstream extent of the project downstream to the confluence with the reservoir at low pool elevation (approximately 1.6 miles; Figure 11 and Map 3). Flows may also need to be partially or completely diverted from the existing channel to allow construction access to bed materials and to prevent fish from encountering major construction activities.

In addition to in-water work, construction activities may require temporary access roads and heavy equipment operation in the riparian areas adjacent to the creek. The disturbance of riparian vegetation would be transient, as temporary roads and other disturbed areas would be regraded and revegetated with appropriate native plant species immediately following construction. Erosion and sediment control plans would be implemented to reduce the risk of upland sediments entering the creek.

The timing of all in-water work would be subject to work windows that minimize the disturbance of bull trout and other aquatic and terrestrial species in the project area. The project would adhere to local, state, and Federal regulatory requirements

3.6. Box Canyon Passage Assessment

This assessment would determine if passage at a natural barrier is biologically sound and if it would address any limiting factors for bull trout within Kachess Reservoir. Bull trout access to the upper reaches of Box Canyon Creek is restricted by a natural, impassable waterfall (Peek-a-Boo Falls) approximately 1.6 miles upstream of the confluence with Kachess Reservoir (Map 4; Reiss et al. 2012).

This assessment would evaluate habitat condition and capacity (fish production) downstream from the falls, examine the benefits of providing passage for bull trout and anadromous fish (when future passage is provided at Kachess Dam) above the falls, and to evaluate risks to fish species and ecological relationships currently found above the falls. The benefits of this project would also be considered within the context of the population enhancement evaluation (see Section 3.8) which would help determine the extent to which access to new tributary habitat would address population limiting factors. The estimated cost of the assessment is $200,000. If the assessment results in support for expanding habitat access upstream of the falls, fish passage design and project construction would be completed in Phase 2 of the Bull Trout Enhancement Plan. Reclamation, Ecology, and participating agencies and entities intend to pursue and implement a passage project at Peek-a-Boo Falls within Box Canyon Creek that is guided by the results of the assessment.

3.7. South Fork Tieton River Passage Assessment and Design

Improving passage into the South Fork Tieton is important for the bull trout populations affected by the KKC and KDRPP projects. This action would provide flow management options that could reduce drawdown impacts in the upper Yakima reservoirs by using Rimrock storage in a manner that could delay the need for pumping from Kachess and allowing more time for bull trout to pass into Kachess tributaries. In addition, this proposal also could provide increased flexibility and options to reduce high flows during “flip-flop” operations that adversely affect habitat for bull trout, steelhead, salmon, and lamprey in the Tieton and lower Naches. Finally, enhancing the South Fork Tieton population is important to help maintain a potential future donor population and to provide an opportunity for colonization and metapopulation function when passage is provided throughout the upper Yakima Basin through the Integrated Plan (Reclamation and Ecology, 2011).

This assessment would examine existing passage issues, habitat conditions, and reservoir operations with the goal of improving passage into the South Fork Tieton River (Map 5), reducing potential passage issues in Kachess Reservoir during operation of the KDRPP pumps, and reducing the risk of injury to downstream migrants. Upon the completion of the assessment, a fish passage option will be chosen and project engineering and design will be completed as part of this phase. When Forest Service Road 1200 was constructed, the natural channel of the South Fork Tieton River was relocated to flow under the bridge through a notch blasted out of bedrock (Figure 14). A waterfall begins to form at this location when the reservoir is drafted below 131,000 acre-feet. It is believed to become impassable for bull trout attempting to migrate upstream when the pool volume drops below 127,000 acre-feet (Thomas, 2001, cited in Reiss et al. 2012). The falls create a downstream passage and injury issue when post-spawning bull trout drop over the waterfall and land in a shallow pool and then have to descend a shallow braided channel to get back to the reservoir.

The habitat assessment would evaluate different opportunities to provide passage through consideration of approaches such as a roughened channel, grade control, or rerouting the channel back to natural thalweg. The estimated cost of the habitat assessment is $200,000. An additional analysis of reservoir operations would also be conducted to determine the value of adjusting reservoir elevations to improve passage and promote habitat functions downstream. The estimated cost of the operational assessment would be $100,000.

Figure 14. Rimrock Reservoir drawdown resulting in passage barrier at the South Fork Tieton River below Forest Service Road 1200 (Photo by William Meyer, WDFW)

Reclamation, Ecology, and participating agencies and entities intend to pursue passage improvement project(s) at South Fork Tieton River that are identified as beneficial in the assessments, subject to environmental review and permitting. The estimated cost of the passage assessment is $300,000. Following the assessment, a passage option will be chosen and project engineering and design will be completed. The estimated cost of engineering and design is estimated to be $250,000. Implementing the passage project will be part of Phase 2 of the Bull Trout Enhancement Plan.

3.8. Bull Trout Population Enhancement Evaluation

This assessment would evaluate the efficacy of directly increasing the abundance and diversity of bull trout in the reservoirs using translocation and or supplementation methods. Translocation moves bull trout from a healthy population to place them into a population in need of enhancement and/or into habitat that bull trout have been extirpated. An example of this would be to move bull trout from healthy external population to habitats within Keechelus and Kachess reservoirs or the Teanaway watershed (likely an extirpated population). The method of obtaining fish from the donor populations has not been determined.

DeHaan and Bernall (2013) demonstrated that transporting fish to habitats above passage barriers is an effective conservation strategy that can reduce the effects of population fragmentation. In their study, bull trout transported upstream from below Cabinet Gorge Dam, Clark Fork River, Idaho, successfully spawned and produced a significant number of juveniles that were later attributable to transported parents. Translocation has been used effectively in other basins to reintroduce bull trout to habitats they formerly occupied. In the Clackamas River Basin, translocation occurred after completion of a feasibility study and the results have been promising. Introduced bull trout have dispersed throughout the Clackamas River and its tributaries and spawning behavior has been documented (Barry et al. 2014). Genetic risks will need to be evaluated. Translocation of even a few fish from another population may have significant impacts to the genetics of a small population.

The keys to successful translocation efforts are an understanding of the potential for recipient habitats to support a reintroduction and the potential of available donor populations to support a reintroduction (Dunham et al. 2011).   In recognition of these requirements, a feasibility assessment will be conducted similar to Dunham et al. (2011), which will consider population status, habitat quality and quantity, habitat limiting factors in reservoirs and tributary habitats, entrainment risk, fish health, threats, metapopulation dynamics, genetic analysis, extinction risk, and donor-recipient sensitivity analysis.

Another approach to population enhancement that will be evaluated is supplementation. Supplementation differs from translocation in that bull trout would be bred in a more controlled environment (e.g. a hatchery) to increase juvenile survival rates and their offspring would be planted in the reservoirs or tributary habitats. Supplementation is an effective tool for increasing the number of fish available for reintroduction but poses potentially significant genetic risks (Leary et al. 1993) such as inbreeding effects that can accelerate population declines (Rieman and Allendorf, 2001).

The feasibility assessment will result in a quantitative decisionmaking framework that will ensure the priority and efficacy of subsequent population enhancement efforts. The assessment will play an important role in determining whether or not population enhancement is congruent with available habitat capacity and genetic risks. To ensure coordination and consultation requirements are met in a timely fashion, the project will utilize existing proposal information that has been developed by key stakeholders and managers including WDFW, Yakama Nation, the Service, USGS, USFS, and Yakima Basin Fish and Wildlife Recovery Board (e.g., Conley, et al. 2014). Because the results from this project will inform where habitat capacity may be limited, the evaluation will also have utility guiding other decisions related to habitat restoration projects. The estimated cost for the population enhancement evaluation is $500,000. If the population enhancement evaluation recommends implementation, translocation and/or supplementation actions will be part of the Phase 2 Bull Trout Enhancement Plan.

3.9. Improve Productivity and Food Resources

Both Keechelus and Kachess reservoirs are oligotrophic environments (unproductive systems) that may have limited food resources to support bull trout at different life history stages. Providing nutrient enhancement in tributaries and the reservoirs (i.e., salmon carcasses, carcass/analogs, or chemical inputs) is one method of replacing nutrients formerly provided by anadromous salmon (Pearsons et al. 2007). Nutrient enhancement increases productivity through a bottom-up approach where nutrients are first utilized by primary producers (i.e., algae and plants) which are then consumed by insects and zooplankton that feed fish and other aquatic life in a cascade of food chain interactions. Over the long term, the Integrated Plan (Reclamation and Ecology, 2011) proposes to establish passage for anadromous species which would functionally recreate the historic productivity (marine-based nutrient inputs) and prey base that bull trout experienced prior to the installation of dams at both Keechelus and Kachess reservoirs. As an interim measure, this plan proposes nutrient enhancement using treated salmon carcasses and/or carcass/analogs to increase ecological productivity, thereby increasing the prey base for bull trout, recognizing that the long-term solution is represented by anadromous passage above the reservoir dams. The goal of this project is to add nutrients (i.e., salmon carcasses and/or carcass/analogs), to these oligotrophic systems. Added nutrients will increase ecological productivity, translating into an increase in food supply for bull trout. Adaptive management will be used to determine appropriate levels on nutrient inputs as this project is implemented over time.

Introducing pathogens with the placement of carcasses is a primary concern. To address this, all carcasses will be treated by heat to kill any pathogens that may be present prior to hauling and placement. Carcasses will be placed in tributaries that are historic spawning streams including Gold Creek, Box Canyon Creek and Kachess River. Carcasses will be placed when spawning would have historically occurred during the fall months starting in late September and ending in November. Impacts to water quality are expected to be insignificant because carcass decomposition and nutrient release will occur overtime and nutrient uptake is expected to be relatively quick due to the lack of nutrients in the existing system.

The cost estimate for this project is $200,000 for the study component and $50,000 per year for 10 years of nutrient enhancement activities ($500,000 over 10 years).

If the ongoing food web studies of limiting factors in Keechelus and Kachess reservoirs indicate that the abundance of prey is a limiting factor for bull trout survival or productivity in the reservoirs, an evaluation of the feasibility of providing additional kokanee prey may be warranted.

CHAPTER 4: SUMMARY OF ANTICIPATED ENHANCEMENT PROJECT BENEFITS AND THREATS ADDRESSED

All the proposed enhancement actions address significant population threats identified in the YBTAP (2012) and are consistent with recommended actions therein (Tables 1-4). The potential benefits of each project and action, relative to the primary threats they address, are summarized in Table 5 and described below.

Table 5. Summary of Enhancement Projects and Primary Threats Addressed for Bull Trout Populations

Enhancement Project	Threats Addressed				
	Low Abundance	Passage Barriers	Dewatering	Limited Habitat	Prey Base
Gold Creek Passage and Habitat Improvement	X	XXX	XXX	XXX	X
Gold Creek USFS Bridge Replacement	X	X	X	X	
Cold Creek Passage Improvement	X	XXX		XXX	X
Bull Trout Task Force	X	XXX			
Kachess River and Box Canyon Creek Assessment and Design	X	XXX	XXX	XXX	X
Box Canyon Passage Assessment (Peek-a-boo falls) [1]	X			XXX	X
South Fork Tieton River Passage Assessment and Design	X	XXX	X	XXX	
Bull Trout Population Enhancement Evaluation	XXX				
Improve Productivity and Food Resources	X				XXX

[1] Assumes results of assessment support future project implementation
XXX Denotes substantial benefit
X Denotes minor benefit

The Gold Creek Passage and Habitat Improvements Project will directly address threats posed by dewatering and seasonal passage barriers within the Gold Creek tributary. This project, in conjunction with bull trout population enhancement efforts, should increase the abundance and diversity of bull trout by improving access to spawning habitats, reducing loss caused by predation and desiccation, and improving stream rearing conditions for both existing and introduced bull trout.

The Gold Creek USFS Bridge Replacement project will restore floodplain and channel forming processes to a more natural state. This project would support the goal of increasing abundance through improving connectivity with important spawning and rearing habitats.

The Cold Creek Passage Improvement and Box Canyon Passage Assessment will provide passage (Cold Creek) and assessments and design solutions (for Box Canyon if determined to be biologically sound) to open habitats that are not currently utilized by bull trout. The effectiveness of the design solutions will be dependent upon the results of the assessment and whether or not supplemental habitat improvements are implemented in the future. These actions, in conjunction with the bull trout population enhancement efforts, should increase the abundance and diversity of bull trout by improving access to new spawning and rearing habitats and increasing the diversity of available habitats.

The Kachess River and Box Canyon Creek Assessment and Design has the potential to directly address threats posed by dewatering and seasonal passage barriers within the Kachess River and Box Canyon Creek. The effectiveness of this action will be dependent upon the results of the assessment/design and whether or not habitat improvements are implemented in Phase 2. Successfully addressing stream dewatering would improve access to spawning and rearing habitat and reduce losses caused by predation and desiccation.

Conducting the Bull Trout Population Enhancement Evaluation will provide baseline data to inform decisions related to bull trout translocation and/or supplementation. The evaluation will ensure that enhancement activities are well aligned with available habitat capacity, consider population genetic risks, and provide a decisionmaking framework for implementation. Successfully enhancing bull trout populations will be dependent on determining the best method of population enhancement consistent with available habitat (includes restored habitat) and evaluating if population enhancement is biologically sound. Future implementation would be included in the Bull Trout Enhancement Plan Phase 2.

Improving reservoir and tributary productivity and availability of food resources utilizing nutrient enhancement will improve bull trout prey base.

Overall, the proposed habitat improvements, bull trout population enhancement efforts, and prey base enhancements have the highest potential benefit when combined. The expected incremental improvements in habitat function, increase in abundance of bull trout, and additional food resources will interact synergistically to reduce several of the more significant threats to populations in the Keechelus and Kachess watersheds and larger Yakima Basin—low abundance, passage barriers, dewatering, limited habitat and prey base.

CHAPTER 5: COST FOR PHASE 1 OF THE BULL TROUT ENHANCEMENT PLAN

The information provided in this section is a summary of estimated costs for each project and action. Each of the proposed projects will require funding and authorization prior to implementation. Individual estimated project costs are summarized in Table 6. If all of the projects and actions were implemented, the estimated total cost would be $13,316,000. Future actions based on assessments and design work completed in Phase 1 will require additional funding not included in the list below and will be implemented as part of Phase 2 of the Bull Trout Enhancement Plan.

Table 6. Summary of Estimated Project Costs for Phase 1 of the BTE

Project	Assessment and Design Costs	Construction and Implementation	Total
Gold Creek Passage & Habitat Improvements*	$250,000	$3,000,000	$3,250,000
Gold Creek USFS Bridge Replacement	N/A	$5,600,000	$5,600,000
Cold Creek Passage Improvement*	$250,000	$1,600,000	$1,850,000
Bull Trout Task Force	N/A	$66,000	$66,000
Kachess River & Box Canyon Passage & Habitat Assessment and Design*	$600,000	TBD	$600,000
Box Canyon Passage Assessment and Design	$200,000	TBD	$200,000
South Fork Tieton River Passage Assessment & Design*	$550,000	TBD	$550,000
Bull Trout Population Enhancement Evaluation*	$500,000	TBD	$500,000
Improve Productivity and Food Resources (nutrient enhancement)*	$200,000	$500,000	$700,000
		Grand Total	$13,316,000

*Priority actions based on expected benefit and information needs to address bull trout restoration needs.
TBD: To be determined.

CHAPTER 6: BULL TROUT ENHANCEMENT – PHASE 2

Bull Trout Enhancement Plan - Phase 2 would include implementation of the results of each assessment listed in Phase 1. As the Kachess Drought Relief Pumping Plant and Keechelus-To-Kachess Conveyance projects are implemented, Reclamation and Ecology, with the assistance of the Yakama Nation and fish agencies, will prioritize the work to be accomplished. Anticipated projects and actions include:

- Construct passage and habitat restoration for
  - Kachess River passage and habitat improvements
  - Box Canyon passage and habitat improvements.
- Construct Box Canyon Passage at Peek-a-boo falls (if determined sound and beneficial).
- Construct South Fork Tieton River Passage Restoration Action.
- Implement Bull Trout Population Enhancement Actions (translocation and/or supplementation).

CHAPTER 7: MEMORANDUM OF UNDERSTANDING

A Memorandum of Understanding (MOU) has been entered into by the Yakama Nation, the Service, WDFW, USFS, and Ecology, with Reclamation's Columbia-Cascades Area (collectively, "the parties") to define their respective roles in the development and the implementation of the Integrated Plan, specifically, to implement bull trout recovery actions and/or projects within the Yakima Basin to achieve self-sustainable, healthy, harvestable populations of native bull trout, which are currently listed with the Service as a threatened species pursuant to the Endangered Species Act of 1973, as amended (Act) (64 FR 58910; November 1, 1998).

The purpose of the MOU is to provide a framework in which to coordinate and facilitate cooperation among the parties to develop and implement bull trout recovery actions within the Yakima River basin. Bull trout recovery actions are intended to support the fish passage, habitat restoration, and habitat/watershed protection elements contained in the Integrated Plan Final PEIS, as well as subsequent project-level EISs. Objectives of this MOU include using Integrated Plan processes and committees to ensure proposed bull trout recovery actions are most effective at achieving bull trout recovery in the Yakima Basin. The YBTAP (Reiss, et al. 2012) and the Service's Bull Trout Recovery Plan (Whitesel, et al. 2004) are examples of bull trout resource protection and enhancement plans that will be used to inform the Integrated Plan bull trout decisions.

CHAPTER 8: MITIGATION

As noted in the introduction, the enhancement projects proposed in this document are separate from the mitigation actions that may be required for the proposed KDRPP and KKC projects. The mitigation actions are described here as a reference and to clearly delineate the differences between mitigation and enhancement projects. Additional mitigation may be identified through environmental compliance processes; such as, but not limited to ESA, Clean Water Act, etc.

8.1. Mitigation Measures

To address KDRPP and KKC project-specific bull trout impacts, Reclamation proposes to conduct the following activities:

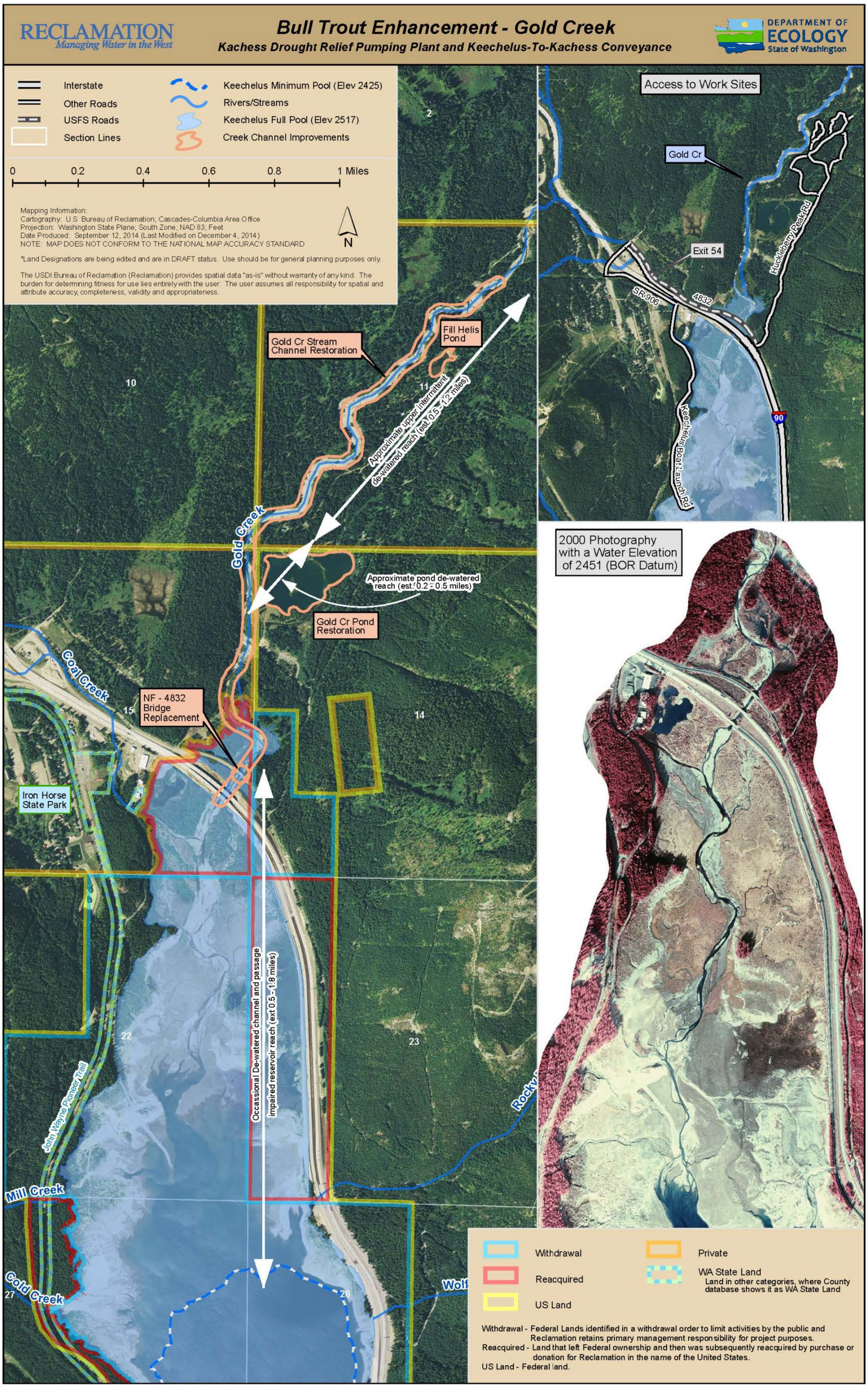
- Adaptively manage Reclamation's emergency monitoring/passage program so that it is responsive to increased passage risk into spawning tributaries.
    - Monitor for new or increased occurrence of barriers to spawning tributaries caused by reservoir drawdown operations.
    - Provide emergency passage for bull trout if permanent facilities are not in place to address passage barriers affected by operations.
- Construct permanent fish passage structures or habitat modifications to minimize or fully address potential passage barriers
    - Between Kachess Reservoir and Lower Box Canyon Creek,

- Between Kachess Reservoir and Little Kachess basins,
- Between Keechelus Reservoir and Gold Creek (the Gold Creek project is unlikely to fix operations-based fish barriers), and
- Any other identified locations

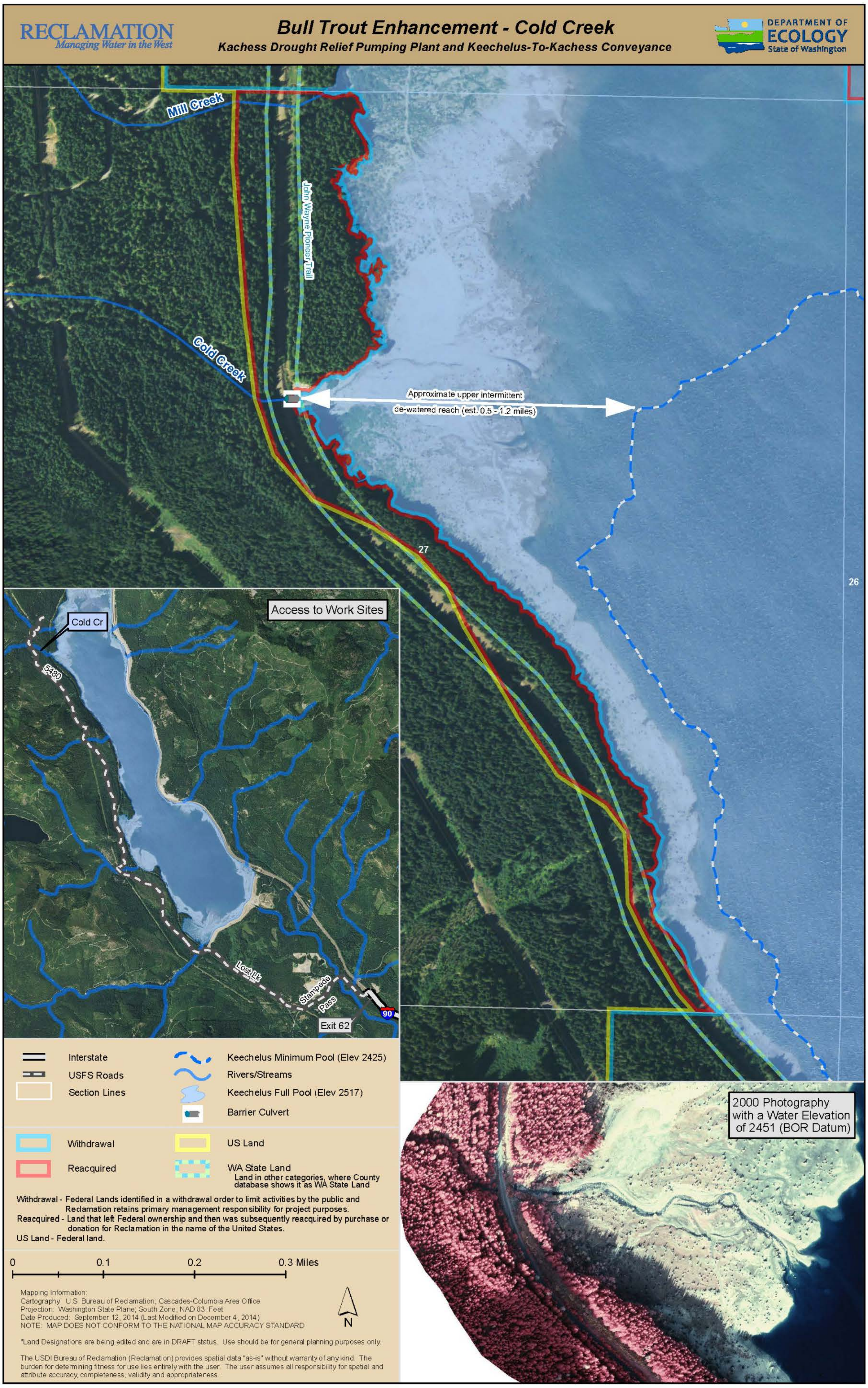
- Examine reservoir productivity and food web impacts from future use of Kachess Reservoir inactive storage.
- Address increased entrainment risk associated with new facilities.
    - Install screening on all new diversions and pumps.

In conducting mitigation and enhancement activities, Reclamation will adhere to state, Federal, and local regulations as well as consult with the Service and NMFS on ESA requirements.

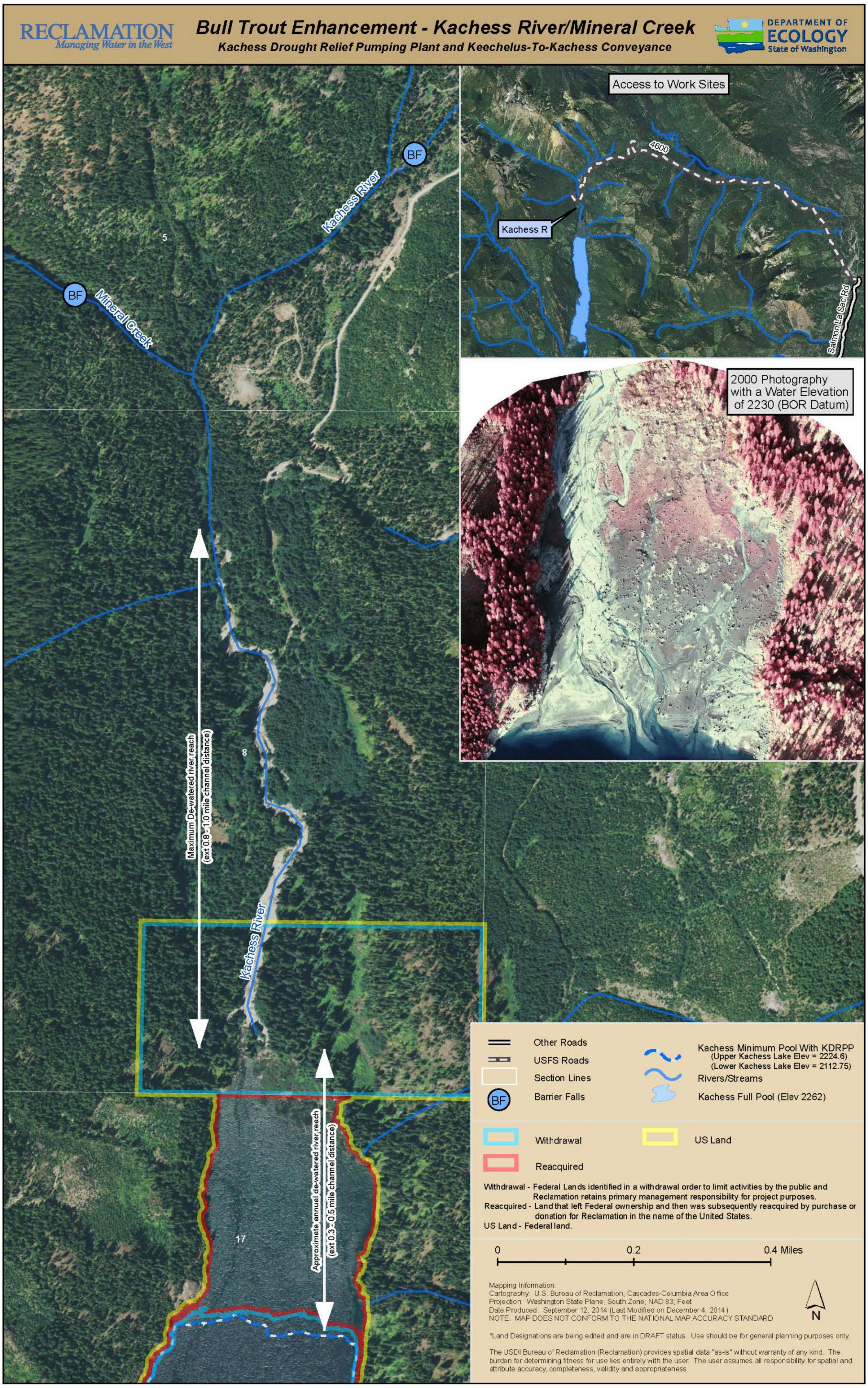
CHAPTER 9: MAPS



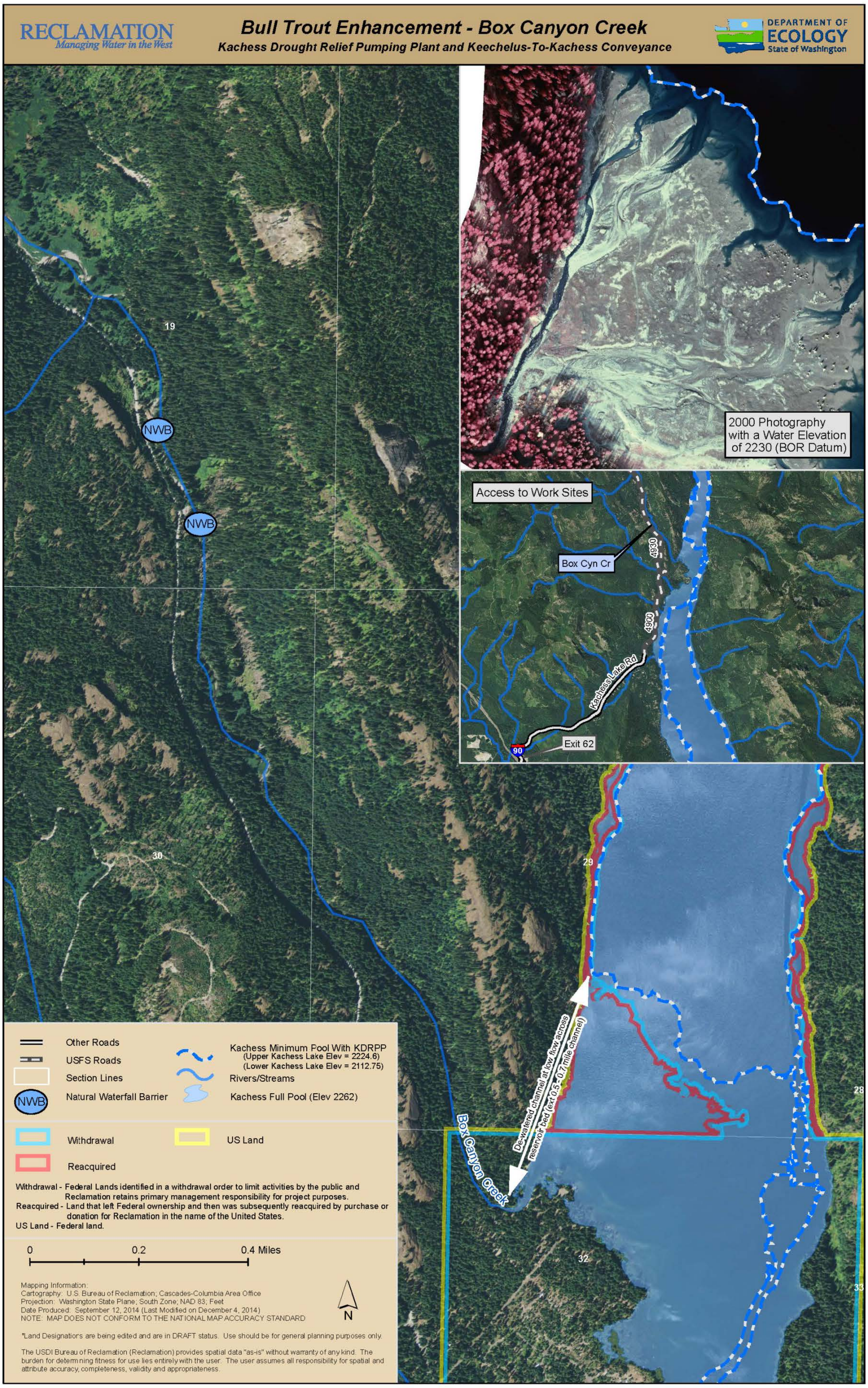
Map 1. Gold Creek Project Area depicting Gold Creek, Keechelus Reservoir, and adjacent land ownership



Map 2. Cold Creek Project Area depicting Cold Creek, Keechelus Reservoir, and adjacent land ownership



Map 3. Kachess River Project Area depicting Kachess River, Mineral Creek, Kachess Reservoir, and adjacent land ownership



Map 4. Box Canyon Creek Project Area depicting Box Canyon Creek, Kachess Reservoir, and adjacent land ownership

Map 5. South Fork Tieton Project Area depicting South Fork Tieton River, Rimrock Reservoir, and adjacent land ownership

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Appendix D

SPECIES LISTS

Table D-1. Survey and Manage Species in Keechelus and Kachess Reservoir Vicinity

Species Common Name	Survey and Manage Category[1]	Habitat
Vascular Plants		
Mingan moonwort	A	Riparian zones and old-growth western red cedar in dense shade, sparse understory, alluvium substrate, and often a duff layer of cedar branchlets.
Mountain grape-fern	A	Dark coniferous forests, usually near western red cedar swamps and streams from 3,300-9,800 feet in elevation.
Cold-water corydalis	A	In western hemlock and pacific silver fir zone and near cold flowing water and seeps and small streams.
Hemlock dwarf mistletoe	F	Principal host trees are mountain hemlock and true firs. Secondary host trees include pines and spruces.
Clustered lady's slipper	C	Habitat varies from dry to damp, rocky to loamy. Found in areas with 60 to 100 percent shade provided by various plant communities including mixed evergreen, mixed conifer, Douglas-fir, and pine forest.
Mountain lady's slipper	C	Grows on a wide variety of substrates in wooded communities with 60-80 percent canopy closure in mixed Coniferous forests commonly consisting of Douglas-fir with pine or grand fir.
Lichens		
Cladonia norvegica	C	Decaying bark or wood at the base of conifer trees and on decaying logs in humid Douglas-fir, Sitka spruce, and Western hemlock forests.
Hypogymnia duplicata	C	Epiphyte on mountain hemlock, western hemlock, Pacific silver fir, Douglas-fir and subalpine fir in old-growth forests between 1,100-5,450 feet.
Lobaria linita	A	Moss-covered rocks in cool, moist areas in forests bordering Pacific silver fir and mountain hemlock zones. May also grow on trunks of fir trees.
Usnea longissima	F	Old-growth and late-successional conifer stands, hardwood stands, and riparian areas.
Fungi		
Acanthophysium farlowii	B	Recently dead twigs of live true firs, Douglas-fir, and hemlock.
Albatrellus ellisii	B	Found on ground in forests.
Bondarzewia mesenterica (B. montana)	B	Late successional Coniferous forests in Washington; often associated with stumps or snags.
Cantharellus subalbidus	D	Coniferous forests

Species Common Name	Survey and Manage Category[1]	Habitat
Chalciporus piperatus	D	Scattered in humus in mixed woods.
Clavariadelphus occidentalis	B	On soil or duff under mixed deciduous-coniferous forests.
Clavariadelphus sachalinensis	B	
Clavariadelphus truncatus (borealis)	B	
Craterellus tubaeformis	D	On wet soil, often along streams or near springs or in bogs under conifers; also juxtaposed to rotten logs.
Cudonia monticola	B	On spruce needles and coniferous debris.
Gastroboletus turbinatus	B	Montane and subalpine forests of true firs, spruce, and pine.
Gomphus clavatus	F	Partially hidden in deep humus in coniferous forests.
Gomphus kauffmanii	E	
Gyromitra californica	B	Well-rotted stumps or logs of coniferous trees.
Helvella crassitunicata	B	Found on soil, especially along trails, in montane regions with true pines.
Hypomyces luteovirens	B	Obligate parasite of species in the *Russulaceae*; found in association with roots of various tree species in the pine family.
Mycena overholtsii	D	Decayed wood in true fir forests.
Otidea leporina	D	Spruce, Douglas-fir, and western hemlock forests.
Polyzellus multiplex	B	Occurs in association with roots of true firs in late-successional, mid-elevation, montane, Coniferous forests.
Ramaria araiospora	B	Spruce, Douglas-fir, and western hemlock forests.
Rhizopogon evadens var. *subalpinus*	B	Roots of mountain hemlock or true firs.
Sarcodon fuscoindicus	B	Found in soil throughout forests
Sparassis crispa	D	Within 6 feet of the base of a living Douglas-fir or pine tree.
Spathularia flavida	B	Litter or woody debris of conifer and hardwood forests.
Tremiscus helvelloides	D	Duff, soil, and rotten wood under conifers.

[1] Categories A through F are ranked highest to lowest based on level of relative rarity, ability to reasonably and consistently locate occupied sites during surveys prior to habitat disturbing activities, and the level of information known about the species or group of species (USFS, 2001).

Source: Garvey-Darda, P. 2014. Personal Communication. Wildlife Biologist. U.S. Forest Service. Cle Elum, Washington.

Table D-2. USFS Management Indicator Species

	Species	Habitat
Birds	Cooper's hawk	Common in all forest types.
	Downy woodpecker	Lowland riparian woodlands and broadleaf forests.
	Flammulated owl	Associated with ponderosa pine forests and mixed conifer stands with a mean 67% canopy closure, open understory with dense patches of saplings or shrubs.
	Golden eagle	Associated with open and semi-open habitats. Nest on cliffs, in the upper one-third of deciduous and coniferous trees, or on artificial structures (e.g. artificial nesting platforms, electricity transmission towers, windmills).
	Hairy woodpecker	Conifer forest
	Northern pygmy owl	Inhabits dense woodlands in foothills and mountains.
	Osprey	Nest near water. Eat fish almost exclusively.
	Pileated woodpecker	Mature and old growth forests
	Red-breasted sapsucker	Mixed conifer, ponderosa pine, and lodgepole pine near riparian areas. Need large diameter dead and decaying trees. Nests in snags.
	Ruffed grouse	Multi-story coniferous forests used for breeding and escape cover.
	Sharp-shinned hawk	Common in all forest types.
	Western screech owl	Common in open woodlands.
	Williamson's sapsucker	Found in the east Cascades, mid to high elevation, mature open and mixed coniferous - deciduous forests. Snags are a critical component.
	Common loon	Breed on quiet, remote freshwater lakes of the northern U.S. In winter and during migration, use lakes, rivers, estuaries, and coastlines.
Mammals	Beaver	Streams and lakes with trees or alders on banks.
	Mule deer	Typically inhabit higher elevations in the summer and lower elevations in the winter. Benefit from mix of forest and open foraging areas. Riparian areas important for fawning.
	Pine marten	Mature mesic forest with complex physical structure near the ground (course woody debris, large talus, low hanging branches. Generally avoid cleared or open areas.
	Rocky Mountain elk	Combination of forest and open habitats. Seclusion from human disturbances important for calving.
	Mountain goat	Steep, rocky cliffs, pinnacles, ledges, and talus slopes. Dense conifer stands, including mature and old-growth, may be important in providing winter forage and thermal cover

Table D-3. Invasive Plant Species in that could occur in the Primary Study Area

Common Name	Cle Elum Ranger District Priority Weeds	Kittitas County Regulated Noxious Weed
Absinth wormwood	X	X
Musk thistle	X	X
Diffuse knapweed	X	X
Brown knapweed	X	X
Spotted knapweed	X	X
Meadow knapweed	X	X
Russian thistle	X	X
Chicory	X	X
Canada thistle	X	X
Bull thistle	X	X
Hounds tongue	X	X
Scotch broom	X	X
Foxglove		X
Herb robert		X
English Ivy		X
Orange hawkweed	X	X
Yellow hawkweed	X	X
Common Hawkweed	X	X
European hawkweed	X	X
Common velvet grass		
St. Johnswort	X	X
Cat’s ear	X	X
Yellow flag iris		X
Yellow archangel		X
Everlasting peavine		X
Oxeye daisy	X	X
Dalmatian toadflax		X
Butter and eggs		X
Reed canarygrass		
Narrowleaf plaintain		
Greater plaintain		
Bohemian knotweed		X
Sulfur cinquefoil	X	X
English laurel		

Common Name	Cle Elum Ranger District Priority Weeds	Kittitas County Regulated Noxious Weed
Creeping buttercup		
Himalayan blackberry	X	X
Evergreen blackberry	X	X
Red sorrel		
Curly dock		
Tansy ragwort	X	X
Woodland ragwort	X	
Common groundsel	X	
Bladder campion		X
Common tansy	X	X
Dandelion		
Salsify		
Red clover		
White clover		
False mayweed		
Common mullein		
Field veronica		
Common speedwell		

Table D-4. State Listed Wildlife Species of Concern Documented near Kachess and Keechelus Reservoirs (WDFW PHS database)

	Priority Species	State Status
Birds	Bald eagle	Sensitive
	Great blue heron	Monitor
	Northern goshawk	Candidate
	Northern spotted owl	Endangered
	Osprey	None
	Pileated woodpecker	Candidate
Amphibians	Larch mountain salamander	Sensitive
	Tailed frog	Monitor
	Western toad	Candidate
Mammals	Elk	None
	Gray wolf	Endangered
	Grizzly bear	Endangered
	Mountain goat	None
	Wolverine	Candidate
	Little brown myotis	None
	Yuma myotis	None

Appendix E

STREAMFLOW HYDROGRAPHS

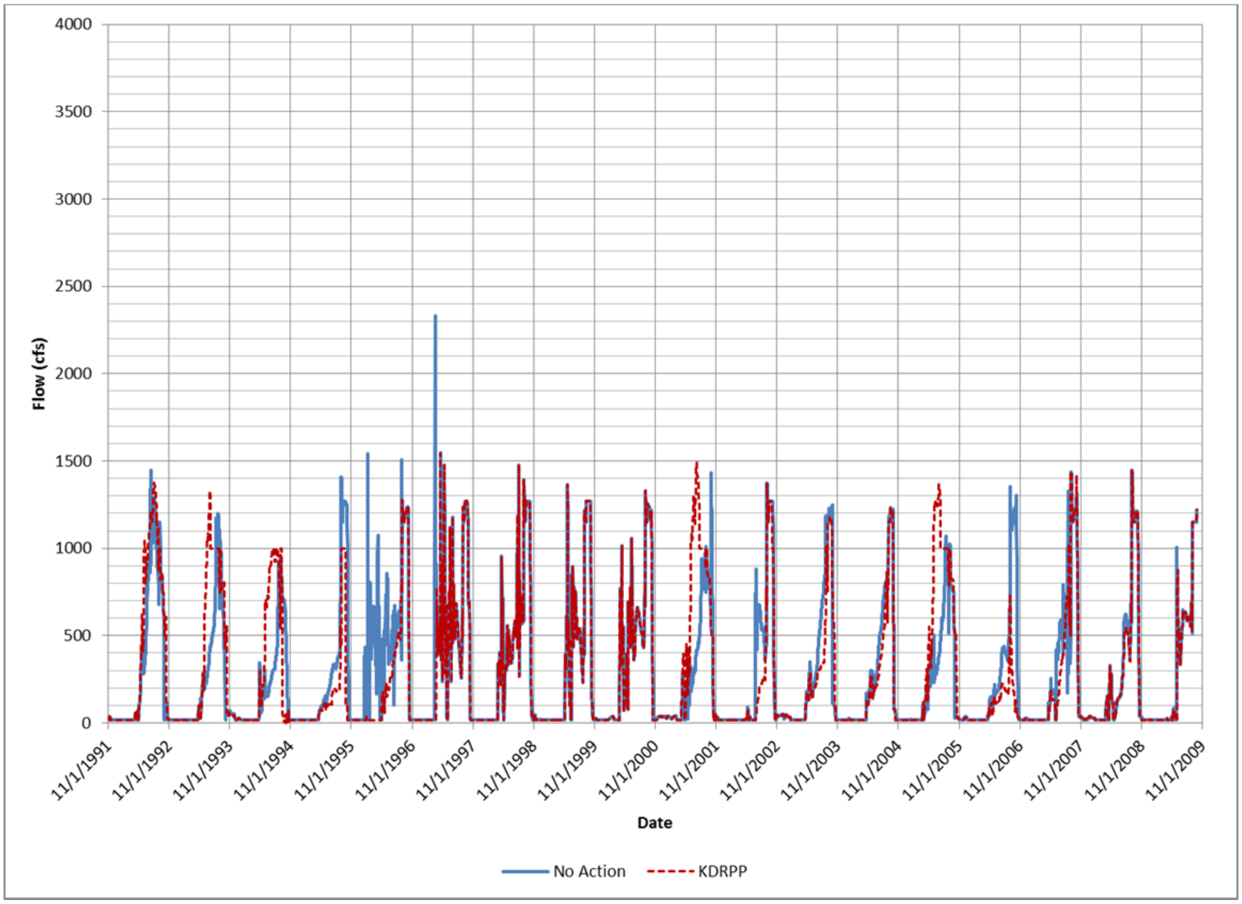

Figure E-1. Kachess River Flow under Alternative 2A – KDRPP East Shore Pumping Plant

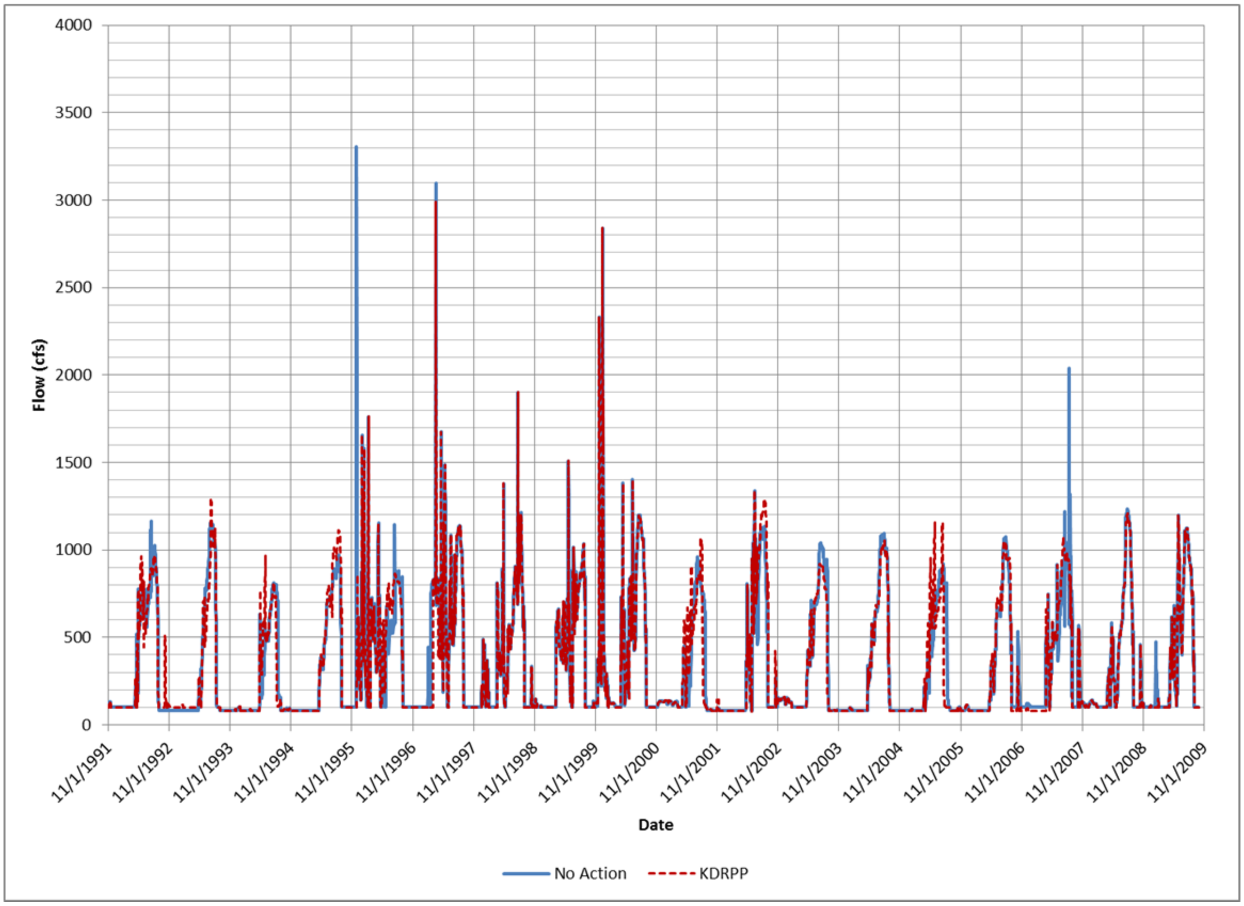

Figure E-2. Keechelus Reach Flow under Alternative 2A – KDRPP East Shore Pumping Plant

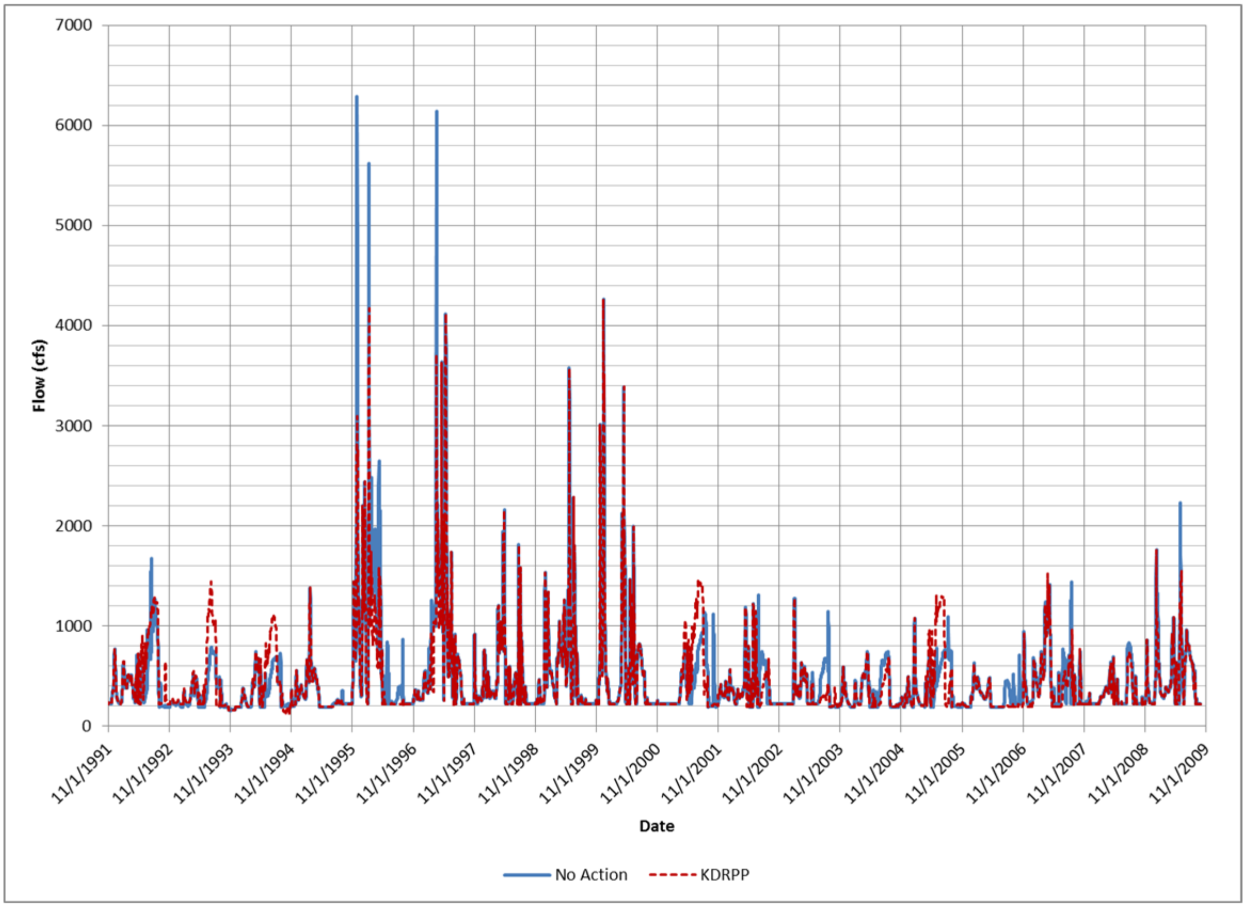

Figure E-3. Yakima River at Easton (Easton Reach) Flow under Alternative 2A – KDRPP East Shore Pumping Plant

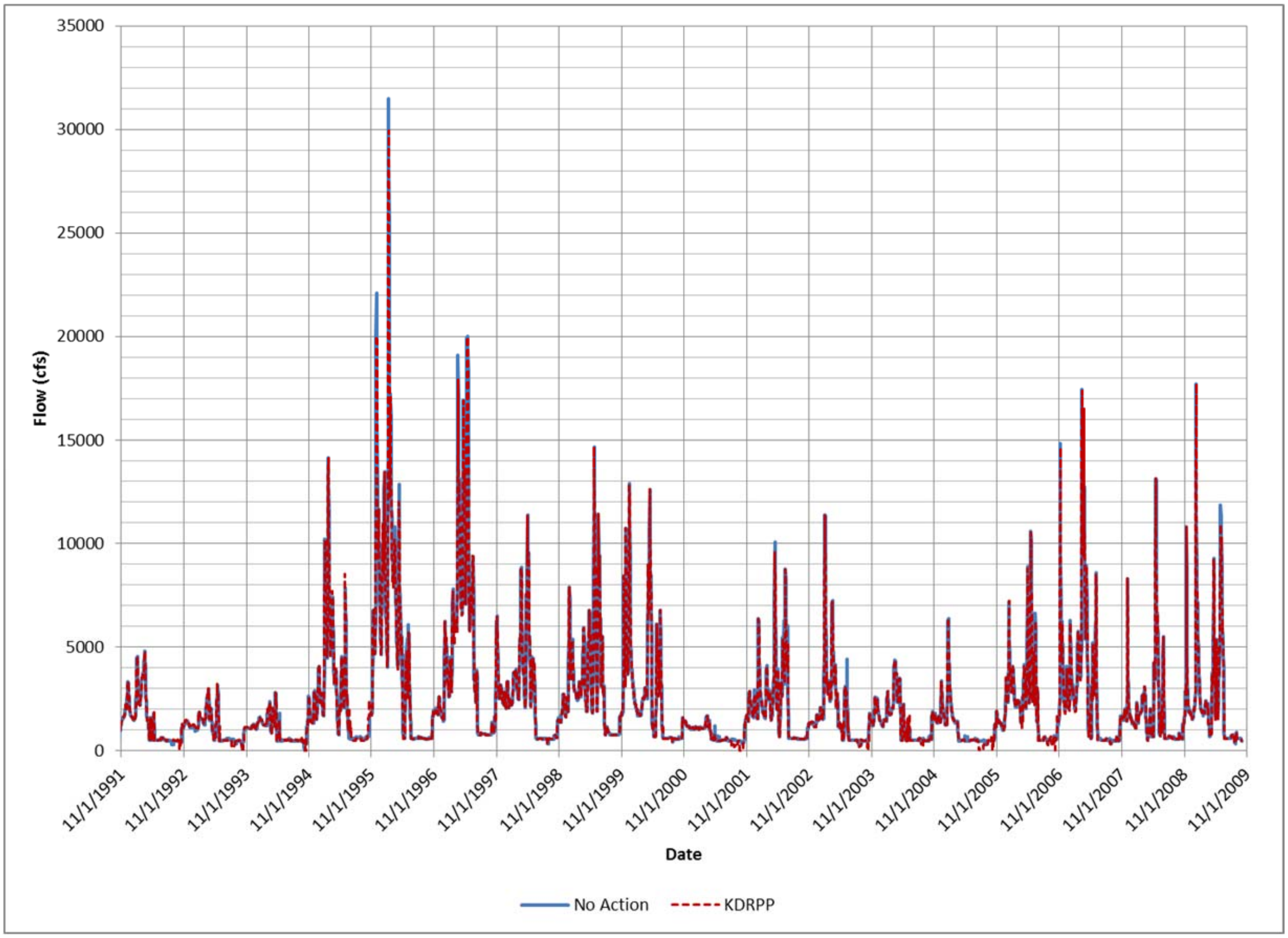

Figure E-4. Yakima River (Parker Gage) Flow under Alternative 2A – KDRPP East Shore Pumping Plant

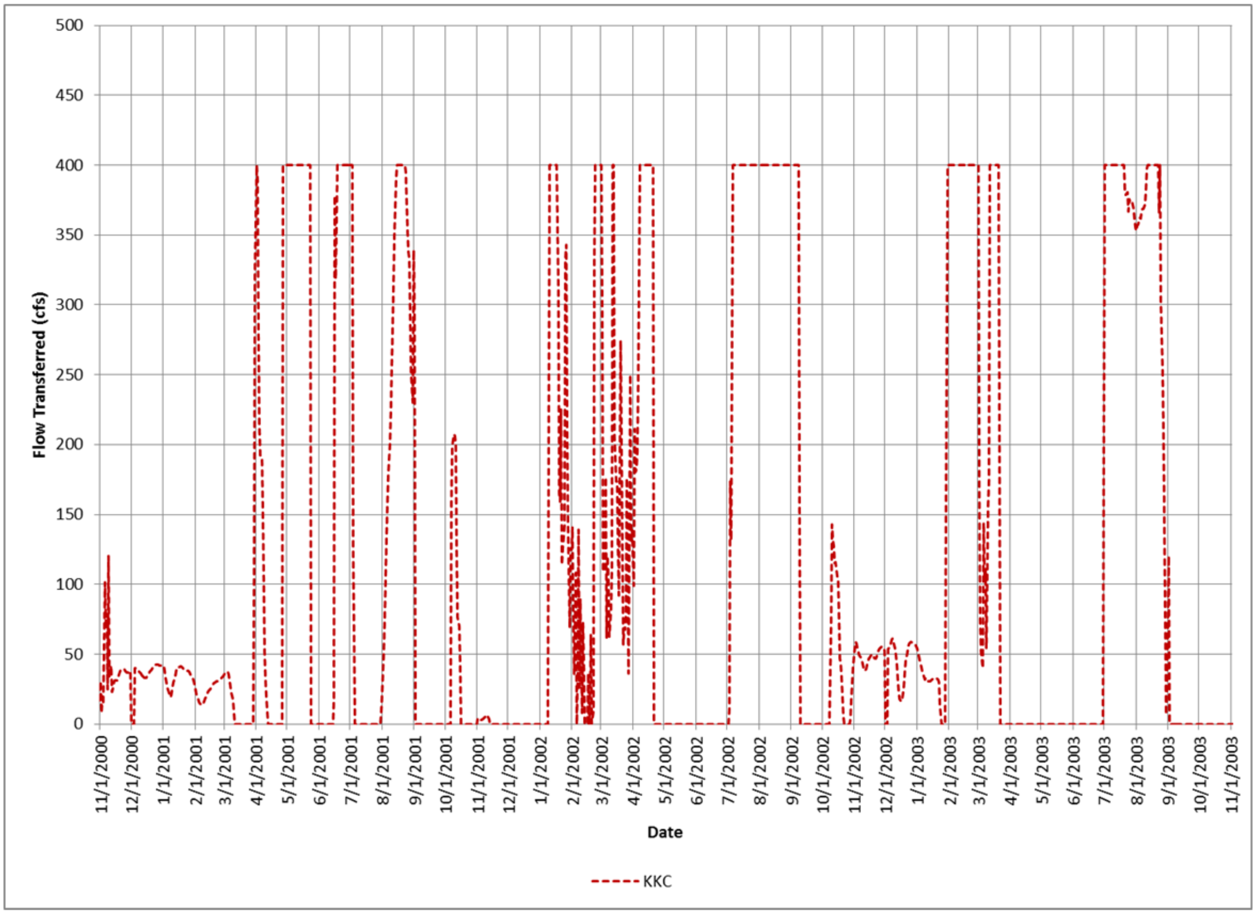

Figure E-5. Flow Transferred through KKC under Alternative 3A – KKC North Tunnel Alignment (Water Years 2001-2203)

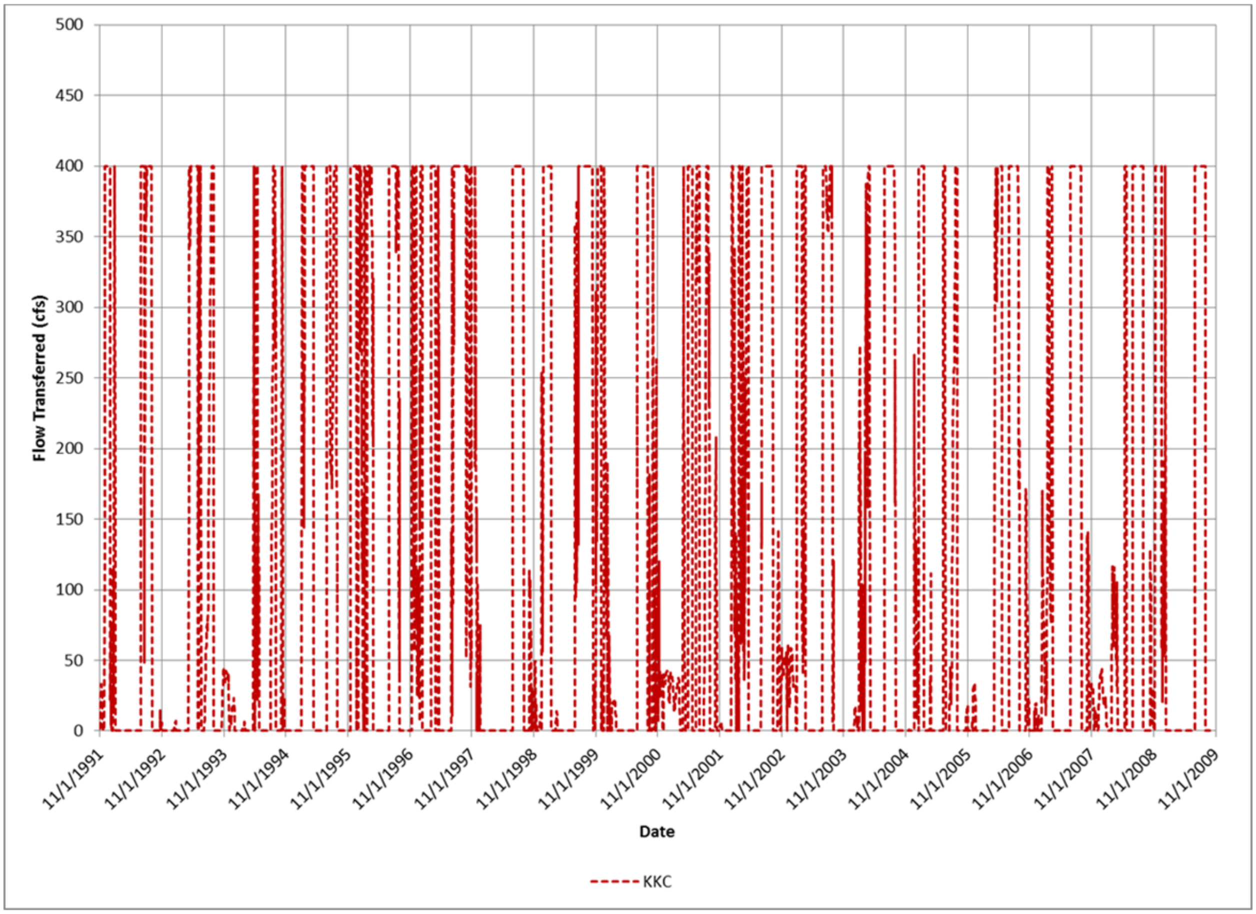

Figure E-6. Flow Transferred through KKC under Alternative 3A – KKC North Tunnel Alignment (Water Years 1992-2009)

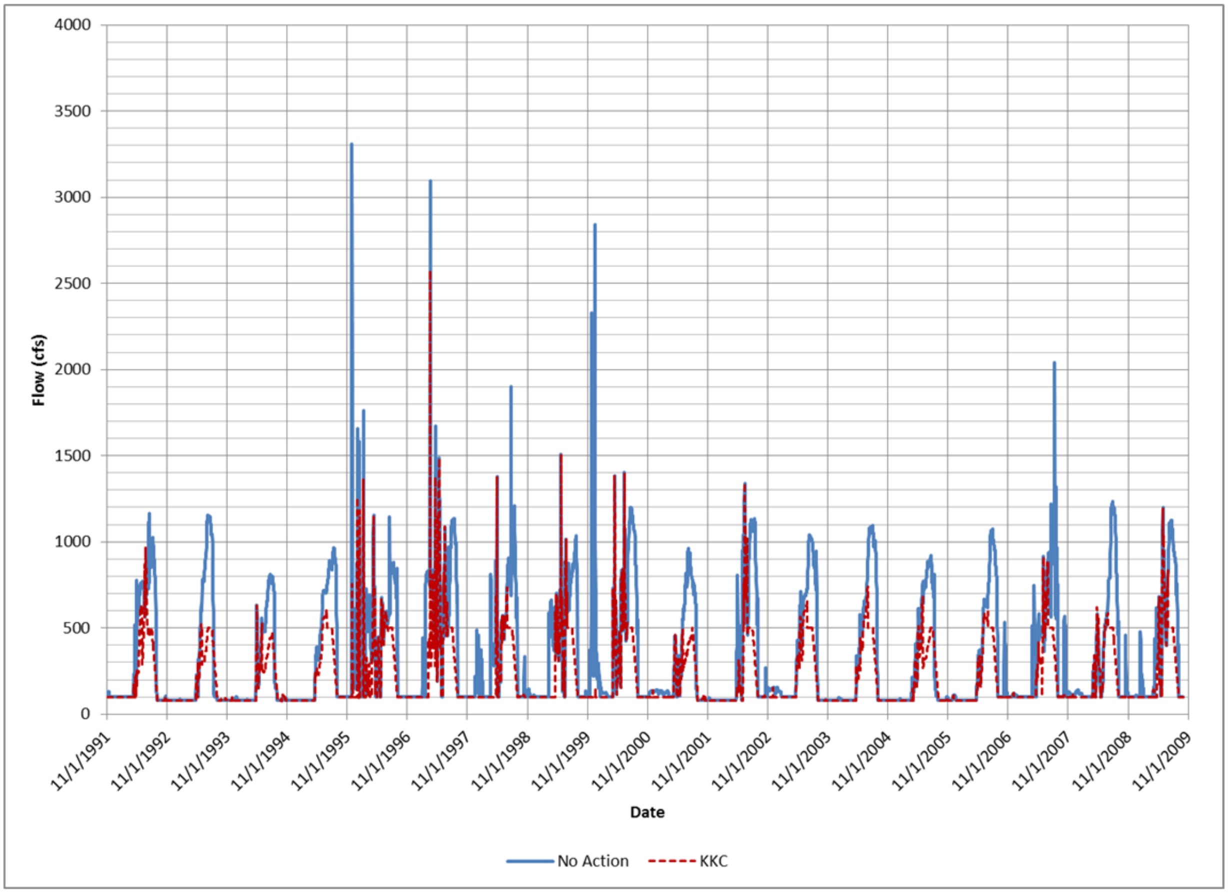

Figure E-7. Yakima River Flow below Keechelus Reservoir (Keechelus Reach) under Alternative 3A – KKC North Tunnel Alignment

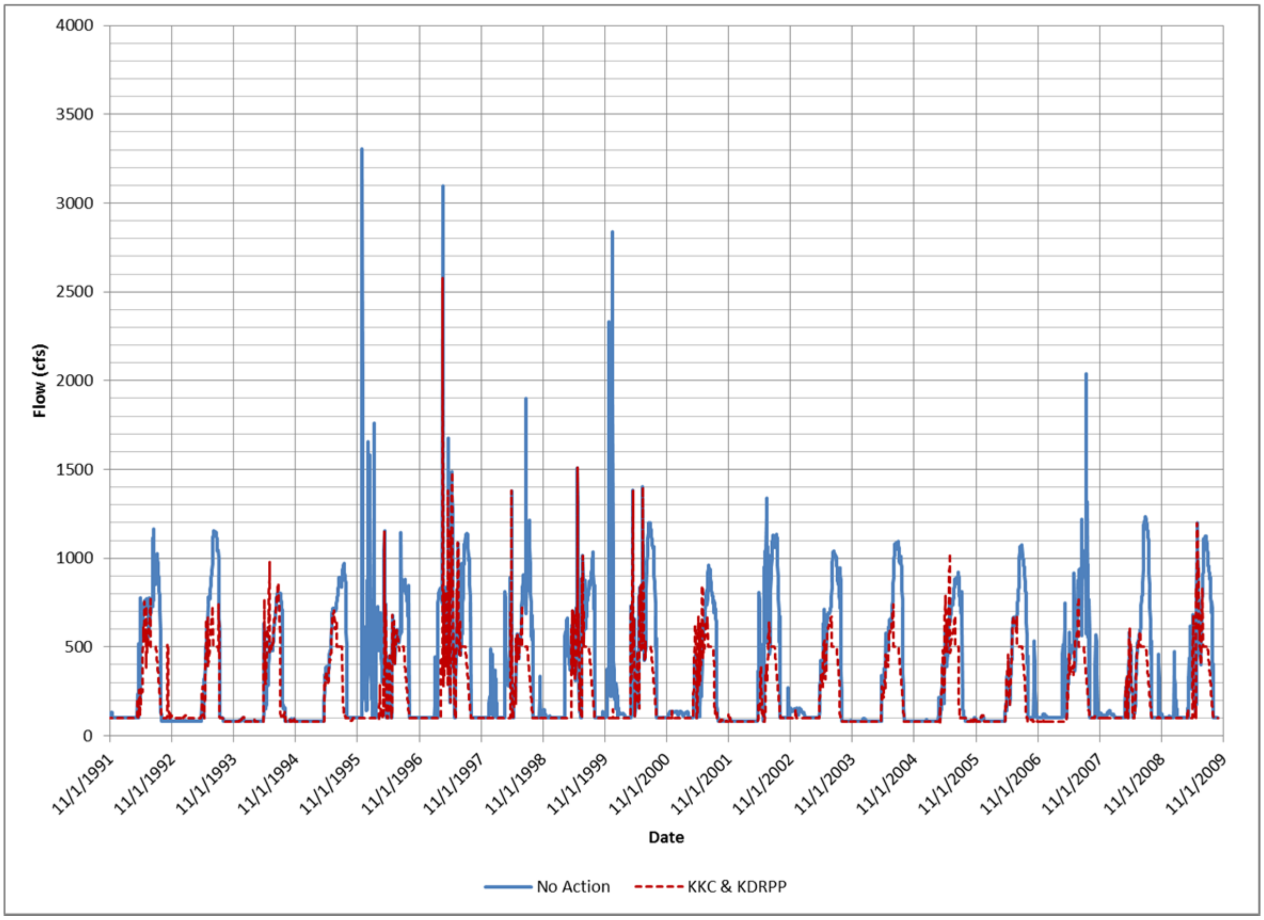

Figure E-8. Keechelus Reach Flow under Alternative 4 – Combined KDRPP and KKC