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

## FINAL Environmental Impact Statement

KITTITAS and YAKIMA COUNTIES, WASHINGTON




Estimated Total Cost Associated with Developing and Producing this Final EIS is approximately $3,500,000.


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: 18-12-011

Volume I of III

March 2019

# 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.

Ecology is Washington's environmental protection agency. Our mission is to protect, preserve, and enhance Washington's land, air, and water for current and future generations. Our innovative partnerships support environmental work throughout the state.

RECLAMATION
*Managing Water in the West*

DEPARTMENT OF ECOLOGY
State of Washington

March 6, 2019

CCA-1600
2.1.4.17

Subject: Kachess Drought Relief Pumping Plant and Keechelus Reservoir-to-Kachess Reservoir Conveyance Projects Final Environmental Impact Statement, Kittitas and Yakima Counties, Washington

Dear Interested Party:

The Final Environmental Impact Statement (FEIS) for the proposed Kachess Drought Relief Pumping Plant (KDRPP) and Keecheles Reservoir-to-Kachess Reservoir Conveyance (KKC) projects has been prepared jointly by the Bureau of Reclamation and the Washington State Department of Ecology (Ecology) Office of Columbia River. These projects are components of the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan).

In 2013, Reclamation and Ecology published in the Federal Register a Notice of Intent to prepare the KDRPP and KKC Draft EIS (DEIS) followed by a joint National Environmental Policy Act (NEPA) and State Environmental Policy Act (SEPA) scoping process. In 2015 both agencies then issued the DEIS for public review. Due to substantial changes to the Proposed Action and action alternatives, Reclamation and Ecology determined that a Supplemental Draft EIS (SDEIS) was required. The SDEIS was released for public review April 13, 2018 and the 90-day comment period ended July 11, 2018.

Reclamation and Ecology have identified Alternative 4 – KDRPP Floating Pumping Plant – as the Preferred Alternative. As described in Alternative 4, Reclamation and Ecology have identified Roza Irrigation District as the entity responsible for the design, construction, operation, maintenance and funding (with potential participation by other proratable entities) of Alternative 4 at Kachess Reservoir. Alternative 4 improves water supply reliability during drought years; improves the ability of water managers to respond and adapt to potential changing hydrology; and contributes to the vitality of the regional economy and riverine environment in the Yakima River Basin.

This FEIS was prepared in compliance with NEPA, Public Law 91-190, 42 U.S.C. §§ 4371 *et seq*., and SEPA, Chapter 43.21C RCW, and the SEPA Rules (Chapter 197-11 WAC).

If you would like to have a copy of the FEIS in the form of a printed document, or compact disc (CD-ROM), or have a copy of the Executive Summary, please contact Ms. Candace McKinley by phone at (509) 573-8193, or email: kkbt@usbr.gov.

The FEIS 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,

ACTING FOR

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

G. Thomas Tebb, L.h.G., L.E.G.
Director
Office of Columbia River
Washington State Department of Ecology
1250 W. Alder Street
Union Gap, WA 98903-0009

**Final Environmental Impact Statement**
**Kachess Drought Relief Pumping Plant**
**Kittitas County and Yakima County, Washington**

| **Joint Lead Agencies:** | **For further information contact**: |
|---|---|
| U.S. Department of the Interior<br>Bureau of Reclamation | Ms. Candace McKinley<br>Environmental Program Manager<br>Columbia-Cascades Area Office<br>1917 Marsh Road<br>Yakima, Washington 98901-2058<br>509-573-8193 |
| State of Washington<br>Department of Ecology | Mr. G. Thomas Tebb, L.Hg., L.E.G<br>Director, Office of Columbia River<br>1250 Alder Street<br>Union Gap, Washington 98903-0009<br>509-575-2490 |

**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 Final Environmental Impact Statement (FEIS) for the Kachess Drought Relief Pumping Plant (KDRPP) was prepared jointly by the Bureau of Reclamation and Washington State Department of Ecology. This project is part of the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan). This FEIS evaluates a No Action Alternative and six action alternatives: Alternative 2 – KDRPP East Shore Pumping Plant; Alternative 3 – KDRPP South Pumping Plant; Alternative 4 (Proposed Action) – KDRPP Floating Pumping Plant; Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment; Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment; Alternative 5C – KDRPP Floating Pumping Plant with Keechelus-to- Kachess Conveyance North Tunnel Alignment.

This FEIS 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).

*(This page intentionally left blank)*

## SEPA FACT SHEET

**Brief Description of Proposal:**

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

The action alternatives examine constructing and operating the KDRPP—a pumping plant to access up to 200,000 acre-feet of water in Kachess Reservoir during drought years. The KKC—a gravity flow tunnel from Keechelus Reservoir to Kachess Reservoir —is evaluated as a component of the KDRPP alternatives. The KKC and the KDRPP are components of the Yakima Basin Integrated Water Resources Management Plan (Integrated Plan). The KKC is not being pursued as a standalone project at this time.

**Name of Entities Making Proposal**

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

State of Washington, Department of Ecology

Roza Irrigation District

The tentative date of implementation is 2021.

**Contact and Responsible Official:**

State of Washington, Department of Ecology

Mr. G. Thomas Tebb, L.Hg., L.E.G
SEPA Responsible Official
Director, Office of Columbia River
1250 Alder Street
Union Gap, Washington 98903-0009
509-575-2490

**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
- State Water Right Permit
- 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:**

March 2019

**Public Comment Period:**

In accordance with WAC 197-11-455, Ecology and Reclamation conducted a public comment period for the KDRPP and KKC Draft EIS (DEIS) from January 9, 2015 to June 15, 2015 and for the KDRPP and KKC Supplemental Draft EIS (SDEIS) from April 13, 2018 to July 11, 2018. A total of approximately 577 comment letters were received from agencies and individuals on the DEIS. A total of 1,746 comment letters were received from agencies and individuals on the SDEIS.

**Timing of Additional Environmental Review:**
Reclamation will issue the Record of Decision on the KDRPP and KKC no earlier than 30 days after the release of this FEIS. As noted in the FEIS, if there are changes in the project that could result in adverse impacts that are not identified in this FEIS, Reclamation and Ecology would conduct the appropriate environmental review required to identify and address potential significant adverse effects prior to taking action.

**Document Availability:**

The FEIS 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-ROM by written request to the SEPA Responsible Official listed above, or by calling 509-573-8193. To ask about the availability of this document in a format for the visually impaired, call the Office of Columbia River at 509-454-4241. 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 FEIS 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.

*(This page intentionally left blank)*

# Kachess Drought Relief Pumping Plant and Keechelus to Kachess Conveyance Project Locations

*(This page intentionally left blank)*

# Acronyms and Abbreviations

| Term | Definition |
|---|---|
| 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 |

| Term | Definition |
|---|---|
| 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 |

| Term | Definition |
|---|---|
| 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 |
| $\mu g/m^3$ | 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 |

| Term | Definition |
|---|---|
| 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 |
| Roza | Roza Irrigation District |
| RM | river mile |
| RV | recreational vehicle |
| SDEIS | Supplemental Draft Environmental Impact Statement |
| 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 |

| Term | Definition |
|---|---|
| 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 |

*(This page intentionally left blank)*

# Table of Contents

**VOLUME I:**

MISSION STATEMENT

COVER LETTER

JOINT LEAD AGENCIES

SEPA FACT SHEET

FRONTISPIECE

ACRONYMS AND ABBREVIATIONS

TABLE OF CONTENTS

EXECUTIVE SUMMARY

**Chapter 1 Introduction and Background ........ 1-1**

1.1 Introduction ........ 1-1

1.2 History and Background ........ 1-1

1.2.1 Yakima Project ........ 1-3

1.2.2 Integrated Plan and Programmatic FEIS ........ 1-5

1.2.3 Integrated Plan – A Package of Seven Elements ........ 1-5

1.2.4 Integrated Plan Implementation ........ 1-6

1.3 Purpose and Need ........ 1-7

1.3.1 Reclamation's Purpose and Need ........ 1-9

1.3.2 Ecology's Purpose and Need ........ 1-9

1.3.3 Roza and Proratable Entities' Purpose and Need ........ 1-9

1.4 Proposed Action ........ 1-9

1.5 Description of Changes from the DEIS and SDEIS ........ 1-11

1.5.1 Release of 2015 KDRPP-KKC DEIS and 2018 SDEIS ........ 1-11

1.5.2 Decision to Prepare the Supplemental Draft Environmental Impact Statement ........ 1-12

1.5.3 Changes to KDRPP from DEIS to SDEIS ........ 1-12

1.5.4 Changes to KKC from DEIS to SDEIS ........ 1-13

1.5.5 Changes Regarding BTE from DEIS to SDEIS ........ 1-13

1.5.6 Changes from the SDEIS to FEIS ........ 1-14

1.6 Public Involvement ........ 1-15

1.7 National and State Environmental Policy Act Review Process ........ 1-16

1.7.1 Tiered to Integrated Plan FPEIS ........ 1-16

1.7.2 Integrated Plan FPEIS Incorporated by Reference intoKDRPP-KKC FEIS ..... 1-17

1.7.3 SEPA Adoption of the Integrated Plan PEIS ..... 1-18

1.8 Authorizations ..... 1-18

1.8.1 Federal ..... 1-18

1.8.2 Washington State Authorization ..... 1-19

1.9 Water Rights and Contracts ..... 1-20

1.9.1 Water Rights ..... 1-20

1.9.2 Water Contracts ..... 1-20

1.10 Permits, Consultations, and Approvals ..... 1-20

**Chapter 2 Proposed Action and Alternatives ..... 2-1**

2.1 Introduction ..... 2-1

2.1.1 Ongoing and Related Actions ..... 2-1

2.2 Alternative 1 – No Action ..... 2-4

2.2.1 Current Yakima Project Operations and Typical Annual Operations – No Action ..... 2-4

2.3 Alternative 2 – KDRPP East Shore Pumping Plant ..... 2-6

2.3.1 Facilities ..... 2-10

2.3.2 Construction ..... 2-13

2.3.3 Typical Annual Operations ..... 2-18

2.3.4 Maintenance Activities ..... 2-22

2.3.5 Volitional Bull Trout Passage Improvements ..... 2-22

2.3.6 Avoidance, Minimization, and Mitigation Measures Common to All Action Alternatives ..... 2-25

2.4 Alternative 3 – KDRPP South Pumping Plant ..... 2-27

2.4.1 Facilities ..... 2-27

2.4.2 Construction ..... 2-31

2.4.3 Typical Annual Operations ..... 2-35

2.4.4 Maintenance Activities ..... 2-35

2.4.5 Volitional Bull Trout Passage Improvements ..... 2-36

2.4.6 Avoidance, Minimization, and Mitigation Measures ..... 2-36

2.5 Alternative 4 (Preferred Alternative) – Floating Pumping Plant ..... 2-36

2.5.1 Facilities ..... 2-39

2.5.2 Construction ........ 2-45
2.5.3 Typical Annual Operations ........ 2-50
2.5.4 Maintenance Activities ........ 2-50
2.5.5 Volitional Bull Trout Passage Improvements ........ 2-51
2.5.6 Avoidance, Minimization, and Mitigation Measures ........ 2-51
2.6 Alternative 5 – KDRPP with KKC North Tunnel Alignment ........ 2-51
2.6.1 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ........ 2-51
2.6.2 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ........ 2-62
2.6.3 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ........ 2-62
2.7 Estimated Cost of Alternatives ........ 2-62
2.7.1 Estimated Costs for the No Action Alternative ........ 2-63
2.7.2 Estimated Costs for Action Alternatives ........ 2-63
2.8 Other Alternatives Considered but Eliminated from Detailed Study ........ 2-64
2.8.1 KDRPP Alternatives ........ 2-64
2.8.2 KKC Alternatives ........ 2-65
2.9 Comparison of Alternatives ........ 2-67
2.10 Summary Comparison of Environmental Impacts of Alternatives ........ 2-69
2.11 Comparison of Alternatives and Selection of Preferred Alternative ........ 2-86
**Chapter 3 Affected Environment ........ 3-1**
3.1 Introduction ........ 3-1
3.2 Earth ........ 3-2
3.2.1 Regulatory Setting ........ 3-3
3.2.2 Regional Geology ........ 3-3
3.2.3 Kachess Reservoir Area ........ 3-7
3.2.4 Keechelus Reservoir Area ........ 3-10
3.2.5 KKC North Tunnel Alignment ........ 3-10
3.2.6 Seismicity in the Extended Study Area ........ 3-10
3.2.7 Soil Erosion in the Extended Study Area ........ 3-12
3.3 Surface Water Resources ........ 3-12
3.3.1 Project Operations ........ 3-12

3.3.2 Keechelus Dam and Reservoir Operations ..... 3-19
3.3.3 Upper Yakima River between Keechelus Reservoir and Lake Easton .. 3-22
3.3.4 Kachess Dam and Reservoir Operations ..... 3-23
3.3.5 Kachess River between Kachess Reservoir and Lake Easton ..... 3-26
3.3.6 Lake Easton ..... 3-26
3.3.7 Yakima River Downstream from Lake Easton ..... 3-27
3.3.8 Upper Yakima River Tributaries Downstream from Lake Easton ..... 3-28
3.4 Surface Water Quality ..... 3-28
3.4.1 Regulatory Setting ..... 3-28
3.4.2 Surface Water Permits and Approvals ..... 3-36
3.4.3 Existing Surface Water Quality Conditions ..... 3-36
3.4.4 Kachess Reservoir and Tributaries ..... 3-43
3.4.5 Lake Easton ..... 3-47
3.4.6 Kachess River ..... 3-47
3.4.7 Yakima River ..... 3-49
3.5 Groundwater ..... 3-51
3.5.1 Regulatory Setting ..... 3-54
3.5.2 Kachess Reservoir Area ..... 3-54
3.5.3 Keechelus Reservoir Area ..... 3-66
3.5.4 KKC North Tunnel Alignment ..... 3-66
3.6 Fish ..... 3-68
3.6.1 Regulatory Setting ..... 3-69
3.6.2 Kachess Reservoir Area ..... 3-69
3.6.3 Keechelus Reservoir Area ..... 3-78
3.6.4 Yakima River and Kachess River Downstream from Keechelus and Kachess Dams ..... 3-81
3.7 Vegetation and Wetlands ..... 3-89
3.7.1 Regulatory Setting ..... 3-90
3.7.2 Kachess Reservoir Area ..... 3-90
3.7.3 Keechelus Reservoir Area ..... 3-95
3.7.4 KKC North Tunnel Alignment ..... 3-98
3.7.5 USFS Survey and Manage Standards and Guidelines for Vascular Plant Species ..... 3-99

3.7.6 State Sensitive Species ........ 3-99
3.7.7 Invasive Species ........ 3-99
3.8 Wildlife ........ 3-99
3.8.1 Regulatory Setting ........ 3-100
3.8.2 Kachess and Keechelus Watersheds ........ 3-101
3.8.3 Kachess Reservoir Area ........ 3-102
3.8.4 Keechelus Reservoir Area ........ 3-104
3.8.5 KKC North Tunnel Alignment ........ 3-105
3.8.6 State Species of Concern ........ 3-105
3.9 Federal Threatened and Endangered Species ........ 3-106
3.9.1 Regulatory Setting ........ 3-107
3.9.2 Listed Species and Critical Habitat ........ 3-107
3.9.3 Bull Trout ........ 3-108
3.9.4 Middle Columbia River Steelhead ........ 3-116
3.9.5 Northern Spotted Owl ........ 3-120
3.9.6 Other Listed Species ........ 3-121
3.10 Visual Quality ........ 3-125
3.10.1 Kachess Reservoir Area ........ 3-126
3.10.2 Keechelus Reservoir Area ........ 3-127
3.10.3 KKC North Tunnel Alignment ........ 3-130
3.10.4 Forest Service Criteria ........ 3-130
3.11 Air Quality ........ 3-132
3.11.1 Regulatory Setting ........ 3-132
3.11.2 Current Air Quality Environment ........ 3-134
3.12 Climate Change ........ 3-135
3.12.1 Assessment of Climate Change in the Yakima River Basin ........ 3-138
3.12.2 Climate Change Effects in the Yakima River Basin ........ 3-139
3.12.3 Changes in Related Resources ........ 3-147
3.13 Noise ........ 3-148
3.13.1 Regulatory Setting ........ 3-149
3.13.2 Kachess Reservoir Area ........ 3-150
3.13.3 Keechelus Reservoir Area ........ 3-151
3.13.4 KKC North Tunnel Alignment ........ 3-151

3.14 Recreation ........ 3-151
3.14.1 Kachess Reservoir Area ........ 3-154
3.14.2 Keechelus Reservoir Area ........ 3-157
3.14.3 KKC North Tunnel Alignment Area ........ 3-158
3.15 Land and Shoreline Use ........ 3-159
3.15.1 Federal Plans and Policies ........ 3-162
3.15.2 State and Local Land Use Planning ........ 3-164
3.16 Utilities ........ 3-167
3.16.1 Electrical Service and Infrastructure ........ 3-167
3.16.2 Water Supply ........ 3-168
3.16.3 Wastewater and Solid Waste ........ 3-168
3.16.4 Telecommunications ........ 3-168
3.17 Transportation ........ 3-169
3.17.1 Kachess Reservoir Area ........ 3-171
3.17.2 Keechelus Reservoir Area ........ 3-171
3.17.3 KKC North Tunnel Alignment ........ 3-171
3.17.4 Primary Study Area Road Conditions and Standards ........ 3-171
3.17.5 Primary Study Area Traffic and Transportation Safety Information ... 3-172
3.17.6 Emergency Response ........ 3-172
3.17.7 Other Means of Transportation ........ 3-172
3.17.8 School Bus Routes ........ 3-173
3.18 Cultural Resources ........ 3-173
3.18.1 Regulatory Setting ........ 3-174
3.18.2 Archaeological and Historical Overview ........ 3-175
3.18.3 Known and Reported Resources in the Kachess Reservoir Area ........ 3-177
3.18.4 Known and Reported Resources in the Keechelus Reservoir and KKC Conveyance Areas ........ 3-178
3.19 Indian Sacred Sites ........ 3-181
3.20 Indian Trust Assets ........ 3-182
3.21 Socioeconomics ........ 3-183
3.21.1 Income and Employment ........ 3-184
3.21.2 Lodging Supply and Demand ........ 3-185
3.21.3 Property Values ........ 3-186

3.22 Environmental Justice ........ 3-186
3.22.1 Regulatory Setting ........ 3-187
3.22.2 Study Area Population Characteristics ........ 3-187
3.23 Health and Safety ........ 3-188
3.23.1 Kachess Reservoir Area ........ 3-189
3.23.2 Keechelus Reservoir Area ........ 3-189
3.23.3 KKC North Tunnel Alignment ........ 3-189
**Chapter 4 Environmental Consequences ........ 4-1**
4.1 Introduction ........ 4-1
4.1.1 Terms Used in this Chapter ........ 4-1
4.2 Earth ........ 4-2
4.2.1 Methods and Impact Indicators ........ 4-2
4.2.2 Summary of Impacts ........ 4-3
4.2.3 Alternative 1 – No Action ........ 4-4
4.2.4 Alternative 2 – KDRPP East Shore Pumping Plant ........ 4-4
4.2.5 Alternative 3 – KDRPP South Pumping Plant ........ 4-9
4.2.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ........ 4-11
4.2.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ........ 4-13
4.2.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ........ 4-15
4.2.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ........ 4-15
4.2.10 Avoidance, Minimization, and Mitigation Measures ........ 4-16
4.3 Surface Water Resources ........ 4-17
4.3.1 Methods and Impact Indicators ........ 4-17
4.3.2 Summary of Impacts ........ 4-18
4.3.3 Alternative 1 – No Action ........ 4-24
4.3.4 Alternative 2 – KDRPP East Shore Pumping Plant ........ 4-24
4.3.5 Alternative 3 – KDRPP South Pumping Plant ........ 4-53
4.3.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ........ 4-54

4.3.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ... 4-55

4.3.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ... 4-83

4.3.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ... 4-83

4.3.10 Avoidance, Minimization, and Mitigation Measures ... 4-83

4.4 Surface Water Quality ... 4-84

4.4.1 Methods and Impact Indicators ... 4-84

4.4.2 Summary of Impacts ... 4-85

4.4.3 Alternative 1 – No Action ... 4-88

4.4.4 Alternative 2 – KDRPP East Shore Pumping Plant ... 4-89

4.4.5 Alternative 3 – KDRPP South Pumping Plant ... 4-96

4.4.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ... 4-97

4.4.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ... 4-101

4.4.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ... 4-106

4.4.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ... 4-106

4.4.10 Avoidance, Minimization, and Mitigation Measures ... 4-106

4.5 Groundwater Quantity and Quality ... 4-108

4.5.1 Methods and Impact Indicators ... 4-108

4.5.2 Summary of Impacts ... 4-109

4.5.3 Alternative 1 – No Action ... 4-110

4.5.4 Alternative 2 – KDRPP East Shore Pumping Plant ... 4-110

4.5.5 Alternative 3 – KDRPP South Pumping Plant ... 4-116

4.5.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ... 4-117

4.5.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ... 4-117

4.5.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ... 4-119

4.5.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ... 4-119

4.5.10 Avoidance, Minimization, and Mitigation Measures .......................... 4-120

4.6 Fish ........................................................................................................ 4-120

4.6.1 Methods and Impact Indicators ......................................................... 4-120

4.6.2 Summary of Impacts ........................................................................ 4-122

4.6.3 Alternative 1 – No Action ................................................................. 4-127

4.6.4 Alternative 2 – KDRPP East Shore Pumping Plant ............................ 4-132

4.6.5 Alternative 3 – KDRPP South Pumping Plant ................................... 4-146

4.6.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ........................................................................................... 4-147

4.6.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ................................................................................. 4-151

4.6.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ................................................................................. 4-157

4.6.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ................................................................................. 4-157

4.6.10 Avoidance, Minimization, and Mitigation Measures .......................... 4-157

4.7 Vegetation and Wetlands ........................................................................ 4-158

4.7.1 Methods and Impact Indicators ......................................................... 4-158

4.7.2 Summary of Impacts ........................................................................ 4-159

4.7.3 Alternative 1 – No Action ................................................................. 4-161

4.7.4 Alternative 2 – KDRPP East Shore Pumping Plant ............................ 4-162

4.7.5 Alternative 3 – KDRPP South Pumping Plant ................................... 4-167

4.7.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ........................................................................................... 4-170

4.7.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ................................................................................. 4-172

4.7.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ................................................................................. 4-176

4.7.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ................................................................................. 4-176

4.7.10 Avoidance, Minimization and Mitigation Measures ........................... 4-176

4.8 Wildlife ................................................................................................... 4-177

4.8.1 Methods and Impact Indicators ......................................................... 4-177

4.8.2 Summary of Impacts ........................................................................ 4-181

4.8.3 Alternative 1 – No Action ................................................................. 4-182

4.8.4 Alternative 2 – KDRPP East Shore Pumping Plant ............................ 4-182

4.8.5 Alternative 3 – KDRPP South Pumping Plant.................................... 4-185

4.8.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ........................................................................... 4-186

4.8.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment .................................................................. 4-189

4.8.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment .................................................................. 4-190

4.8.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment .................................................................. 4-191

4.8.10 Avoidance, Minimization and Mitigation Measures .......................... 4-191

4.9 Threatened and Endangered Species ............................................... 4-191

4.9.1 Methods and Impact Indicators.......................................................... 4-191

4.9.2 Summary of Impacts ........................................................................... 4-193

4.9.3 Alternative 1 – No Action.................................................................... 4-196

4.9.4 Alternative 2 – KDRPP East Shore Pumping Plant ............................ 4-198

4.9.5 Alternative 3 – KDRPP South Pumping Plant.................................... 4-207

4.9.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ........................................................................... 4-209

4.9.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment .................................................................. 4-212

4.9.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment .................................................................. 4-217

4.9.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment .................................................................. 4-217

4.9.10 Avoidance, Minimization and Mitigation Measures .......................... 4-217

4.10 Visual Quality ..................................................................................... 4-218

4.10.1 Methods and Impact Indicators.......................................................... 4-218

4.10.2 Summary of Impacts ........................................................................... 4-220

4.10.3 Alternative 1 – No Action.................................................................... 4-221

4.10.4 Alternative 2 – KDRPP East Shore Pumping Plant ............................ 4-222

4.10.5 Alternative 3 – KDRPP South Pumping Plant.................................... 4-226

4.10.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ........................................................................... 4-228

4.10.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment .................................................................. 4-232

4.10.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ...... 4-235

4.10.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ...... 4-236

4.10.10 Avoidance, Minimization and Mitigation Measures...... 4-236

4.11 Air Quality ...... 4-236

4.11.1 Methods and Impact Indicators...... 4-236

4.11.2 Summary of Impacts ...... 4-237

4.11.3 Alternative 1 – No Action...... 4-237

4.11.4 Alternative 2 -- KDRPP East Shore Pumping Plant......4-237

4.11.5 Alternative 3 – KDRPP South Pumping Plant...... 4-239

4.11.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ...... 4-240

4.11.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ...... 4-241

4.11.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ...... 4-242

4.11.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ...... 4-242

4.11.10 Avoidance, Minimization, and Mitigation Measures ...... 4-242

4.12 Climate Change...... 4-243

4.12.1 Methods and Impact Indicators...... 4-243

4.12.2 Summary of Impacts ...... 4-246

4.12.3 Climate Change Impacts on Operation ...... 4-246

4.12.4 Alternative 1 – No Action...... 4-248

4.12.5 Alternative 2 – KDRPP East Shore Pumping Plant...... 4-254

4.12.6 Alternative 3 – KDRPP South Pumping Plant...... 4-264

4.12.7 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ...... 4-265

4.12.8 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ...... 4-266

4.12.9 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ...... 4-274

4.12.10 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ...... 4-274

4.12.11 Avoidance, Minimization and Mitigation Measures...... 4-275

4.13 Noise ...... 4-275

4.13.1 Methods and Impact Indicators.......... 4-275
4.13.2 Summary of Impacts.......... 4-277
4.13.3 Alternative 1 – No Action.......... 4-277
4.13.4 Alternative 2 – KDRPP East Shore Pumping Plant.......... 4-278
4.13.5 Alternative 3 – KDRPP South Pumping Plant.......... 4-280
4.13.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) .......... 4-280
4.13.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment.......... 4-282
4.13.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment.......... 4-284
4.13.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment.......... 4-284
4.13.10 Avoidance, Minimization and Mitigation Measures.......... 4-284

4.14 Recreation .......... 4-284

4.14.1 Methods and Impact Indicators.......... 4-284
4.14.2 Summary of Impacts.......... 4-285
4.14.3 Alternative 1 – No Action.......... 4-285
4.14.4 Alternative 2 – KDRPP East Shore Pumping Plant.......... 4-285
4.14.5 Alternative 3 – KDRPP South Pumping Plant.......... 4-289
4.14.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) .......... 4-289
4.14.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment.......... 4-290
4.14.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment.......... 4-291
4.14.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment.......... 4-291
4.14.10 Avoidance, Minimization and Mitigation Measures .......... 4-292

4.15 Land and Shoreline Use.......... 4-292

4.15.1 Methods and Impact Indicators.......... 4-292
4.15.2 Summary of Impacts.......... 4-293
4.15.3 Alternative 1 – No Action.......... 4-297
4.15.4 Alternative 2 – KDRPP East Shore Pumping Plant.......... 4-297
4.15.5 Alternative 3 – KDRPP South Pumping Plant.......... 4-298

4.15.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ..... 4-299

4.15.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ..... 4-299

4.15.8 Alternative 5B – KDRPP South with Pumping Plant KKC North Tunnel Alignment ..... 4-300

4.15.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ..... 4-301

4.15.10 Avoidance, Minimization, and Mitigation Measures ..... 4-301

4.16 Utilities ..... 4-301

4.16.1 Methods and Impact Indicators ..... 4-301

4.16.2 Summary of Impacts ..... 4-302

4.16.3 Alternative 1 – No Action ..... 4-303

4.16.4 Alternative 2 – KDRPP East Shore Pumping Plant ..... 4-303

4.16.5 Alternative 3 – KDRPP South Pumping Plant ..... 4-304

4.16.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ..... 4-304

4.16.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ..... 4-305

4.16.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ..... 4-307

4.16.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ..... 4-307

4.16.10 Avoidance, Minimization and Mitigation Measures ..... 4-307

4.17 Transportation ..... 4-307

4.17.1 Methods and Impact Indicators ..... 4-307

4.17.2 Summary of Impacts ..... 4-308

4.17.3 Alternative 1 – No Action ..... 4-310

4.17.4 Alternative 2 – KDRPP East Shore Pumping Plant ..... 4-310

4.17.5 Alternative 3 – KDRPP South Pumping Plant ..... 4-312

4.17.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ..... 4-313

4.17.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ..... 4-314

4.17.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ..... 4-317

4.17.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ........ 4-317

4.17.10 Avoidance, Minimization and Mitigation Measures ........ 4-317

4.18 Cultural Resources ........ 4-318

4.18.1 Methods and Impact Indicators ........ 4-318

4.18.2 Summary of Impacts ........ 4-319

4.18.3 Alternative 1 – No Action ........ 4-321

4.18.4 Alternative 2 – KDRPP East Shore Pumping Plant ........ 4-321

4.18.5 Alternative 3 – KDRPP South Pumping Plant ........ 4-322

4.18.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ........ 4-323

4.18.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ........ 4-323

4.18.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ........ 4-324

4.18.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ........ 4-324

4.18.10 Avoidance, Minimization and Mitigation Measures ........ 4-324

4.19 Indian Sacred Sites ........ 4-325

4.19.1 Methods and Impact Indicators ........ 4-325

4.19.2 Summary of Impacts ........ 4-325

4.19.3 Mitigation Measures ........ 4-326

4.20 Indian Trust Assets ........ 4-326

4.20.1 Methods and Impact Indicators ........ 4-326

4.20.2 Alternative 1 – No Action ........ 4-326

4.20.3 Alternatives 2– KDRPP East Shore Pumping Plant, 3– KDRPP South Pumping Plant and 4 – KDRPP Floating Pumping Plant ........ 4-326

4.20.4 Alternatives 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment, 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment, and 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ........ 4-326

4.20.5 Mitigation Measures ........ 4-326

4.21 Socioeconomics ........ 4-326

4.21.1 Methods and Impact Indicators ........ 4-326

4.21.2 Summary of Impacts ........ 4-329

4.21.3 Alternative 1 – No Action ... 4-330
4.21.4 Alternative 2 – KDRPP East Shore Pumping Plant ... 4-331
4.21.5 Alternative 3 – KDRPP South Pumping Plant ... 4-341
4.21.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ... 4-343
4.21.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ... 4-346
4.21.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ... 4-349
4.21.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ... 4-350
4.21.10 Avoidance, Minimization and Mitigation Measures ... 4-350
4.22 Environmental Justice ... 4-350
4.22.1 Methods and Impact Indicators ... 4-350
4.22.2 Summary of Impacts ... 4-350
4.22.3 Avoidance, Minimization and Mitigation Measures ... 4-351
4.23 Health and Safety ... 4-351
4.23.1 Methods and Impact Indicators ... 4-351
4.23.2 Summary of Impacts ... 4-352
4.23.3 Alternative 1 – No Action ... 4-353
4.23.4 Alternative 2 – KDRPP East Shore Pumping Plant ... 4-353
4.23.5 Alternative 3 – KDRPP South Pumping Plant ... 4-356
4.23.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative) ... 4-356
4.23.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment ... 4-357
4.23.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment ... 4-358
4.23.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment ... 4-358
4.23.10 Avoidance, Minimization and Mitigation Measures ... 4-358
4.24 Relationship of the Proposed Action to the Integrated Plan ... 4-358
4.25 Cumulative Impacts Analysis ... 4-360
4.25.1 Regulatory Framework ... 4-360

4.25.2 Cumulative Impacts by Resource ..................... 4-362
4.26 Relationship between Short-term Uses and Long-term Productivity ..... 4-365
4.27 Unavoidable Adverse Impacts ..................... 4-366
4.28 Irreversible and Irretrievable Commitments of Resources ..................... 4-366
4.29 Energy and Depletable Resources ..................... 4-367
**Chapter 5 Public Involvement, Consultation, and Coordination ..................... 5-1**
5.1 Introduction ..................... 5-1
5.2 Public Involvement ..................... 5-1
5.2.1 Scoping Process ..................... 5-1
5.2.2 Scoping Comments Received from the Public ..................... 5-2
5.2.3 Comments on the DEIS ..................... 5-2
5.2.4 Comments on the SDEIS ..................... 5-3
5.2.5 Stakeholder Engagement ..................... 5-3
5.3 Consultation and Coordination ..................... 5-3
5.4 Tribal Consultation and Coordination ..................... 5-4
5.5 Compliance with Federal and State Laws and Executive Orders ..................... 5-4
5.5.1 Endangered Species Act ..................... 5-4
5.5.2 Fish and Wildlife Coordination Act ..................... 5-4
5.5.3 National Historic Preservation Act ..................... 5-5
5.5.4 Clean Water Act ..................... 5-5
5.5.5 Executive Order 11990: Protection of Wetlands ..................... 5-6
5.5.6 Executive Order 12898: Environmental Justice ..................... 5-6
5.5.7 Executive Order 11988: Floodplain Management ..................... 5-6

## Tables

Table 1-1. Agency Roles and Responsibilities ..................... 1-11
Table 1-2. Summary of Potential Permit Requirements, Consultations, and Required Approvals ..................... 1-21
Table 2-1. *Alternative 2 – KDRPP East Shore Pumping Plant* Approximate Construction Schedule ..................... 2-17
Table 2-2. *Alternative 3 – KDRPP South Pumping Plant* Approximate Construction Schedule ..................... 2-35
Table 2-3. Alternative 4 (*Preferred Alternative*) – KDRPP Floating Pumping Plant Approximate Construction Schedule ..................... 2-49

Table 2-4. KKC North Tunnel Alignment Approximate Construction Schedule ...... 2-60

Table 2-5. Estimated Costs of KDRPP Alternatives ................................................ 2-63

Table 2-6. Estimated Cost of KKC ........................................................................... 2-64

Table 2-7. Summary of KDRPP *Alternatives 2, 3,* and *4:* Facilities and Construction ........................................................................................... 2-69

Table 2-8. Summary of KKC North Tunnel Alignment Facilities and Construction 2-69

Table 2-9. Summary Comparison of Impacts ........................................................... 2-70

Table 3-1. Yakima River Reaches ............................................................................. 3-13

Table 3-2. Yakima River Target Flows ..................................................................... 3-17

Table 3-3. Title XII Target Flows .............................................................................. 3-18

Table 3-4. Yakima Project Irrigation District Water Rights (acre-feet per year) ...... 3-19

Table 3-5. Keechelus Dam and Reservoir Data ........................................................ 3-20

Table 3-6. Keechelus Reservoir Operating Elevations ............................................. 3-21

Table 3-7. Kachess Dam and Reservoir Data ........................................................... 3-23

Table 3-8. Kachess Reservoir Operating Elevations ................................................ 3-25

Table 3-9. Water Bodies in the Extended Study Area Included in Category 5 of the 2014 State 303(d) List ................................................................................ 3-30

Table 3-10. Water Bodies in the Extended Study Area Included in Other Designated Categories of the 2014 State 303(d) ........................................................ 3-30

Table 3-11. Use Designations of Water Bodies in the Extended Study Area (WAC 173-201A-600) ........................................................................................ 3-33

Table 3-12. Lake Nutrient Criteria Guidelines .......................................................... 3-35

Table 3-13. Well Construction Information............................................................... 3-55

Table 3-14. Potential Habitat Use by Resident (Nonanadromous) Fish Species Inhabiting the Upper Yakima Basin including Kachess and Keechelus Reservoirs ................................................................................................. 3-70

Table 3-15. Zooplankton Weight and Abundance in Yakima Basin Reservoirs .......... 3-75

Table 3-16. Kachess Tributary Habitats Considered Suitable for Anadromous Salmonids ................................................................................................ 3-76

Table 3-17. Keechelus Tributary Habitats Considered Suitable for Anadromous Salmonids ................................................................................................ 3-79

Table 3-18. Comparison of Current Seasonal Streamflow Regime to Natural Streamflow Regime for Selected Yakima River Mainstem Reaches ........ 3-82

Table 3-19. Adult Salmon Migration Patterns in the Yakima Basin ........................... 3-86

Table 3-20. Juvenile Salmon Migration Patterns in the Yakima Basin ....................... 3-86

Table 3-21. Species Federally Listed or Proposed for Listing that Potentially Occur in the Primary Study Area and Extended Study Area ... 3-107

Table 3-22. Yakima Basin Bull Trout Stocks Recognized by WDFW (Definitions for status classifications appear below table) ... 3-109

Table 3-23. Bull Trout Local Populations and Primary Life History Types in the Yakima Core Area ... 3-111

Table 3-24. Passage of Steelhead at Prosser Dam (RM 47.1) and Roza Dam (RM 127.9) for Brood Years 2000 to 2014 ... 3-119

Table 3-25. Relationship between Visual Quality Objectives and Scenic Integrity Levels ... 3-131

Table 3-26. Ambient Air Quality Standards ... 3-133

Table 3-27. Summary of Climate Change Scenarios ... 3-139

Table 3-28. Comparison of Average Seasonal Inflows into Keechelus and Kachess Reservoirs for the Historic and Adverse Climate Change Scenarios ... 3-141

Table 3-29. Comparison between Simulated Water Supply Conditions under Historic and Adverse Climate Change Scenarios ... 3-144

Table 3-30. Mean Keechelus Reach Flow under *Alternative 1 – No Action* ... 3-145

Table 3-31. Seasonal Change in Keechelus Reach Flow under Historic and Adverse Climate Scenarios ... 3-145

Table 3-32. Mean Easton Reach Flows under *Alternative 1 – No Action* ... 3-146

Table 3-33. Seasonal Change in Easton Reach Flow under Historic and Adverse Climate Scenarios ... 3-147

Table 3-34. Maximum Allowable Noise Levels ... 3-150

Table 3-35. Recreation Facilities Affected by KDRPP ... 3-154

Table 3-36. Recreation Facilities Affected by KKC ... 3-157

Table 3-37. Recreation Facilities between Keechelus and Kachess Reservoirs ... 3-159

Table 3-38. Roadway Design Standards ... 3-172

Table 3-39. Washington State Economic Sectors, 2012 ... 3-184

Table 3-40. Four-County Study Area Economic Sectors, 2012 ... 3-184

Table 3-41. Rental Housing Unit Availability, 2010 ... 3-185

Table 3-42. Temporary Accommodations ... 3-185

Table 3-43. Characteristics of Properties Surrounding Keechelus Reservoir ... 3-186

Table 3-44. Characteristics of Properties Surrounding Kachess Reservoir ... 3-186

Table 3-45. Minority and Low-Income Populations by County ... 3-188

Table 4-1. Impact Indicators for Earth Resources ... 4-3

Table 4-2. Summary of Impacts for Earth Resources .................................................. 4-3
Table 4-3. Disturbance Area by Alternative ................................................................ 4-4
Table 4-4. Summary of Impacts for Surface Water Resources ................................. 4-18
Table 4-5. Percentage of Entitlement Available in Drought Years under *Alternative 2 – KDRPP East Shore Pumping Plant* .................................................. 4-26
Table 4-6. Kachess Reservoir Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* ................................................................. 4-27
Table 4-7. Kachess Reservoir Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* ................................................................. 4-32
Table 4-8. Kachess Reservoir Seasonal Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* ......................................................... 4-32
Table 4-9. Kachess Reservoir Annual Maximum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* .................................................. 4-33
Table 4-10. Kachess Reservoir Annual Minimum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* .................................................. 4-34
Table 4-11. Change in Keechelus Reservoir Levels under *Alternative 2 – KDRPP East Shore Pumping Plant* ........................................................ 4-37
Table 4-12. Keechelus Reservoir Seasonal Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* ......................................................... 4-37
Table 4-13. Keechelus Reservoir Annual Maximum Pool Elevations *under Alternative 2 – KDRPP East Shore Pumping Plant* ................................. 4-38
Table 4-14. Keechelus Reservoir Annual Minimum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* ................................. 4-39
Table 4-15. Cle Elum Reservoir Annual Maximum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* .................................................. 4-40
Table 4-16. Bumping Reservoir Annual Maximum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* .................................................. 4-40
Table 4-17. Rimrock Reservoir Annual Maximum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* .................................................. 4-41
Table 4-18. Cle Elum Reservoir Annual Minimum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* .................................................. 4-42
Table 4-19. Bumping Reservoir Annual Minimum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* .................................................. 4-42
Table 4-20. Rimrock Reservoir Annual Minimum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* .................................................. 4-43
Table 4-21. Change in Kachess River Flow below Kachess Reservoir under *Alternative 2 – KDRPP East Shore Pumping Plant* ................................. 4-44

Table 4-22. Change in Keechelus Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-45

Table 4-23. Seasonal Change in Keechelus Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-45

Table 4-24. Keechelus Reach Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-46

Table 4-25. Change in Yakima River Flow at Easton under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-47

Table 4-26. Seasonal Change in Easton Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-47

Table 4-27. Easton Reach Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-48

Table 4-28. Seasonal Change in Umtanum Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-48

Table 4-29. Umtanum Reach Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-49

Table 4-30. Seasonal Change in Roza Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-50

Table 4-31. Roza Reach Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-50

Table 4-32. Seasonal Change in Wapato Reach (Parker) Flow under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-51

Table 4-33. Wapato Reach (Parker) Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-51

Table 4-34. Seasonal Change in Naches Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-52

Table 4-35. Naches Reach Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant* ... 4-53

Table 4-36. Volume of Water Transferred by KKC under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ... 4-56

Table 4-37. Change in Prorationing under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ... 4-56

Table 4-38. Kachess Reservoir Pool Elevations under All Alternatives ... 4-58

Table 4-39. Frequency and Duration of Kachess Pool Elevation below Benchmark Elevations, All Alternatives ... 4-59

Table 4-40. Kachess Reservoir Seasonal Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ... 4-60

Table 4-41. Kachess Reservoir Annual Maximum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-60

Table 4-42. Kachess Reservoir Annual Minimum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-61

Table 4-43. Keechelus Reservoir Pool Elevations under All Alternatives ........ 4-63

Table 4-44. Frequency and Duration of Keechelus Pool Level below Elevation 2,466, All Alternatives ........ 4-63

Table 4-45. Keechelus Reservoir Seasonal Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* .. 4-64

Table 4-46. Keechelus Reservoir Annual Maximum Pool Elevations under *Alternative 5A – KKC North Tunnel Alignment* ........ 4-65

Table 4-47. Keechelus Reservoir Annual Minimum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-65

Table 4-48. Cle Elum Reservoir Seasonal Pool Elevations under A*lternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* .. 4-66

Table 4-49. Bumping Reservoir Seasonal Pool Elevations under Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment . 4-67

Table 4-50. Rimrock Reservoir Seasonal Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* .. 4-67

Table 4-51. Cle Elum Reservoir Annual Maximum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-68

Table 4-52. Bumping Reservoir Annual Maximum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-69

Table 4-53. Rimrock Reservoir Annual Maximum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-69

Table 4-54. Cle Elum Reservoir Annual Minimum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-70

Table 4-55. Bumping Reservoir Annual Minimum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-70

Table 4-56. Rimrock Reservoir Annual Minimum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-71

Table 4-57. Kachess River Flow below Kachess Reservoir under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* .. 4-72

Table 4-58. Change in Yakima River Flow in Keechelus Reach under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* 4-73

Table 4-59. Seasonal Change in Keechelus Reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* .. 4-73

Table 4-60. Keechelus Reach Flows by Year Type under *Alternative 5A – KKC North Tunnel Alignment* ........ 4-74

Table 4-61. Change in Yakima River Flow at Easton with *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-75

Table 4-62. Seasonal Change in Easton Reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-75

Table 4-63. Easton Reach Flows by Year Type under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-76

Table 4-64. Seasonal Change in Umtanum Reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* .. 4-77

Table 4-65. Umtanum Reach Flows by Year Type under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-77

Table 4-66. Seasonal Change in Roza Reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-78

Table 4-67. Roza Reach Flows by Year Type under A*lternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-79

Table 4-68. Change in Yakima River Flow at Parker under *Alternative 5A – KKC North Tunnel Alignment* ........ 4-79

Table 4-69. Seasonal Change in Wapato Reach (Parker) Flow under *Alternative 5A – KKC North Tunnel Alignment* ........ 4-80

Table 4-70. Wapato Reach (Parker) Flows by Year Type under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* .. 4-81

Table 4-71. Seasonal Change in Naches Reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-82

Table 4-72. Naches Reach Flows by Year Type under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-82

Table 4-73. State Surface Water Quality Standards (173-201A) ........ 4-84

Table 4-74. Summary of Impacts for Surface Water Quality ........ 4-84

Table 4-75. Impact Indicators for Groundwater ........ 4-109

Table 4-76. Summary of Impacts for Groundwater ........ 4-110

Table 4-77. Impact Indicators for Fish ........ 4-122

Table 4-78. Summary of Impacts for Fish ........ 4-122

Table 4-79. Percentage Attainment of Seasonal Instream Flow Targets, Keechelus Reach of the Yakima River ........ 4-131

Table 4-80. Percentage Attainment of Seasonal Instream Flow Targets, Easton Reach of the Yakima River ........ 4-132

Table 4-81. Kachess Reservoir Mean Hydraulic Residence Times in Days ........ 4-138

Table 4-82. Keechelus Reservoir Mean Hydraulic Residence Times in Days ........ 4-142

Table 4-83. Changes in Habitat Availability at the Easton Reach for Spring Chinook Fry and Subyearling Chinook ........ 4-144

Table 4-84. Impact Indicators for Vegetation and Wetlands ........ 4-159

Table 4-85. Summary of Estimated Permanent Impacts (Acres) to Wetlands and Vegetation Due to Construction of Each Alternative ........ 4-160

Table 4-86. Summary of Impacts on Vegetation and Wetlands ........ 4-161

Table 4-87. Vegetation Disturbance Area Associated with Construction of *Alternative 2 – East Shore Pumping Plant* ........ 4-162

Table 4-88. Permanent Wetland Impact Area Associated with Construction of *Alternative 2 – East Shore Pumping Plant* ........ 4-164

Table 4-89. Vegetation Disturbance Area Associated with *Alternative 3 – South Pumping Plant* ........ 4-168

Table 4-90. Vegetation Disturbance Area Associated with Construction of *Alternative 4 (Preferred Alternative)* ........ 4-170

Table 4-91. Vegetation Disturbance Area Associated with Construction of the KKC North Tunnel Alignment ........ 4-172

Table 4-92. Impact Indicators for Wildlife ........ 4-177

Table 4-93. Summary of Impacts for Wildlife ........ 4-182

Table 4-94. Impact Indicators for Bull Trout and MCR Steelhead ........ 4-193

Table 4-95. Impact Indicators for Northern Spotted Owl ........ 4-193

Table 4-96. Summary of Impacts for Bull Trout and MCR Steelhead ........ 4-194

Table 4-97. Summary of Impacts for Northern Spotted Owl ........ 4-196

Table 4-98. Changes in Habitat Availability for Fry and Subyearling Steelhead and Bull Trout ........ 4-205

Table 4-99. Relationship between Visual Quality Objectives and Scenic Integrity Levels ........ 4-219

Table 4-100. Impact Issues and Indicators for Visual Resources ........ 4-220

Table 4-101. Summary of Impacts for Visual Resources ........ 4-221

Table 4-102 Comparison of Visual Impacts from the KDRPP alternatives during construction ....... 4-221

Table 4-103. Summary of Impacts for Air Quality ....... 4-237

Table 4-104. Emissions from *Alternative 2 – KDRPP East Shore Pumping Plant* Construction and Hauling ....... 4-238

Table 4-105. Emissions from *Alternative 3 – KDRPP South Pumping Plant* Construction and Hauling ....... 4-239

Table 4-106. Construction Emission Summary (Tons) – *Alternative 4 (Preferred Alternative)* ....... 4-240

Table 4-107. Emissions from KKC North Tunnel Alignment Construction and Hauling ....... 4-241

Table 4-108. $CO_2$ Equivalents and Emission Factors per 1 Gallon of Diesel Fuel ....... 4-244

Table 4-109. Impact Indicators for Climate Change ....... 4-246

Table 4-110. Summary of Impacts for Climate Change ....... 4-247

Table 4-111. Keechelus Reservoir Pool Elevation under *Alternative 1 – No Action* ....... 4-249

Table 4-112. Kachess Reservoir Pool Elevation under *Alternative 1 – No Action* ....... 4-249

Table 4-113. Comparison between Simulated Water Supply Conditions under Historic and Adverse Climate Change Scenarios ....... 4-250

Table 4-114. Mean Keechelus Reach Flow under *Alternative 1 – No Action* ....... 4-251

Table 4-115. Keechelus Reach Seasonal Flow Exceedance under *Alternative 1 – No Action* ....... 4-252

Table 4-116. Mean Easton reach Flows under *Alternative 1 – No Action* ....... 4-252

Table 4-117. Easton Reach Seasonal Flow under *Alternative 1 – No Action* ....... 4-253

Table 4-118. Kachess Reservoir Pool Elevation under *Alternative 2 – KDRPP East Shore Pumping Plant* ....... 4-256

Table 4-119. Keechelus Reservoir Pool Elevation under *Alternative 2 – KDRPP East Shore Pumping Plant* ....... 4-258

Table 4-120. Effects of Climate Change on *Alternatives 2, 3*, and *4* Water Supply Results ....... 4-260

Table 4-121. Mean Keechelus Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant* ....... 4-261

Table 4-122. Keechelus Reach Seasonal Flow under *Alternative 2 – KDRPP East Shore Pumping Plant* ....... 4-261

Table 4-123. Mean Easton reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant* ....... 4-262

Table 4-124. Easton reach Seasonal Flow under *Alternative 2 – KDRPP East Shore Pumping Plant* ....... 4-263

Table 4-125. Kachess Reservoir Pool Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ...................... 4-267

Table 4-126. Keechelus Reservoir Pool Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ...................... 4-269

Table 4-127. Effects of Climate Change on *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* Water Supply Results4-270

Table 4-128. Mean Keechelus reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ................................ 4-271

Table 4-129. Keechelus reach Seasonal Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ...................... 4-272

Table 4-130. Mean Easton reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ................................ 4-273

Table 4-131. Easton reach Seasonal Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ................................ 4-273

Table 4-132. Construction Equipment Average Maximum Noise Level ($L_{max}$).......... 4-276

Table 4-133. Impact Indicators for Noise ........................................................ 4-277

Table 4-134. Summary of Impacts for Noise..................................................... 4-277

Table 4-135. Summary of Impacts for Recreation.............................................. 4-285

Table 4-136. Impact Indicators for Land and Shoreline Use.............................. 4-292

Table 4-137. Impact Indicators for Land and Shoreline Use.............................. 4-294

Table 4-138. Impact Indicators for Utilities ...................................................... 4-302

Table 4-139. Summary of Impacts for Utilities.................................................. 4-302

Table 4-140. Impact Indicators for Transportation............................................. 4-308

Table 4-141. Summary of Construction Round Trips ........................................ 4-308

Table 4-142. Summary of Impacts for Transportation ....................................... 4-309

Table 4-143. Impact Indicators for Cultural Resources...................................... 4-318

Table 4-144. Summary of Indicators and Impacts for Cultural Resources.................. 4-319

Table 4-145. Assumptions for IMPLAN Analysis of Construction Impacts............... 4-327

Table 4-146. Impact Indicators for Socioeconomics .......................................... 4-329

Table 4-147. Summary of Impacts for Socioeconomics...................................... 4-330

Table 4-148. *Alternative 2 – KDRPP East Shore Pumping Plant* Construction Expenditures ........................................................................ 4-332

Table 4-149. *Alternative 2 – KDRPP East Shore Pumping Plant* Construction Impacts, by Type ................................................................................ 4-332

Table 4-150. *Alternative 2 – KDRPP East Shore Pumping Plant* Operating Expenditures ........................................................................ 4-333

Table 4-151. *Alternative 2 – KDRPP East Shore Pumping Plant* Operating Impacts, by Type, Rounded ........ 4-333
Table 4-152. Summary of Economic Impacts from Agricultural Production Associated with *Alternative 2 - KDRPP East Shore Pumping Plant* (Historical Climate Conditions)[a,b] ........ 4-336
Table 4-153. Distribution of Economic Impacts Associated with *Alternative 2 - KDRPP East Shore Pumping Plant*, by Industry Sector (Historical Climate Conditions)[a] ........ 4-339
Table 4-154. Summary of Economic Impacts from Agricultural Production Associated with *Alternative 2 - KDRPP East Shore Pumping Plant* (Adverse Climate Conditions)[a] ........ 4-340
Table 4-155 Distribution of Economic Impacts Associated with Increased Agricultural Production, by Industry Sector, Four-County Study Area (Adverse Climate Conditions)[a] ........ 4-340
Table 4-156. *Alternative 3 – KDRPP South Pumping Plant* Construction Expenditures4-341
Table 4-157. *Alternative 3 – KDRPP South Pumping Plant* Construction Impacts, by Type ........ 4-341
Table 4-158. *Alternative 3 – KDRPP South Pumping Plant* Operating Expenditures . 4-342
Table 4-159. *Alternative 3 – KDRPP South Pumping Plant* Operating Impacts, by Type ........ 4-342
Table 4-160. *Alternative 4 (Preferred Alternative)* Construction Expenditures.......... 4-343
Table 4-161. *Alternative 4 (Preferred Alternative)* Construction Impacts, by Type.... 4-344
Table 4-162. *Alternative 4 (Preferred Alternative)* Operating Expenditures ............... 4-344
Table 4-163. *Alternative 4 (Preferred Alternative)* Operating Impacts by Type, Rounded ........ 4-345
Table 4-164. KKC North Tunnel Alignment with Option B Construction Expenditures4-347
Table 4-165. KKC North Tunnel Alignment with Option B Construction Impacts, by Type ........ 4-347
Table 4-166. KKC North Tunnel Alignment with Option B Operating Expenditures . 4-348
Table 4-167. KKC North Tunnel Alignment with Option B Average Annual Operating Impacts, by Type, Rounded ........ 4-348
Table 4-168. Summary of Impacts for Environmental Justice ........ 4-350
Table 4-169. Impact Indicators for Health and Safety ........ 4-352
Table 4-170. Summary of Impacts for Health and Safety ........ 4-353

## Figures

Figure 1-1. Yakima River Basin ........ 1-2

Figure 1-2. Surface Water Rights ........ 1-4

Figure 1-3. Kachess Reservoir Schematic Hydraulic Profile ........ 1-8

Figure 2-1. *Alternative 2 – KDRPP East Shore Pumping Plant Overview* ........ 2-8

Figure 2-2. *KDRPP East Shore Pumping Plant* Conceptual Site Plan ........ 2-9

Figure 2-3. *KDRPP East Shore Pumping Plant* Conceptual Rendering ........ 2-10

Figure 2-4. Drawdown at End of 1-year Drought with Use of 73,000 acre-feet ........ 2-19

Figure 2-5. Drawdown at End of Multi-year Drought with Maximum Use of 200,000 acre-feet ........ 2-20

Figure 2-6. Proposed Volitional Bull Trout Passage Improvements at the Kachess Narrows ........ 2-24

Figure 2-7. *Alternative 3 – KDRPP South Pumping Plant* Overview ........ 2-28

Figure 2-8. *KDRPP South Pumping Plant* Conceptual Site Plan ........ 2-29

Figure 2-9. *KDRPP South Pumping Plant* Conceptual Rendering ........ 2-30

Figure 2-10. *Alternative 4 – KDRPP Floating Pumping Plant* Overview ........ 2-37

Figure 2-11. Conceptual Site Plan - *Alternative 4 – KDRPP Floating Pumping Plant*. 2-38

Figure 2-12. *Alternative 4 – Floating Pumping Plant Conceptual Rendering – Maximum Pool* ........ 2-40

Figure 2-13. *Alternative 4 – Floating Pumping Plant Conceptual Rendering – Start of Drought Relief Pumping* ........ 2-41

Figure 2-14. *Alternative 4 – Floating Pumping Plant Conceptual Rendering – Minimum Drought Relief Pool* ........ 2-41

Figure 2-15. KKC North Tunnel Alignment Overview ........ 2-52

Figure 2-16. KKC North Tunnel Alignment Conceptual Site Plan ........ 2-53

Figure 2-17. Locations of the KDRPP Facilities for *Alternatives 2, 3, 4, 5A, 5B,* and *5C* ........ 2-68

Figure 3-1. Surface Geologic Units near Kachess and Keechelus Reservoirs (Source: Tabor et al., 2000) ........ 3-5

Figure 3-2. Yakima River Reaches ........ 3-14

Figure 3-3. Typical Streamflow Conditions in Upper Yakima River, November 2007 to October 2008 ........ 3-15

Figure 3-4. Modeled Keechelus Reservoir Operating Elevations, November 1998 to October 2003 ........ 3-21

Figure 3-5. Modeled Flow Patterns in the Keechelus Reach of the Yakima, November 1998 to October 2003 ........ 3-22

Figure 3-6. Modeled Kachess Reservoir Operating Elevations, November 1998 to October 2003 ........ 3-25

Figure 3-7. Modeled Kachess River Flow, November 1998 to October 2003 ... 3-26

Figure 3-8. Modeled Yakima River at Lake Easton Dam Flow Conditions, November 1998 to October 2003 ... 3-27

Figure 3-9. Water Resources in the Primary Study Area ... 3-38

Figure 3-10. Keechelus Reservoir Summer Temperature-Depth Profiles ... 3-40

Figure 3-11. Keechelus Reservoir Summer Dissolved Oxygen-Depth Profile ... 3-41

Figure 3-12. Kachess Reservoir Summer Temperature-Depth Profiles ... 3-44

Figure 3-13. Kachess Reservoir Summer Dissolved Oxygen versus Depth Profile ... 3-45

Figure 3-14. Kachess River 7-Day Average Daily Maximum Temperature ... 3-48

Figure 3-15. Yakima River 7-Day Average Daily Maximum Temperature ... 3-49

Figure 3-16. Kachess Reservoir Groundwater Study Area ... 3-52

Figure 3-17. Keechelus Reservoir Groundwater Study Area ... 3-53

Figure 3-18. Well Monitoring Locations ... 3-57

Figure 3-19. Reclamation Monitoring Well, West Side of Kachess ... 3-59

Figure 3-20. Carlson Domestic Well, West Side of Kachess ... 3-60

Figure 3-21. Brandt Domestic Well, East Side of Kachess ... 3-60

Figure 3-22. Reclamation Monitoring Well, East Side of Kachess ... 3-61

Figure 3-23. Reclamation Monitoring Well, at Kachess Dam ... 3-61

Figure 3-24. Reclamation Monitoring Well, below Kachess Dam ... 3-62

Figure 3-25. Kachess Reservoir and the Narrows ... 3-64

Figure 3-26. Approximate Locations of Surface Water Rights ... 3-65

Figure 3-27. Wetlands in the Kachess Reservoir Study Area ... 3-92

Figure 3-28. Wetlands in the Narrows Study Area of Kachess Reservoir ... 3-93

Figure 3-29. Wetlands in the KKC Study Area ... 3-97

Figure 3-30. Conifer Habitat at KDRPP Kachess River Discharge ... 3-104

Figure 3-31. Upper Yakima River Drainage Bull Trout Distribution and Spawning Areas ... 3-113

Figure 3-32. Average Steelhead Abundance by Month and Cumulative Passage Timing of Steelhead Passing Roza Dam between 1996 and 2013 ... 3-118

Figure 3-33. Kachess Narrows ... 3-126

Figure 3-34. Kachess Dam – East End (at Dam) Facing West ... 3-127

Figure 3-35. Keechelus Reservoir – South End (at Dam) Facing Northwest ... 3-128

Figure 3-36. View of Palouse to Cascades State Park Trail and Cold Creek Culvert ... 3-129

Figure 3-37. Comparison of Average Monthly Combined Reservoir Inflow to Keechelus and Kachess Reservoirs between Historic and Adverse Scenarios ..... 3-141
Figure 3-38. Comparison of Average Monthly Keechelus Reservoir Water Surface Elevation between Historic and Adverse Scenarios for the Alternative 1 – No Action Alternative ..... 3-142
Figure 3-39. Comparison of Average Monthly Kachess Reservoir Water Surface Elevation between Historic and Adverse Scenarios for the Alternative 1 – No Action Alternative ..... 3-143
Figure 3-40. Recreation Facilities in the Primary Study Area ..... 3-153
Figure 3-41. Maintained Gravel Boat Launch at Kachess Campground ..... 3-155
Figure 3-42. Paved Boat Launch at Kachess Campground ..... 3-156
Figure 3-43. Gold Creek Pond ..... 3-158
Figure 3-44. Land Ownership in the Primary Study Area ..... 3-161
Figure 3-45. Zoning in the Primary Study Area ..... 3-165
Figure 3-46. Local Transportation Facilities in the Primary Study Area ..... 3-170
Figure 3-47. Archaeological Field Investigations by YCRP at Kachess Reservoir, 2015 (YCRP, 2015). ..... 3-174
Figure 3-48. Fish Weir Similar to McClellan’s 1853 Description (from YCRP, 2015)3-176
Figure 3-49. A Selection of Precontact Artifacts Observed at Kachess Reservoir (From YCRP, 2015) ..... 3-178
Figure 3-50. View of Keechelus Construction Camp circa 1914 ..... 3-180
Figure 3-51. Keechelus Depot of the Milwaukee Road, circa 1910 ..... 3-181
Figure 4-1. Kachess Reservoir Hydraulic Profile ..... 4-7
Figure 4-2. Drawdown at End of 1-year Drought with Use of 73,000 Acre-feet ..... 4-21
Figure 4-3. Drawdown at End of Multi-year Drought with Maximum Use of 200,000 Acre-feet ..... 4-22
Figure 4-4. Little Kachess Inundation Map ..... 4-28
Figure 4-5. Big Kachess Inundation Map ..... 4-29
Figure 4-6. Kachess Reservoir Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* ..... 4-31
Figure 4-7. Percent of time that the Kachess Reservoir Pool Elevations would fall below the Existing and New Minimum Pool under each Alternative ..... 4-31
Figure 4-8. Kachess Reservoir Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* in which Roza Irrigation District is the Only Participant ..... 4-35

Figure 4-9. Change in Keechelus Reservoir Pool Elevation under *Alternative 2 – KDRPP East Shore Pumping Plant* ........ 4-36
Figure 4-10. Kachess Reservoir Pool Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-57
Figure 4-11. Keechelus Reservoir Pool Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-62
Figure 4-12. 100-foot Topographic Elevation Zones around Kachess Reservoir ........ 4-115
Figure 4-13. Potential Noise Wildlife Impact Zone in the Kachess Reservoir Study Area ........ 4-179
Figure 4-14. Potential Noise Wildlife Impact Zone in the Keechelus and Kachess Reservoir Study Areas ........ 4-180
Figure 4-15. Visual Simulation of Kachess Reservoir Pool Levels for Current Full Pool, Current Minimum Pool, and KDRPP Maximum Drawdown from Southeast Shore ........ 4-223
Figure 4-16. Visual Simulation of Kachess Reservoir Pool Levels for Current Full Pool, Current Minimum Pool, and KDRPP Maximum Drawdown from Boat Launch ........ 4-224
Figure 4-17. Typical Forested Condition on East Shore ........ 4-225
Figure 4-18. South Pumping Plant Location (South of Kachess Dam) ........ 4-227
Figure 4-19. Rendered View of Alternative 4 from East Shore of Kachess Reservoir 4-230
Figure 4-20. Rendered View of Alternative 4 from Kachess Boat Ramp ........ 4-231
Figure 4-21. Kachess Lake Road Portal Location – Forested Condition ........ 4-233
Figure 4-22. Effect of Climate Change on Average Kachess Reservoir Water Surface Elevation – *Alternatives 2, 3,* and *4* ........ 4-257
Figure 4-23. Effect of Climate Change on Average Keechelus Reservoir Water Surface Elevation – *Alternatives 2, 3,* and *4* ........ 4-259
Figure 4-24. Effect of Climate Change on Average Kachess Reservoir Water Surface Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-268
Figure 4-25. Effect of Climate Change on Average Keechelus Reservoir Water Surface Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* ........ 4-269
Figure 4-26. Land Ownership in the Kachess Reservoir Area for All Alternatives ........ 4-295
Figure 4-27. Land Ownership in the North Tunnel Construction Area ........ 4-296

REFERENCES

LIST OF PREPARERS

DISTRIBUTION LIST

GLOSSARY

## Appendices

APPENDIX A – DRAFT BULL TROUT ENHANCEMENT MEMORANDUM OF UNDERSTANDING

APPENDIX B – NOTICE OF ADOPTION

APPENDIX C – BULL TROUT ENHANCMENT

APPENDIX D – SPECIES LIST

APPENDIX E – STREAMFLOW HYDROGRAPHS

APPENDIX F – FREQUENTLY ASKED QUESTIONS ON WATER USE, OPERATIONS AND HYDROLOGY FOR THE PROPOSED KACHESS DROUGHT RELIEF PUMPING PLANT (KDRPP)

APPENDIX G – DEPARTMENT OF ARCHAEOLOGY & HISTORIC PRESERVATION LETTER OF DETERMINATION

**VOLUME II:**

DEIS COMMENTS AND RESPONSES

**VOLUME III:**

SDEIS COMMENTS AND RESPONSES

# EXECUTIVE SUMMARY

*(This page intentionally left blank)*

# Executive Summary

## Introduction

In January 2015, the U.S. Department of the Interior Bureau of Reclamation (Reclamation) and Washington State Department of Ecology (Ecology) released the Kachess Drought Relief Pumping Plant (KDRPP) and Keechelus Reservoir-to-Kachess Reservoir Conveyance (KKC) Draft Environmental Impact Statement (DEIS) to evaluate the potential environmental effects of implementing one or both of two closely related water resource projects in the upper Yakima River basin. The KDRPP and KKC are components of the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan).

Reclamation and Ecology prepared a Supplemental Draft Environmental Impact Statement (SDEIS) to examine changes to the proposed action and alternatives described in the DEIS and to provide additional information. The SDEIS supplemented the analysis with respect to the No Action and action alternatives, where new circumstances or information existed that was relevant to environmental concerns and impacts. The SDEIS provided documentation of the purpose and need, proposed action and alternatives, affected environment, environmental effect, proposed mitigation, tribal and agency coordination, and public involvement.

Public comments on both the DEIS and SDEIS were received and considered by Reclamation and Ecology. This Final EIS (FEIS) includes some revisions to the SDEIS in response to public comments. This FEIS presents the updates and identifies Reclamation and Ecology's Preferred Alternative, which is Alternative 4, the Floating Pumping Plant Alternative of KDRPP, without KKC.

Reclamation and Ecology have prepared this FEIS as co-lead agencies to meet requirements of the National Environmental Policy Act (NEPA) and State Environmental Policy Act (SEPA). The Confederated Tribes and Bands of the Yakama Nation (Yakama Nation), the U.S. Forest Service (USFS), and Bonneville Power Administrative (BPA) are cooperating agencies in preparation of this FEIS 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 under NEPA. Roza Irrigation District is a state cooperating agency to Ecology under SEPA.

## Background of the Proposed Action

In June 2009, Ecology and Reclamation brought representatives from the Yakama Nation, Federal, State, county, and city governments, irrigation districts, and environmental organizations 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 subsequent 18 months, the group developed the Integrated Plan[1].

The Integrated Plan includes the following components:

- 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 Final Programmatic Environmental Impact Statement* (Integrated Plan FPEIS) to determine the effects of implementing the Integrated Plan (Reclamation and Ecology, 2012) [2]. The Integrated Plan FPEIS 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 2013 Integrated Plan PEIS Record of Decision (Integrated Plan PEIS ROD) identified 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). KDRPP and KKC are identified in the Integrated Plan PEIS ROD as necessary components of the Integrated Plan that contribute to achieving the Integrated Plan's overall goals. This FEIS provides a site-specific assessment of KDRPP and KKC tiered from the Integrated Plan PEIS and ROD.

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

- https://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html
- https://ecology.wa.gov/Water-Shorelines/Water-supply/Water-supply-projects-EW/Yakima-River-Basin-projects/Yakima-integrated-plan

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

## Proposed Action

The Proposed Action is to fund, design, construct, operate, and maintain a floating pumping plant on Kachess Reservoir in order to recover up to 200,000 acre-feet of inactive water storage from Kachess Reservoir during drought years when prorationing is less than 70 percent supply.[3] This water would otherwise remain in Kachess Reservoir at an elevation below the existing gravity outlet works (see Figure 1-2). The Proposed Action would also include volitional fish passage at the downstream end of the Narrows which is located between the upper and lower Kachess Reservoir. Roza proposes to fund, design, construct, operate, and maintain some or all of the Proposed Action. Alternatively, Reclamation if authorized or the State may fund, design, construct, operate, and maintain some or all of the Proposed Action.

The Proposed Action implements the Kachess Reservoir Inactive Storage project identified in the 2012 Integrated Plan FPEIS to provide additional water supply from Kachess Reservoir during a drought. Since 2012, the KDRPP has undergone additional refinement and design. Reclamation and Ecology have identified *Alternative 4 – Floating Pumping Plant* as their Preferred Alternative in this FEIS.

To implement the proposed action, Reclamation would need to issue a ROD documenting the selected alternative and approving the construction of the pumping plant on Kachess Reservoir, over which the agency has jurisdiction. The agency would provide any necessary permits, agreements, or other approvals, review design, monitor construction, coordinate and manage water releases from Kachess Dam and deliveries to downstream users, and possibly enter into water, power, and transmission contracts. Ecology would take actions implementing applicable regulations and would issue permits as required for implementation of the preferred alternative. Reclamation and Ecology would also participate in avoidance, minimization, and mitigation actions described in the supporting FEIS.

## Purpose and Need for the Action

As described in Section 1.4, Reclamation and Ecology each propose to fund, design, construct, operate, and maintain some or all of KDRPP and/or KKC or to authorize Roza Irrigation District (Roza)[4] to fund, design, construct, operate, and maintain some or all of KDRPP and/or KKC. Reclamation, Ecology, and Roza are each referred to herein as a "project proponent" and, collectively, as "project proponents" and each entities purpose and need for the action is set forth in Section 1.3.

---

[3] See Sections 3.3 and 4.3 Surface Water Resources of this FEIS, and Section 1.3 of the Integrated Plan PEIS for details on the 70 percent proration level determination.

[4] Roza is an irrigation district that operates 95 miles of main canal and more than 350 miles of laterals to serve Yakima Project water to 1,700 growers on 72,000 acres from the northwestern edge of the Yakima Valley at Selah, to the southeastern end at Benton City. Other proratable irrigation entities, such as the Kittitas Reclamation District (KRD), Wapato Irrigation Project (WIP), and Kennewick Irrigation District (KID), may also participate, and are referred to herein as "Proratable Entities."

### Reclamation’s Purpose and Need

Reclamation’s purpose and need for action is to provide more sustainable water resources for agricultural, municipal, and domestic needs, while also helping to restore the ecological functions and health of the riverine environment in the Yakima River basin.

Specifically, Reclamation needs to analyze and authorize, the site-specific projects identified here in accordance with the 2013 Integrated Plan PEIS ROD. Reclamation may fund, design, construct, operate, and maintain some or all of the Proposed Action, if authorized to do so pursuant to Section 4007 of the Water Infrastructure Improvements for the Nation Act or other law that provides similar authorization.

### Ecology’s Purpose and Need

Ecology’s purpose for the action is to participate in the Integrated Plan and fund (not more than 50 percent) of the plan, and promote timely and effective implementation of associated projects in an aggressive pursuit of water supply solutions for instream and out-of-stream uses in the Yakima River basin [Revised Code of Washington (RCW) 90.38.005]. Ecology is also responding to the need to evaluate and consider, and determine whether to provide the necessary authorizations for Roza to fund, design, construct, operate and maintain some or all of KDRPP and/or KKC.”

### Roza and Proratable Entities’ Purpose and Need

Roza and other Proratable Entities’ purpose for the action is to access up to 200,000 acre-feet of water from Kachess Reservoir during drought years, as they need to improve water supply and reduce prorationing, whenever feasible, and improve flexibility to respond to the uncertainties of climate change. To participate in the Proposed Action, Roza and/or other Proratable Entities would need to seek all necessary authorizations. This FEIS was prepared by Reclamation and Ecology, but Roza and/or other Proratable Entities may adopt this FEIS for their own purposes.

## Alternatives

### Alternative 1 – No Action

The No Action Alternative represents the most likely future in the absence of implementing any of the action alternatives. The No Action Alternative forms the baseline for comparing potential impacts of the Proposed Action and alternatives. Under *Alternative 1*, project proponents would not implement the Proposed Action or alternatives. Reclamation would continue to manage the 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 action alternatives.

### Alternative 2 – KDRPP East Shore Pumping Plant

#### *KDRPP East Shore Pumping Plant*

*Alternative 2* consists 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 2,112.75, approximately 80 feet lower than the current outlet and 149.25 feet below full pool, by using a pumping plant. This pumping plant 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 gravity 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 participating Proratable Entities, potentially including Roza, Kittitas Reclamation District, and Wapato Irrigation Project[5]. For the Yakima Project Reclamation and Ecology define a drought year as a year when water supply falls below 70 percent of proratable water entitlements. KDRPP would contribute to increasing prorationing up to 70 percent in these years. The quantity 200,000 acre-feet is the maximum capacity of KDRPP, and this quantity would not be needed during every drought. In addition to drought years, pumping will be needed in some years following a drought to meet Reclamation water delivery obligations and instream flow requirements in conjunction with other reservoirs, as Kachess Reservoir refills to a level above the existing gravity outlet.

*Alternative 2* includes an underground pumping plant on the east shore of Kachess Reservoir. The pumping plant would receive water through a tunnel from an intake on the floor of the reservoir. A buried pipeline on the reservoir bed would convey water from the pumping plant to a spillway and discharge structure just downstream from the existing Kachess Dam outlet channel, where it would be released to the Kachess River.

#### *Volitional Bull Trout Passage Improvements*

Volitional Bull Trout Passage Improvements are proposed as a component of the KDRPP *Alternative 2* and all other action alternatives. When operation of the KDRPP reduces the pool elevation of Kachess Reservoir below a pool elevation of approximately 2,220 feet, the reservoir separates into an upper pool (Little Kachess) and a lower pool (Big Kachess) at a location known as the Kachess Narrows (the Narrows). As the pool elevation of Big Kachess is drawn below 2,208 feet, a steep shelf is exposed that impedes passage into Little Kachess for resident bull trout in Big Kachess. To encourage migration through the Narrows during drought relief pumping and refill, project proponents would construct a roughened channel between Little Kachess and Big Kachess. The roughened channel would be approximately 5.5 feet deep and 28 feet wide and would function as intended only when Big Kachess is below pool elevation 2,208. It would function both during draw down and while the reservoir refills.

---

[5] Kennewick Irrigation District has also expressed interest in participating in KDRPP.

***Avoidance, Minimization, and Mitigation Measures***

Project proponents would incorporate measures to avoid, minimize, and mitigate impacts associated with *Alternative 2* and all other action alternatives. Project proponents would also comply with the applicable environmental laws and regulations. Avoidance, minimization, and mitigation measures include the following:

- Prior to construction, conduct geotechnical studies to identify subsurface issues, unstable slopes, and other local factors that could contribute to slope instability and increase erosion potential.
- Implement best management practices (BMPs), when appropriate, to enhance resource protection and avoid additional potential effects to surface and groundwater quality, earth resources, fish, wildlife, and their habitats.
- Restore areas disturbed during construction to pre-construction conditions or better.
- Conduct continued monitoring of site conditions and erosion potential.
- Continue a surface water quality monitoring program to support design efforts and minimize and avoid water quality impacts.
- Monitor a representative group of wells near Kachess Reservoir to determine whether groundwater levels are lowered by additional reservoir drawdown attributable to the action alternatives and coordinate with affected parties on a case-by-case basis. If well water levels fall and water yields in specific wells are adversely affected to the point that property uses are compromised, then mitigation will be applied to restore or replace the ground water supply.
- Pursuant to the 2013 Integrated Plan PEIS ROD, Reclamation, Ecology, the Yakama Nation, the U.S. Fish and Wildlife Service (Service), Washington Department of Fish and Wildlife, and the USFS (Bull Trout Enhancement [BTE] parties) are developing and implementing improvements to bull trout habitat within the Yakima River basin as described in the BTE framework (Appendix C). Consistent with environmental commitments in this section, Reclamation and Ecology will continue to support and fulfill roles in implementation of specific BTE improvement actions.
- 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. Implement specific mitigation for listed fish and wildlife species that the agencies require as part of consultation. Update WDFW preconstruction surveys prior to construction. Reclamation would implement the conservation measures and recommendations provided by the Service in the Fish and Wildlife Coordination Report.

- Monitor for infestations of invasive plant species associated with project ground disturbances and periods of prolonged drawdown of the reservoirs and implement suppression strategies using BMPs to control invasive plant populations.
- Extend boat ramps at Kachess Reservoir when the reservoir is drawn down during drought years, and construct new east shore ramp that would be available at all reservoir elevations.
- Implement a public communication strategy to prepare recreation users for the 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 areas that would be disturbed by construction.
- In consultation with WA Department of Archaeology and Historic Preservation (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 and to restore service, if needed, for utilities disrupted by construction.
- Design facilities according to applicable standards and codes; having construction crews comply with all applicable guidelines and standards of construction practices for installing facilities; and limiting access to authorized and trained personnel.

### Alternative 3 – KDRPP South Pumping Plant

*Alternative 3* is similar to *Alternative 2,* except that the pumping plant would be located at the south end of the reservoir, downstream from Kachess Dam and adjacent to the Kachess River. The proposed south pumping plant would be adjacent to the existing gravity 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. *Alternative 3* would include Volitional Bull Trout Passage Improvements and mitigation similar to *Alternative 2.*

### Alternative 4 – Floating Pumping Plant (Preferred Alternative)

*Alternative 4* differs from *Alternative 2* and *Alternative 3* in that the intake and pumping plant would be located on a floating barge, and support facilities would be located at the south end of the reservoir, adjacent to Kachess Dam. The proposed floating pumping plant would be moored adjacent to the existing outlet channel. The floating pumping plant would discharge water to the existing outlet channel where it would be retained by a new flow control structure and would be released through the existing Kachess Dam outlet works.

*Alternative 4* would include Volitional Bull Trout Passage Improvements and mitigation similar to *Alternative 2.*

### Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

Under *Alternative 5A*, the KDRPP East Shore Pumping Plant would be the same as described above for *Alternative 2*, including Volitional Bull Trout Passage Improvements and mitigation. In addition, *Alternative 5A* would include the KKC North Tunnel Alignment to enhance refill of Kachess Reservoir during and following drought relief pumping and to improve flows for fish in the Keechelus reach of the Yakima River.

#### *KKC North Tunnel Alignment Facilities*

KKC would consist of an underground tunnel to convey water from Keechelus Reservoir to Kachess Reservoir. This tunnel would allow Reclamation to reduce flows in the upper Yakima River, thereby improving rearing habitat for steelhead and spring Chinook salmon and enabling more rapid refill of Kachess Reservoir following drought years after pumping of KDRPP. The proposed conveyance would extend east from the Keechelus Dam outlet and would discharge on the west shore of Kachess Reservoir. The tunnel would be a single segment tunnel that would be excavated upgradient from a portal at Kachess Reservoir.

Reclamation would operate KKC by diverting water by gravity flow from the Yakima River downstream from Keechelus Reservoir into the new tunnel so it could be conveyed to Kachess Reservoir. Reclamation would transfer flows in years when Keechelus Reservoir is above its target pool elevation and Kachess Reservoir is below its target pool elevation.

### Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

*Alternative 5B* would include the South Pumping Plant of *Alternative 3*, and would also include the KKC North Tunnel Alignment described for *Alternative 5A*, above. *Alternative 5B* would include Volitional Bull Trout Passage Improvements and mitigation, similar to *Alternative 3*.

### Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

*Alternative 5C* would include the Floating Pumping Plant of *Alternative 4*, and would also include the KKC North Tunnel Alignment described for *Alternative 5A*, above. *Alternative 5C* would include Volitional Bull Trout Passage Improvements and mitigation similar to *Alternative 3*.

## Public Scoping and Involvement

Public scoping began on October 30, 2013 with publication of an NOI to prepare the *Kachess Drought Relief Pumping Plant and Keechelus Reservoir-to-Kachess Reservoir Conveyance Draft EIS* in the *Federal Register*. On November 4, 2013, Ecology issued its SEPA Determination of Significance. Two scoping meetings were held in Yakima, Washington on November 20, 2013, and two scoping meetings were held in Cle Elum, Washington on November 21, 2013. At the meetings, Reclamation described the Proposed Action and gave attendees the opportunity to discuss the proposal with Reclamation and Ecology staff, as well as comment on the project, the scope of the EIS, the process, and resources to be evaluated in the EIS.

The scoping period concluded on December 16, 2013. During this period, 39 comment documents and telephone calls were received. More information about the scoping process, including the comments received, may be found in the Scoping Summary Report (Reclamation and Ecology, 2014g) and on the Yakima River Basin Water Enhancement Project 2011 Integrated Plan website: http://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html. Reclamation and Ecology took these comments into consideration in preparing the DEIS, SDEIS and this FEIS.

Reclamation and Ecology issued the DEIS in January 2015. The public comment period for the DEIS closed 60 days later on March 10, 2015. After considering the comments received, Reclamation and Ecology reopened the comment period for an additional 60 days. The second comment period ended June 15, 2015. Public meetings were held on February 3, 2015, and February 5, 2015, in Cle Elum and Ellensburg, Washington, respectively. Reclamation and Ecology reviewed the public comments on the DEIS, while also collecting additional scientific data, and prepared an SDEIS to affirm or revise, as appropriate, the findings presented in the DEIS.

Reclamation and Ecology circulated the SDEIS for review and comment to engage interested public, agencies, stakeholders, and Tribes. The public comment period for the SDEIS began April 13, 2018 and concluded July 11, 2018. Reclamation and Ecology held public meetings on May 16 and 17, 2018 in Cle Elum and Ellensburg, Washington, respectively. Reclamation and Ecology considered comments received on the SDEIS during the public review period. Responses to public comments on both the 2015 DEIS and the 2018 SDEIS are included in this FEIS.

In addition, Reclamation and Ecology have conducted outreach with local stakeholders to understand concerns, provide project information, and encourage input during the public comment periods for the DEIS and SDEIS.

## Consultation and Coordination

Reclamation is consulting with the Service and National Marine Fisheries Service under the Endangered Species Act (ESA). Reclamation has also 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, and the Confederated Tribes of the Colville Reservation is ongoing. Reclamation has contacted the Bureau of Indian Affairs Yakima Office and the Bureau of Indian Affairs 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 continue coordination with the Department of Archaeology and Historic Preservation on impacts to cultural resources. Reclamation and Ecology will continue to consult with the Yakama Nation, Umatilla Tribe, and Colville Confederated Tribes.

## Key Issues

Key issues or resources relevant to the analysis were identified based on public comments raised during scoping, from internal scoping, and outreach to Federal, State, local agencies, Tribal governments, and legal, regulatory and policy requirements. The following issues or resources are analyzed in detail in this FEIS.

- ***Earth and Physical Resources:*** air quality, climate, geology, noise, and soils
- ***Water Resources:*** surface water resources, groundwater, and water quality
- ***Biological Resources***: fish, wildlife, species listed under the Endangered Species Act (ESA) and critical habitat, and vegetation and wetlands
- ***Cultural Resources***: historic properties, Indian sacred sites, and resources of tribal concern
- ***Socioeconomic Resources:*** environmental justice, health and safety, Indian trust assets, land and shoreline use, recreation, regional economic impacts and economic benefits, transportation, visual quality, utilities, and energy requirements

## Major Conclusions

Based upon the analysis of impacts to these resources in Chapter 4, the major conclusions of this FEIS are as follows:

- ***Change in Water Supply***: The action alternatives would improve water supply to proratable water users by up to 22 percentage points in the worst drought years, raising the proration percentage to about 53 percent of entitlement. This would be a substantial benefit to water supply because it would offer substantial progress toward the Integrated Plan's 70 percent proration goal.
- ***Change in Reservoir Levels***: Under all action alternatives, Reclamation would operate Keechelus Reservoir to help Kachess Reservoir refill following a drought. This action would result in slightly lower mean Keechelus Reservoir pool levels, with a maximum incremental reservoir drawdown of 18 feet in late summer (in 1996) compared to *Alternative 1 - No Action*. Under all action alternatives, Kachess Reservoir would be drawn down below the existing minimum pool level in some years. The maximum extent of the drawdown would be 80 feet in some years. In other affected years the drawdown would be much less than 80 feet and pool levels would fluctuate both above and below the existing, minimum pool level. In years when neither drought-relief nor refill operations are needed there would be no pool drawdown below the elevations existing under current operations. At the maximum extent of drawdown Big Kachess will continue to hold approximately 385,000 acre-feet of water. Little Kachess will continue to hold approximately 59,000 acre-feet of water, the same as under existing conditions.
- ***Change in Groundwater Supply to Wells***: Based on groundwater monitoring of wells around Kachess Reservoir, KDRPP operations may result in decreased groundwater levels in shallow aquifers adjacent to the reservoir, potentially decreasing the groundwater supply to some wells. Of the approximately 107 wells in the primary study area, about 15 wells are located in areas that could be affected by reservoir operations
- ***Effects on Listed Species:*** Based on modeled water surface elevations, *Alternatives 2*, *3* and *4* would increase the number of days when Kachess Reservoir's water surface elevation would drop below 2,220 feet (the evaluation at which Big and Little Kachess reservoirs separate and begin to affect fish passage, particularly for bull trout). These impacts to passage of bull trout would be mitigated by the Volitional Bull Trout Passage Improvements. *Alternatives 5A*, *5B*, and *5C* would increase the number of days when flows in the Keechelus reach of the Yakima River are suitable for Middle Columbia River steelhead outmigration. All alternatives would result in noise impacts to northern spotted owls, but the alternatives are not expected to harm or injure northern spotted owls, or impact their habitat.
- ***Regional Economic Impacts and Benefits***: The socioeconomic effects of the action alternatives arising from changes in water supply available for agriculture are expected to be positive, resulting in a net gain in regional economic activity relative to *Alternative 1 - No Action*.

# What Comes Next?

## Public Release of the FEIS

Reclamation will file this FEIS with the U.S. Environmental Protection Agency, who will publish the Notice of Availability in the *Federal Register*. Reclamation and Ecology will announce the release of this FEIS on their websites and in local and regional newspapers.

Reclamation will issue a Record of Decision (ROD) no sooner than 30 days after the Notice of Availability of this FEIS is published in the Federal Register. The ROD will identify Reclamation's decision on KDRPP and KKC and will describe the basis for that decision.

## A Second EIS for Siting and Analysis

Reclamation and Ecology intend to engage in site-specific analysis that will tier to this FEIS in the near future. This FEIS evaluates impacts on a broad scale to allow the decisionmakers to narrow the feasible options for further review in the site-specific, tiered EIS. This tiered EIS ("Tier-2 EIS") will enable the decisionmakers to consider and analyze micro-siting issues and refine, if necessary, the broader analysis in the FEIS. The Tier-2 EIS will be a streamlined EIS under the Department of the Interior and Council of Environmental Quality (CEQ) Regulations and policies (40 CFR 1502.20; 43 CFR 46.120, 46.140; and Secretarial Order 3355).

# Chapter 1 Introduction and Background

## 1.1 Introduction

The U.S. Department of the Interior Bureau of Reclamation (Reclamation) and Washington State Department of Ecology (Ecology) have prepared this Kachess Drought Relief Pumping Plant (KDRPP) and Keechelus-to-Kachess Conveyance (KKC) Final Environmental Impact Statement (FEIS) as co-lead agencies to meet requirements of both the National Environmental Policy Act (NEPA, 43 United States Code [USC] 4321A) and State Environmental Policy Act (SEPA Revised Code of Washington [RCW], Chapter 43.21c).

In January 2015, Reclamation and Ecology issued the *Kachess Drought Relief Pumping Plant and Keechelus-to-Kachess Conveyance Draft Environmental Impact Statement* (DEIS) (Reclamation and Ecology, 2015) to evaluate the potential environmental effects tiered from the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan) (https://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html). Based on comments received on the DEIS, a new alternative along with new information and an updated evaluation of environmental impacts were added and a Supplemental DEIS (SDEIS) was published in April 2018. This FEIS presents revisions and additions to the SDEIS based on public comments provided on both the DEIS and SDEIS, and is intended to support a Record of Decision (ROD) by Reclamation.

## 1.2 History and Background

Kachess Reservoir is located in the upper Yakima River basin (Figure 1-1) and releases water into the Kachess River, which flows into Easton Reservoir about 3 miles northwest of the town of Easton. Kachess Reservoir was constructed over a naturally occurring glacial lake, which was separated into two basins — the Little Kachess Lake (upper) and the Big Kachess Lake (lower). These two basins are exposed when the reservoir elevation drops below 2,224. Kachess Reservoir drains a 63-square-mile area and stores an active capacity of 239,000 acre-feet of water (Reclamation, 2002). The area between the two lakes is called the Narrows.

Keechelus Reservoir is located in the upper Yakima River basin headwaters about 10 miles northwest of Easton. Like Kachess Reservoir, Keechelus Reservoir was constructed over a natural lake. Keechelus Reservoir drains a 54-square-mile area and stores an active capacity of 157,800 acre-feet of water (Reclamation, 2002).

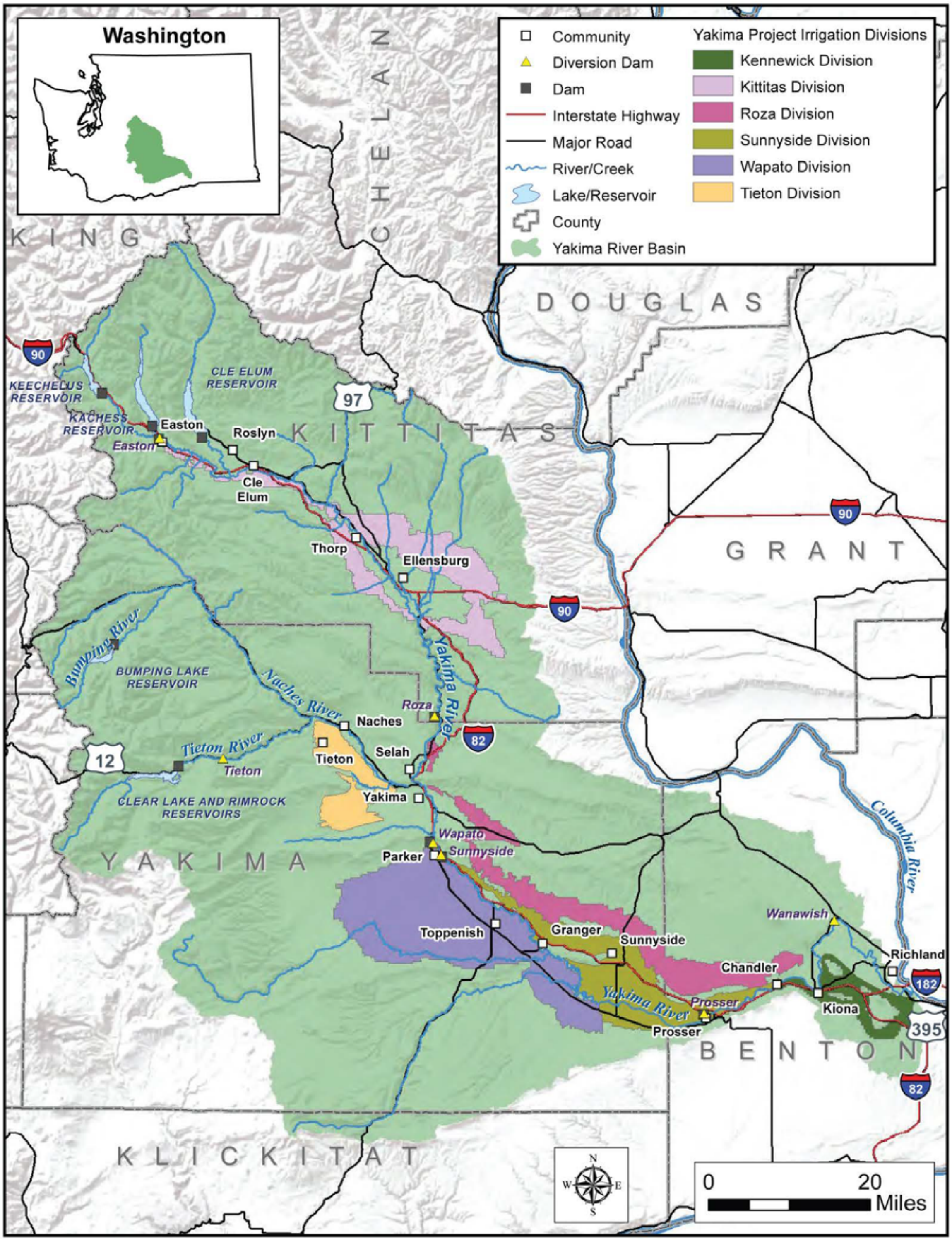



**Figure 1-1. Yakima River Basin**

### 1.2.1 Yakima Project

Congress authorized the Yakima Project under the Reclamation Act of June 17, 1902, directing the development of irrigation facilities in the Yakima River basin. The Yakima Project includes five major storage reservoirs: Keechelus, Kachess, Cle Elum, Bumping, and Rimrock (Figure 1-1). These storage reservoirs release water to meet irrigation demands, flood control, and instream flow requirements in the Yakima River basin. Reclamation manages these storage reservoirs as a system, and does not designate any one reservoir or storage space to a specific irrigation district.

A combination of Federal and State statutes, regulations, and court orders, determines water management in the Yakima River basin (see Section 1.8, Authorizations). Additionally, Reclamation operates the Yakima Project according to treaty obligations of the United States pertaining to the Yakama Nation Treaty of 1855, delivering the Yakama Nation's "time immemorial" water right according to court orders. Sections 1.6.3 and 1.6.4 of the *Yakima River Basin Water Resource Management Plan Final Programmatic Environmental Impact Statement* (Integrated Plan FPEIS) describe regulations and legal decisions related to water management in the basin (Reclamation and Ecology, 2012).

The following water rights (entitlements to water) in the Yakima River basin include:

- Senior surface water rights (referred to as nonproratable) existed prior to the development of the Yakima Project, and are served in the order of their priority dates; they have precedence over proratable and junior rights.
- Proratable water rights share the priority date that the United States obtained for the Yakima Project. Proratable entitlements share equal priority, since they have a common priority date, and their water deliveries are subject to proration (reduced proportionately) in years when the water supply is insufficient to meet demand based on the court doctrine of Total Water Supply Available (TWSA). As described in Section 3.3.5 in the Integrated Plan FPEIS, TWSA is estimated by Reclamation annually based on forecasted runoff, forecasted return flows, and storage contents.
- Junior water rights were established after the Yakima Project, and have priority dates after May 10, 1905. When there is insufficient water, the first deliveries to be curtailed are those with junior water rights in the order of their priority dates.
- No water rights.

Surface water rights are illustrated in Figure 1-2.

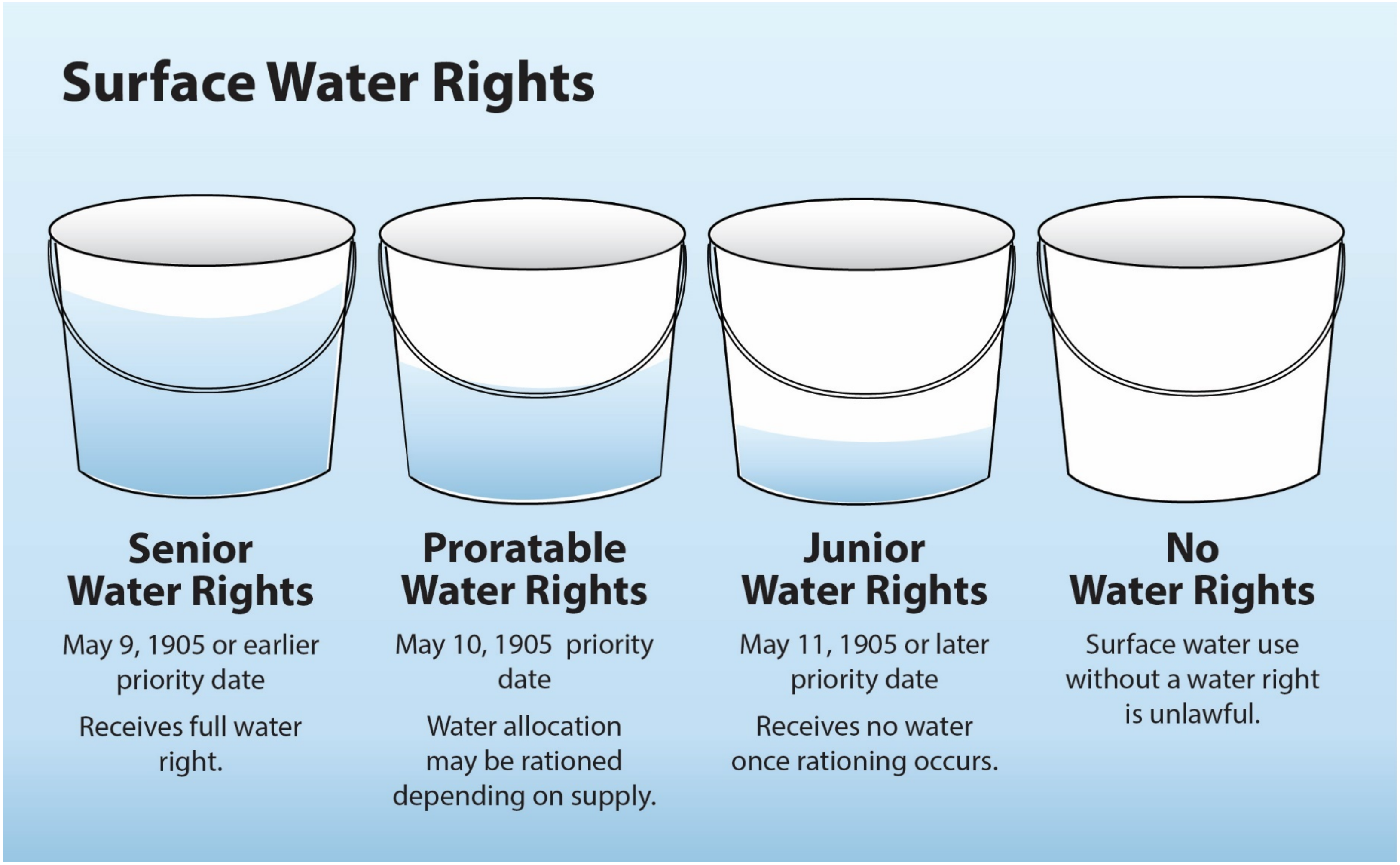



**Figure 1-2. Surface Water Rights**

### 1.2.2 Integrated Plan and Programmatic FEIS

In 2009, Ecology and Reclamation assembled representatives from the Yakama Nation, irrigation districts, environmental organizations, and Federal, State, county, and city entities to form the Yakima River Basin Water Enhancement Project (YRBWEP) Workgroup to develop a solution to the basin's water supply challenges (see Section 1.9.3 of Integrated Plan FPEIS).

The YRBWEP Workgroup focused on the water supply challenges listed below:

- Anadromous and resident fish populations are depleted by the following causes:
  - Degradation of riparian habitat and floodplain functions.
  - Altered stream flows caused by irrigation operations.
  - Impairment or blockage of fish passage to upstream tributaries and spawning grounds.
- Demand for irrigation, municipal, and domestic water by existing users exceeds supply significantly in dry and drought years, which leads to severe prorationing for proratable water users, or curtailing of deliveries to junior water rights holders. These actions cause significant economic losses to farmers in the Yakima River basin. In recent years (2001, 2005, and 2015), proratable irrigation entities received 37 percent, 42 percent, and 47 percent respectively of their water supply (Lynch, 2015).
- Climate change projections indicate the following future changes in the following runoff and streamflow patterns:
  - Decreased snowpack.[1]
  - Increased late winter runoff.
  - Decreased spring and summer runoff.
  - Increased crop and municipal water demand.
  - Increased frequency of drought conditions.
  - Decreased flows, increased air and water temperature, and altered stream flows affecting fish and their migration.

These challenges led to the formulation of an integrated approach to restore ecological functions in the Yakima River basin and provide reliable and sustainable water resources.

### 1.2.3 Integrated Plan – A Package of Seven Elements

Reclamation and Ecology coordinated with the Yakama Nation and other Federal, State, county, and local agencies and environmental groups to develop the Integrated Plan as a comprehensive package[2] to address ecosystem restoration, water supply, and climate change

[1] On an average annual basis, snowpack in the Yakima River basin, provides more than half the available water supply for irrigation district diversions. A decreased snowpack increases the occurrence of droughts.

[2] Visit http://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html and http://www.ecy.wa.gov/programs/wr/cwp/YBIP.html for information about the Integrated Plan

flexibility issues in the basin. The Integrated Plan package contains the following seven elements:

1. **Reservoir Fish Passage –** This element includes building upstream and downstream fish passage facilities at Cle Elum, Bumping, Tieton, Keechelus, Kachess, and Clear Creek Dams.
2. **Structural and Operational Changes –** Structural changes include increasing storage in Cle Elum Reservoir, modifying fish bypass systems and canals, and moving points of diversion to increase flows in reaches of the Yakima River. Operational changes may include reducing the amount of water diverted for power generation at the Roza Irrigation District (Roza) and Chandler power plants in spring to increase instream flow and improve smolt outmigration.
3. **Surface Water Storage –** This element includes increasing or improving water storage to provide water for improved streamflows and to allow flexibility in operating the reservoir system to benefit fish as well as providing secure and reliable water supply for irrigation and for municipal and domestic needs.
4. **Groundwater Storage –** This element includes increasing or improving groundwater storage to use surface water to recharge underground aquifers; use the natural storage capacity of those aquifers to store water for later use; and improve water quality.
5. **Habitat/Watershed Protection and Enhancement –** This element includes projects and programs to protect and enhance habitat for anadromous and resident fish, wildlife, and critical habitats in the Yakima River basin.
6. **Enhanced Water Conservation –** This element includes conservation measures for irrigation district infrastructure improvements, on-farm conservation and irrigation efficiency improvements, as well as a program for commercial, industrial, municipal, and domestic conservation.
7. **Market Reallocation –** This element includes the reallocation of water resources through a “water market” or “water bank,” through which water rights would be bought, sold, or leased on a temporary or permanent basis to improve water supply and instream flow conditions.

### 1.2.4 Integrated Plan Implementation

Following development of the Integrated Plan, Reclamation and Ecology prepared the Integrated Plan FPEIS to assess the environmental effects of implementing the Integrated Plan (Reclamation and Ecology, 2012[3]). The Integrated Plan FPEIS was issued in March 2012. In July 2013, Reclamation published the Record of Decision (2013 Integrated Plan ROD) to implement the Integrated Plan in cooperation with Ecology and other Federal, State, local, and Tribal partners. The selected alternative in the 2013 Integrated Plan ROD implements the Integrated Plan. Projects associated with the seven elements will be implemented in a phased and balanced approach. The Integrated Plan three-phase strategy

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

(10-year increments over 30 years) may combine or implement actions simultaneously. Additional project-level environmental compliance will be completed prior to implementation of specific projects and actions.

The FPEIS and ROD identified the following projects:

- KDRPP is a Surface Water Storage Element that would deliver up to an additional 200,000 acre-feet of water from Kachess Reservoir (Figure 1-3).
- KKC is a Structural and Operational Element that would augment flows into Kachess Reservoir and reduce flows in the Yakima River downstream from Keechelus Reservoir to Lake Easton.[4]

After Reclamation published the 2013 Integrated Plan ROD, the Washington State Legislature authorized implementation of the Integrated Plan including the KDRPP and KKC projects under the 2013 Yakima Policy Bill 2SSB 5367 (see Section 1.8.2).

An updated status of Integrated Plan implementation is provided in the Yakima River Basin Integrated Water Resource Management Plan Implementation Status Report (Ecology 2018) and is available at: https://app.leg.wa.gov/ReportsToTheLegislature/Home/GetPDF?fileName=1812005_c07ca9c0-f135-4c14-95f8-8d8a75020df7.pdf.

## 1.3 Purpose and Need

As described in Section 1.4, Reclamation and Ecology each propose to fund, design, construct, operate, and maintain some or all of KDRPP and/or KKC or to authorize Roza Irrigation District (Roza)[5] to fund, design, construct, operate, and maintain some or all of KDRPP and/or KKC. Reclamation expects that the ROD approving an action alternative for these site-specific projects would identify which entity would carry out each of these functions. Reclamation, Ecology, and Roza are each referred to in this FEIS as a "project proponent" and, collectively, as "project proponents."

[4] 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 flows into Lake Easton from the northwest.

[5] Roza is an irrigation district that operates 95 miles of main canal and more than 350 miles of laterals to serve Yakima Project water to 1,700 growers on 72,000 acres from the northwestern edge of the Yakima Valley at Selah, to the southeastern end at Benton City. Other proratable irrigation entities, such as the Kittitas Reclamation District (KRD), Wapato Irrigation Project (WIP), and Kennewick Irrigation District (KID), may also participate, and are referred to herein as "Proratable Entities."

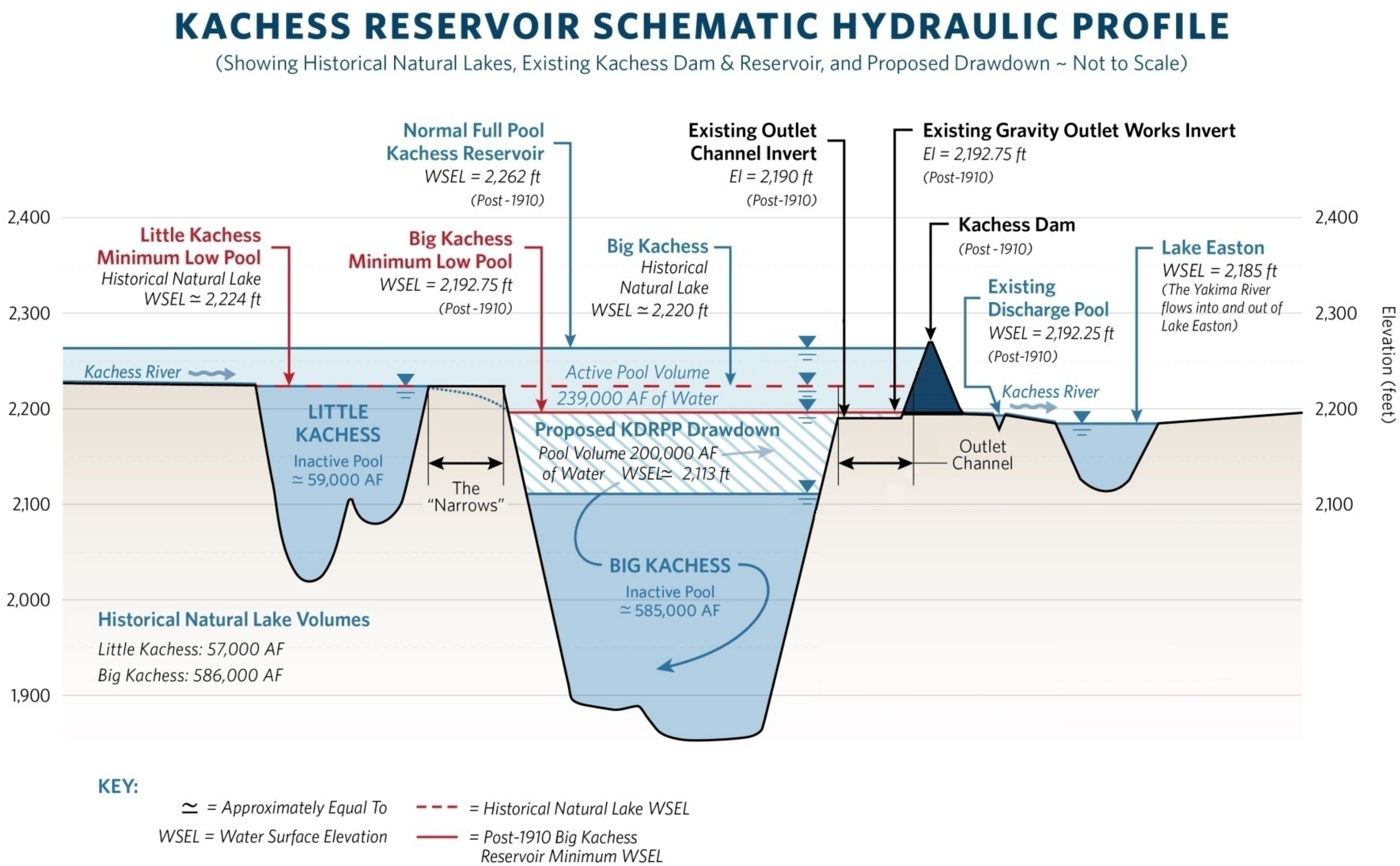



**Figure 1-3. Kachess Reservoir Schematic Hydraulic Profile**

### 1.3.1 Reclamation's Purpose and Need

Reclamation's need is to implement the 2013 Integrated Plan ROD. KDRPP and KKC are site specific projects identified in the ROD and subsequently have been identified as projects to be potentially implemented within the first 10 years after the execution of the ROD to meet water supply of the Integrated Plan. As such Reclamation's objective is to take the necessary steps to implement the proposed action consistent with the 2013 ROD and Yakima Project authorizations.

The purpose is to achieve two objectives set forth in the Integrated Plan: (1) access water below elevation 2,192 (Figure 1-3) that is currently not accessible in the Kachess Reservoir to improve the water supply and reduce prorationing, and (2) improve water supply flexibility and storage between Kachess and Keechelus reservoirs.

As part of fulfilling the intent of the Integrated Plan with respect to the three identified components in Section 1.2.2, Reclamation is also responding to the need to evaluate, and consider, the two proposals above under its applicable regulations, project authority, and existing contracts.

### 1.3.2 Ecology's Purpose and Need

Ecology's purpose for the proposed action is to participate in the Integrated Plan and fund (not more than 50 percent) of the plan, and promote timely and effective implementation of associated projects in an aggressive pursuit of water supply solutions for instream and out-of-stream uses in the Yakima River basin (RCW 90.38.005). Ecology is also responding to the need to evaluate and consider, and determine whether to provide the necessary authorizations for Roza to fund, design, construct, operate, and maintain some or all of KDRPP and/or KKC.

### 1.3.3 Roza and Proratable Entities' Purpose and Need

Roza and the Proratable Entities' purpose for the action is to access up to 200,000 acre-feet of water from Kachess Reservoir during drought years, as they need to improve water supply and reduce prorationing, whenever feasible, and improve flexibility to respond to the uncertainties of climate change. To participate in KDRPP and/or KKC, Roza and/or the Proratable Entities would need to seek all necessary authorizations. Refer to Table 1-2. This document was prepared by Reclamation and Ecology, but Roza and/or other Proratable Entities may adopt this document for their own purposes under the state SEPA law.

## 1.4 Proposed Action

The Proposed Action is to fund, design, construct, operate, and maintain a floating pumping plant on Kachess Reservoir in order to recover up to 200,000 acre-feet of inactive water storage from Kachess Reservoir during drought years when prorationing is less than 70 percent supply.[6] This water would otherwise remain in Kachess Reservoir at an elevation below the existing gravity outlet works (see Figure 1-3). The Proposed Action would also include volitional fish passage at the downstream end of the Narrows which is located between the upper and lower Kachess Reservoir. Roza proposes to fund, design, construct, operate, and maintain some or all of the Proposed Action. Alternatively, Reclamation if authorized or the State may fund, design, construct, operate, and maintain some or all of the Proposed Action.

In the 2015 DEIS, the KDRPP proposal focused on a shoreline pumping plant with deep tunnel intake. As described in Section 1.5.3 since then, Roza identified an additional design for the KDRPP proposal. Based upon new design information, the agencies have decided to include a floating pumping plant project as the Proposed Action, and to analyze the shoreline pumping plant design alternatives considered in the DEIS as alternatives. The alternatives considered also include KKC as a component of certain alternatives, which was identified in the Integrated Plan FPEIS as the Keechelus-to-Kachess Pipeline. Further discussion of the KKC is in Section 2.6. Reclamation and Ecology have identified a Preferred Alternative: it is *Alternative 4 – Floating Pumping Plant Alternative.*

To implement the alternative Reclamation would need to issue a final ROD documenting the preferred alternative and approving the implementation of the alternative, including construction of the pumping plant on Kachess Reservoir, over which the agency has management jurisdiction. The agency would also likely provide a land use authorization, water use authorization, and a water service contract. Additionally, the agency would likely provide other necessary permits, agreements, or approvals, such as design and construction review, coordination and management of water releases, and possibly enter into power and transmission contracts.

In addition to Reclamation's above described actions, Ecology may need to take actions implementing regulations, participating financially, and issuing permits as required for implementing the selected alternative. As a result of the changes described above, Ecology's actions required additional SEPA review in this FEIS.

In August 2016, Ecology and Roza entered into a Memorandum of Understanding (MOU) for SEPA review of the KDRPP and KKC. Individual roles and responsibilities are listed in Table 1-1.

Finally, for full implementation of the Preferred Alternative, Roza proposes to fund, design, construct, operate, and maintain a pumping plant at Kachess Reservoir and implement fish passage at the Narrows and other components of the Proposed Action as described in Chapter 2. These actions would allow access to water below the existing reservoir outlet. Roza would enter into contracts with Reclamation, Bonneville Power Administration (BPA), and/or Puget Sound Energy for power supply.

---

[6] See Sections 3.3 and 4.3 Surface Water Resources of this FEIS, and Section 1.3 of the Integrated Plan PEIS for details on the 70 percent proration level determination.

**Table 1-1. Agency Roles and Responsibilities**

| Federal Agency | Role and Responsibility |
|---|---|
| Bureau of Reclamation | NEPA lead agency<br>• Prepare EIS and Reclamation's ROD<br>• Potential funding of selected alternative<br>• Land use authorization |
| U.S. Forest Service (USFS, cooperating agency) | Regulate occupancy and use of National Forest lands under the National Forest Management Act and Northwest Forest Plan |
| National Marine Fisheries Service (NMFS) | • Complete Federal Endangered Species Act Section 7 Consultation for species under its jurisdiction<br>• Complete Magnuson-Stevens Act Essential Fish Habitat Consultation |
| U.S. Fish and Wildlife Service (Service) | • Complete Federal Endangered Species Act Section 7 Consultation for species under its jurisdiction<br>• Monitor compliance with the Fish and Wildlife Coordination Act |
| U.S. Army Corps of Engineers | Issuance of Section 404 of the Clean Water Act Permit |
| U.S. Environmental Protection Agency | Review EIS |
| Bonneville Power Administration (BPA) | Coordinate with Puget Sound Energy (PSE), Roza, Reclamation, or BPA to develop power and transmission contract(s)/agreement. |
| **State Agency** | **Role and Responsibility** |
| Department of Ecology | • SEPA lead agency<br>• Permit project under Section 401 Certification of the Clean Water Act<br>• Water rights<br>• Potential funding of selected alternative |
| **Local Agency** | **Role and Responsibility** |
| Roza Irrigation District, Kittitas Reclamation District, Wapato Irrigation District, and Kennewick Irrigations District | • Project proponent<br>• Fund, design, construct, operate, and maintain the Preferred Alternative |

# 1.5 Description of Changes from the DEIS and SDEIS

## 1.5.1 Release of 2015 KDRPP-KKC DEIS and 2018 SDEIS

On October 30, 2013, Reclamation published in the *Federal Register* a Notice of Intent (NOI) to prepare the *Kachess Drought Relief Pumping Plant and Keechelus Reservoir-to-Kachess Reservoir Conveyance Draft EIS* (DEIS) to inform the public of the proposed environmental analysis of implementing one or both of the KDRPP and KKC projects. On November 4, 2013, Ecology issued its SEPA Determination of Significance. Both the NOI and Determination of Significance initiated the public scoping process, which provided opportunities for the public to identify concerns, potential impacts, relevant effects of past actions, and suggest possible alternative actions. Reclamation and Ecology issued the DEIS in January 2015. The public comment period for the DEIS closed 60 days later on

March 10, 2015. After considering the comments contained in hundreds of letters, Reclamation and Ecology reopened the comment period for an additional 60 days. The second comment period ended June 15, 2015.

The 2015 KDRPP-KKC DEIS provided further site-specific environmental analysis for projects addressed in the Integrated Plan FPEIS Implementation phase.[7] The 2015 DEIS also provided analysis of the effects of the two specific projects: KDRPP and KKC with Bull Trout Enhancement (BTE) as a component of each project.

On April 13, 2018, Reclamation published the *Kachess Drought Relief Pumping Plant and Keechelus Reservoir-to-Kachess Reservoir Conveyance Supplemental Draft EIS* to document changes to the proposed action and provide additional environmental information. Reclamation and Ecology conducted outreach with the public and agency partners to encourage review and public comment on the SDEIS. Public meetings were held on May 17 and 18, 2018 in Cle Elum and Ellensburg, Washington, respectively, to provide project information and accept public comments. The SDEIS public comment period closed 90 days later on July 11, 2018.

### 1.5.2 Decision to Prepare the Supplemental Draft Environmental Impact Statement

Consistent with Council on Environmental Quality (CEQ) regulations,[8] Reclamation and Ecology determined that an SDEIS was required because of substantial changes to the Proposed Action and alternatives in the 2015 DEIS. New and relevant information had become available that had bearing on the Proposed Action and its impacts on environmental concerns (see resource sections in Chapters 3 and 4).

### 1.5.3 Changes to KDRPP from DEIS to SDEIS

Initially, a design for a floating pumping plant was considered in Reclamation's 2014 KDRPP Value Planning Study, but it was rejected as a feasible alternative in the DEIS because it was determined at the time that a floating pumping plant could not accommodate the large pumps and motors, power demands, and pipeline sizes needed for the KDRPP capacity requirements. In June 2015, in response to a request from the Yakama Nation, Proratable Entities, and Ecology, Reclamation prepared an additional value analysis that suggested the feasibility of a floating pumping plant.

In 2016, Roza (a Proratable Entity) utilized the 2015 value analysis and proposed to construct and operate a "drought emergency" temporary floating pumping plant, referred to as the Kachess Emergency Temporary Floating Pumping Plant (KETFPP). Roza determined that,

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

[8] See 40 C.F.R. Section 1502.9(c) provide that a supplemental environmental impact statement should be prepared if: "(i) The agency makes substantial changes in the proposed action that are relevant to environmental concerns; or (ii) There are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts."

if the 2015 drought continued, the KETFPP would allow access to an additional 50,000 acre-feet of water below the existing reservoir outlet for the upcoming 2016 irrigation season.

Taking into account the new information obtained during Roza's emergency efforts, Reclamation and Ecology collaborated with Roza to consider the substantial change in engineering knowledge that had been obtained. This knowledge indicated that a larger-scale floating pumping plant could be feasible in achieving the KDRPP purposes. Reclamation and Ecology determined that an SDEIS would be required to consider a new floating pumping plant alternative that would withdraw an additional 200,000 acre-feet of water (below the existing gravity outlet works) from Kachess Reservoir. This additional alternative is intended to provide the same benefits to the Yakima River basin as the South and East Shore KDRPP alternatives described in the DEIS consistent with the Integrated Plan PEIS and ROD.

In addition, to encourage resident bull trout migration through the Narrows during drought relief pumping and refill, a project proponent(s) would construct a roughened channel between Little Kachess and Big Kachess. The operations of the KDRPP proposal would reduce the pool elevation of Kachess Reservoir below a pool elevation of approximately 2,223; below this elevation the reservoir separates into an upper pool (Little Kachess) and a lower pool (Big Kachess) at a location known as the Kachess Narrows. As the pool elevation of Big Kachess is drawn below 2,200 a steep shelf is exposed that impedes passage for resident bull trout in Big Kachess.

### 1.5.4 Changes to KKC from DEIS to SDEIS

The KKC project was not presented in the SDEIS as a stand-alone (KKC only) alternative as described in the DEIS; instead, it will advance for purposes of analysis only as a component of a KDRPP alternative. Reclamation and Ecology determined that, at this time, the benefits of KKC in terms of enhancing water supply did not merit its consideration as a standalone project. However, the contribution to refill of Kachess Reservoir when KDRPP would operate warranted consideration as a component of KDRPP. Reclamation and Ecology will continue to analyze KKC for other benefits. Of the two alternative alignments (north tunnel and south tunnel) considered in the DEIS, the south tunnel is considered unfeasible because of geologic explorations and Washington State Department of Transportation construction activities near Interstate-90 (I-90). However, the KKC north tunnel remains under consideration as a component of a KDRPP alternative (see Section 2.6).

### 1.5.5 Changes Regarding BTE from DEIS to SDEIS

As a product of the Integrated Plan Mainstem Floodplain and Tributary Fish Habitat Enhancement Program, the intent of the BTE framework is to support, develop, and implement bull trout restoration and enhancement actions within the Yakima River basin with particular focus on improving the abundance and resiliency of bull trout populations.[9] The BTE framework was developed collaboratively by the Yakama Nation and State and Federal agencies in an effort to identify on-the-ground projects to benefit bull trout and their habitat within the Yakima River basin. In 2013, Reclamation and Ecology worked with the

[9] The bull trout projects were discussed in the 2012 Integrated Plan FPEIS.

other signatories (USFS, the Service, Yakama Nation, and the Washington Department of Fish and Wildlife [WDFW]) from the Bull Trout Enhancement Memorandum of Understanding (Appendix A) to identify projects that would benefit upper Yakima River bull trout populations, but also include projects implemented on the North and South forks of the Tieton River. Actions include both construction projects and assessments. The assessments would develop future restoration and enhancement projects and population management actions that would continue recovery efforts.

Consistent with environmental commitments described in Section 2.3.6, Reclamation and Ecology will continue to support and fulfill roles in implementation of specific BTE improvement actions. However, BTE was not carried forward as part of this action because BTE project designs were not sufficiently advanced. In the future, BTE projects undertaken by Reclamation or Ecology would require separate NEPA or SEPA compliance prior to implementation. This includes Endangered Species Act (ESA) consultation on BTE projects remaining as part of the Integrated Plan. Reclamation and Ecology are committed to working with their partners to implement BTE projects through the Federal and State regulatory processes, as demonstrated in the Bull Trout Enhancement Memorandum of Understanding. (See Appendix A).

Furthermore, portions of BTE actions first identified in the BTE framework have been included in the Supplemental Biological Assessment, 2018 related to the ESA consultation on the ongoing operations of the entire Yakima Project. As a result, it is expected that some projects may be undertaken as a result of that consultation. Given that the BTE actions have become part of the overall Yakima Project ESA consultation, and that the BTE framework was not ready for analysis in the DEIS or SDEIS, the agencies removed the BTE from the proposed action analyzed in this EIS. Including the BTE projects in the Yakima Project operations ESA consultation is appropriate and yet demonstrates the agencies ongoing commitment to future implementation of the BTE.

### 1.5.6 Changes from the SDEIS to FEIS

This FEIS provides updates to the SDEIS in terms of further definition of the Preferred Alternative, revisions to information in the SDEIS in response to public comments and to provide updates. The FEIS contains a record of all public comments received on the DEIS and SDEIS and responses to those comments.

## 1.6 Public Involvement

The scoping process began on October 30, 2013, with the publication of an NOI to prepare an EIS in the *Federal Register*. Reclamation and Ecology held public scoping meetings on November 20, 2013, in Yakima, Washington and November 21, 2013, in Cle Elum, Washington.

Chapter 5 of this FEIS 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, Ecology, and Roza.

The DEIS was released for public and agency review in January 2015. The public comment period for the DEIS began January 9, 2015, and concluded June 15, 2015. Reclamation and Ecology conducted public hearings February 3, 2015, and February 5, 2015, in Cle Elum and Ellensburg, Washington, respectively. Reclamation accepted written public comments and compiled public comments provided at the public hearings. Reclamation and Ecology reviewed the comments on the DEIS, while also collecting additional scientific data, and have prepared the SDEIS to affirm or revise, as appropriate, the findings presented in the DEIS.

Reclamation and Ecology circulated the SDEIS for review and comment to engage interested public, agencies, stakeholders, and Tribes. The public comment period for the SDEIS began April 13, 2018 and concluded July 11, 2018. Reclamation and Ecology held public meetings May 16 and 17, 2018 in Cle Elum and Ellensburg, Washington, respectively. Reclamation and Ecology considered comments received on the SDEIS during the public review period. Responses to public comments on both the 2015 DEIS and the 2018 SDEIS are included in this FEIS. In addition, Reclamation and Ecology have conducted outreach with local stakeholders to understand concerns and provide project information (see Section 5.2).

Reclamation and Ecology intend to use the FEIS to determine whether to adopt the Proposed Action or one of the alternatives. All cooperating agencies (Confederated Tribe and Bands of the Yakama Nation, USFS, and BPA) and other Federal, State, and local agencies with authority over any aspect of the Proposed Action may use some, if not all, of the information in the FEIS to make decisions and issue permits with respect to the Proposed Action consistent with their authority.

## 1.7 National and State Environmental Policy Act Review Process

The NEPA of 1969 (40 USC 4321 et seq.) requires that a Federal agency analyze the impacts on the human environment associated with its proposed Federal action. The SEPA (RCW Chapter 43.21C) requires an EIS for all major actions taken by a State agency having a probable significant adverse environmental impact.

Reclamation will submit this FEIS to the U.S. Environmental Protection Agency (EPA) and announce its availability to the public, Tribes, other Federal and State agencies, decision-makers, and local jurisdictions having interest in the Proposed Action.

Reclamation and Ecology have prepared this FEIS that includes modifications made in response to comments on the DEIS and SDEIS or as a result of additional evaluation. Reclamation will publish a Notice of Availability (NOA) in the *Federal Register* for this FEIS.

The NEPA process concludes when Reclamation completes a ROD. The ROD explains the agency's decision, describes the alternatives considered (including the preferred and environmentally preferred alternative), and discusses any commitments for mitigating potential environmental effects and monitoring them as well as permits that will be acquired. Reclamation would not issue a ROD sooner than 30 days after the NOA is published in the *Federal Register.*

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

### 1.7.1 Tiered to Integrated Plan FPEIS

This FEIS is tiered to the Integrated Plan FPEIS (Reclamation and Ecology, 2012). According to NEPA, to tier an 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 programmatic-level in the Integrated Plan FPEIS (Reclamation and Ecology, 2012). KDRPP and KKC are evaluated in this FEIS as one project action under the Surface Water Storage Element of the Integrated Plan, and as one project action under the Structural and Operational Changes

Element of the Integrated Plan, respectively. The Integrated Plan FPEIS is available at http://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html.

### 1.7.2 Integrated Plan FPEIS Incorporated by Reference into KDRPP-KKC FEIS

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

Chapter 1 of the Integrated Plan FPEIS includes background on the Integrated Plan and provides additional information to support that presented in this FEIS. The specific sections incorporated by reference from the Integrated Plan FPEIS are described below.

- Section 1.1 describes how Reclamation and Ecology developed the Integrated Plan and its specific goals to restore ecological functions in the Yakima River system and to provide more reliable and sustainable water resources.
- Section 1.3 presents the purpose of and need for the Integrated Plan and specific water supply problems in the Yakima River basin that need to be addressed.
- Section 1.5 provides background information about the need to develop an integrated approach to addressing water resource issues in the basin. It includes information about the fisheries and water supply problems in the basin as well as information on the potential impacts of climate change on water supply and fisheries.
- 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 River basin. This information provides additional information to support the descriptions in this FEIS.
- Section 1.7 summarizes the major studies that 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 detailed information about 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 FPEIS presents the alternatives 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.
- 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 (pg. 2 to 7). Those criteria are used to define the No Action Alternative project in this FEIS.
  - Section 2.4 provides details on the Integrated Plan including the seven elements and projects proposed under each.
  - Subsection 2.4.4.3 describes the Keechelus-to-Kachess Pipeline as a project under the Structural and Operational Changes Element.
  - Subsection 2.4.5.2 describes the Kachess Reservoir Inactive Storage project that has been developed into the KDRPP evaluated in this FEIS.

### 1.7.3 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).

## 1.8 Authorizations

### 1.8.1 Federal

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 dams and reservoirs under this authority. President Taft authorized three more divisions of the Yakima Project for the storage and delivery of waters for irrigation purposes on January 5, 1911. President Franklin Roosevelt authorized a later division on November 6, 1935, before Congress authorized the Kennewick Division twelve years later on June 12, 1948.

YRBWEP was authorized on December 28, 1979 (93 Stat. 1241, Public Law 96-162, Feasibility Study—Yakima River Basin Water Enhancement Project) and provides the authority for the ongoing feasibility studies in relation to the FEIS (YRBWEP Phase I). 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 considered (YRBWEP Phase II).

### 1.8.2 Washington State Authorization

The Washington State Legislature authorized implementation of the Integrated Plan, including the KDRPP in the 2013 Yakima Policy Bill (2SSB 5367). The bill established mechanisms for implementing work on the Integrated Plan. It authorized Ecology to implement its responsibilities under the Integrated Plan and to develop solutions that provide concurrent benefits for instream and out-of-stream uses. The goals of the State's 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 included 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 instructs DNR, in collaboration with WDFW, to manage it for the following purposes consistent with the Integrated Plan:

- Protect and enhance the water supply and protect the watershed
- Conserve and restore vital habitat for fish
- 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

The DNR completed its purchase of the Tenanaway property in October 2013. DNR and WDFW are working with an advisory committee to develop a management plan for the TCF. The State's 2013 Yakima River basin water resource management bill (2SSB 5367) establishes a provision for any KDRPP project with a "Water Supply Facility Permit and Funding Milestone" (Milestone) proposal. The Milestone established a timeline for permits and financing to be in place by June 30, 2025, for construction of 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 TCF would benefit from implementing the KDRPP because the intent of the KDRPP proposal is to provide 200,000 acre-feet toward the 214,000-acre-foot Milestone.

Additional State authorization to implement the Integrated Plan is contained in the 2013-2015 Capital Budget (ESSB 5035, Section 3077). This section of the Capital Budget appropriated $32 million in capital funds to move forward several Integrated Plan projects and activities, and approximately $99 million for the purchase of the TCF land. The 2015-2017 State Capital Budget included $30 million in appropriated funds and the 2017-2019 State Capital Budget included $31.1 million in appropriated funds. The 2019-2021 funding request is anticipated to be $42 million.

# 1.9 Water Rights and Contracts

## 1.9.1 Water Rights

Reclamation manages and operates the Yakima Project in accordance with Federal and State law, court orders, and court decisions as set forth in Section 1.2.1of this FEIS and Sections 1.6.3 and 1.6.4 of the Integrated Plan FPEIS. Reclamation will comply with State water rights permitting requirements regarding this Proposed Action.

## 1.9.2 Water Contracts

To protect the interests of the United States, general Reclamation law requires contracts for (1) the delivery and storage of project and non-project water, (2) the use of Federal facilities, and (3) the recovery of reimbursable project costs. Contracts are 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, where Reclamation would fund construction, revised contracts would be required for the repayment of reimbursable project costs not paid for by the Proratable Entities based on the their 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 limited by 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.

# 1.10 Permits, Consultations, and Approvals

Prior to constructing and implementing the Proposed Action, Reclamation and Ecology and/or Roza and other Proratable Entities would 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 permit and other requirements that have been identified to date. The applicable resource sections in Chapters 3 and 4 of this FEIS discuss other laws. Chapter 5 describes public involvement and agency consultation and coordination by Reclamation, Ecology, and Roza.

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

| Agency | Permits and Other Requirements | Jurisdiction or Purpose |
|---|---|---|
| **Federal Agencies** | | |
| Bureau of Reclamation | Land Use Authorization<br>Water Use Authorization<br>Water Service Contract<br>Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 | Existing facilities are owned and operated by Reclamation. See Section 1.8. |
| U.S. Fish and Wildlife Service (Service) and National Marine Fisheries Service (NMFS) | Endangered Species Act (16 USC 1531) | Consultation to determine effects on threatened and endangered species. |
| National Marine Fisheries Service (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. |
| U.S. Fish and Wildlife Service (Service) | Fish and Wildlife Coordination Act (16 USC 661066c) | Coordination with the Service on the effects of the proposed project on fish and wildlife. |
| U.S. Army Corps of Engineers (Corps) | Clean Water Act Section 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. |
| U.S. Forest Service (USFS) | Permits and approvals for actions on National Forest System Lands (e.g., road permit, special use permit, mineral use permit) | Approvals for use of USFS lands and/or roads in the construction of the proposed project. |
| Bonneville Power Administration (BPA) | Coordinate with Puget Sound Energy (PSE), Roza and Reclamation to develop power and transmission contract(s)/agreement. | Power and contract/agreement |
| **State Agencies** | | |
| Department of 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. |

| Agency | Permits and Other Requirements | Jurisdiction or Purpose |
|---|---|---|
| Department of Ecology | Construction National Pollutant Discharge Elimination System (NPDES) (RCW Chapter 90.48); 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. |
| Department of Ecology | WAC 173-160 | If mitigation for domestic wells is needed, Notice of Intent for well construction. |
| Department of Ecology | Chapter 90.03 RCW | Issue water rights, as necessary. |
| Washington Department of Fish and Wildlife (WDFW) | Hydraulic Project Approval (RCW Chapter77.55) | Granting of approval for construction projects that use, divert, obstruct, or change the natural bed or flow of State waters. |
| Washington Department of Fish and Wildlife (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 County | Critical Areas Ordinance, Shoreline Master Program | Granting of approval for actions on private land within the county's shoreline jurisdiction. |

# Chapter 2 Proposed Action and Alternatives

## 2.1 Introduction

The FEIS evaluates the potential environmental impacts associated with all alternatives described below. The Preferred Alternative is the KDRPP Floating Pumping Plant described as *Alternative 4 (Preferred Alternative)* below. As stated in Section 1.4, the Preferred Alternative is the funding, design, construction, operation, and maintenance of a floating pumping plant on Kachess Reservoir by one or all of the project proponents in order to recover up to 200,000 acre-feet of inactive water storage from Kachess Reservoir during drought years when prorationing is less than 70 percent supply.[1] This water would otherwise remain in Kachess Reservoir at an elevation below the existing gravity outlet works (Figure 1-2). Reclamation and Ecology each propose to fund, design, construct, operate, and maintain some or all of the selected action alternative or to authorize Roza to fund, design, construct, operate, and maintain some or all of the Preferred Alternative.

The alternatives are evaluated in this FEIS include following:

- *Alternative 1 – No Action* (Section 2.2)
- *Alternative 2 – KDRPP East Shore Pumping Plant* (Section 2.3)
- *Alternative 3 – KDRPP South Pumping Plant* (Section 2.4)
- *Alternative 4 (Preferred Alternative) – KDRPP Floating Pumping Plant* (Section 2.5)
- *Alternative 5 – KDRPP with KKC North Tunnel Alignment* (Section 2.6)
  - *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* (Section 2.6.1)
  - *Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment* (Section 2.6.2)
  - *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment* (Section 2.6.3)

### 2.1.1 Ongoing and Related Actions

Entities within the Yakima River Basin, including the Yakama Nation, Reclamation, BPA, U.S. Fish and Wildlife Service (Service), National Marine Fisheries Service (NMFS), Ecology, WDFW, county and municipal governments, local conservation districts, non-profits organizations, and other landholders and managers have worked over [30 years]

[1] See Sections 3.3 and 4.3 Surface Water Resources of this FEIS, and Section 1.3 of the Integrated Plan PEIS for details on the 70 percent proration level determination. Proratable Entities recognize KDRPP as a stand-alone project does not meet the Integrated Plan full goal of 70 percent proration.

towards implementing the "Integrated Plan." These parties and other developed the Integrated Plan within the Yakima Basin to address impacts due: to past projects (dams) and severe droughts, to allow or facilitate fish passage, to improve or restore fish habitat, to allow operational and structural changes to improve fish migration, to provide more efficient irrigation facilities and to tap new surface and groundwater storage for improved water supplies. This background was described in the Integrated Plan PEIS at Section 2.3 (Reclamation and Ecology, 2012) and larger known projects outside the basin were described at 4.25.

While it is expected that the parties within the Yakima Basin will continue their efforts to implement projects to further the Integrated Plan's objectives, any future site-specific projects will involve appropriate environmental analysis as may be required by law.

#### *2.1.1.1 YRBWEP Phase II*

Public Law 103-434 Title XII Yakima River Basin Water Enhancement Project, October 31, 1994, as amended (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 cost-effective structural and nonstructural measures to increase the reliability of the irrigation water supply and enhance stream flows and fish passage for anadromous fish in the Yakima River Basin. Facility modifications, implementation of diversion reduction measures, the purchase or lease of land, water, or water rights from willing sellers for habitat improvements, habitat restoration, and changes in operations, management, and administration may be implemented to reduce the demand on the available water supply. In exchange for 65 percent Federal cost share, two-thirds of the water conserved under the Basin Conservation Program, will remain instream and will be used to increase flow requirements for anadromous fish. The current plan also includes improvements to the Wapato Irrigation Project, enhancement of the Toppenish Creek Corridor, and an irrigation demonstration project for the Yakama Nation to enhance tribal economic, fish, wildlife, and cultural resources. The total quantity of conserved water from completed and on-going conservation projects is 69,066 acre-feet which nets approximately an additional 100 cfs at Sunnyside Diversion Dam.

The following YRBWEP Phase II projects are ongoing:

- Sunnyside Division Board of Control Phase II Enclosed Lateral Improvement projects, which would conserve 6,565 acre-feet annually when construction is completed and it is operational in 2032.
- Kittitas Reclamation District YRBWEP Phase II activities, which would conserve 48,500 acre-feet annually.
- Yakama Nation Wapato Irrigation Project System Improvements and Demonstration Project are in progress and will improve irrigation efficiencies.

#### 2.1.1.2 Integrated Plan (YRBWEP Phase III)

The Integrated Plan identifies a comprehensive and balanced 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 water market reallocation. Of the seven elements within the Integrated Plan, 14 Habitat and Conservation projects associated with the Enhanced Water Conservation Element and 23 projects associated with the Habitat/Watershed Protection and Enhancement Element have been funded by Ecology as part of the Initial Development Phase since 2013. Over half of the projects have been implemented through contracts between Ecology and entities providing funding.

The Enhanced Water Conservation Element has and will continue to provide future instream water to increase flow for anadromous fish and a more sustainable irrigation supply for farmers.

The Habitat/Watershed Protection and Enhancement Element will continue to improve habitat to assist in recovery of listed species.

#### 2.1.1.3 Cle Elum Pool Raise

The Cle Elum Pool Raise (CEPR) Project involves raising the maximum water level of Cle Elum Reservoir by 3 feet, from a current maximum elevation of 2,240 to 2,243. Additional stored water would be used to improve instream flows consistent with the existing 1994 authorization. Reclamation and Ecology prepared an EIS for the project, and Reclamation issued a ROD in June 2015. As the first construction project of CEPR, the Cle Elum Dam spillway radial gate modification was completed April 2017. Construction on shoreline protection projects began in October 2017, at Cle Elum River Campground.

#### 2.1.1.4 WSDOT I-90 Snoqualmie Pass East Phase 2

While not a Reclamation or Ecology action, the Washington State Department of Transportation (WSDOT) I-90 – Snoqualmie Pass East Phase 2 – Keechelus Dam Vicinity to the Stampede Pass Interchange project is an ongoing state action. This project will continue to occur under the No Action Alternative. As part of this project, WSDOT and the Federal Highway Administration (FHWA) will replace a 2.1-mile section (mile post 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 overcrossing near Price Noble Creek. Construction began in spring 2015 with completion planned for fall 2019. Additional phases from MP 62.0 to 70.3 are currently being designed by WSDOT. WSDOT evaluated the impacts of this project in the *I-90 – Snoqualmie Pass East Final EIS and Section 4(f) Evaluation* (WSDOT, 2008).

## 2.2 Alternative 1 – No Action

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. For additional information see the *Interim Comprehensive Basin Operating Plan, Yakima Project, Washington* (Reclamation, 2002).

### 2.2.1 Current Yakima Project Operations and Typical Annual Operations – No Action

The following are objectives for the current Yakima Project operation. The reservoirs are operated jointly as a system to meet these objectives.

- Store as much water as possible up to the reservoir system's full active capacity of about one million acre-feet from the end of the irrigation season through early spring subject to provide target flows, pulse flows, and any other water necessary to maintain fish and other aquatic life under the Yakama Nation's Time Immemorial Treaty Water Rights
- Provide for diversion entitlements and target flows downstream from the dams, meeting Title XII[2] flows at Sunnyside and Prosser diversion dams
- Provide reservoir space for flood control operations

At the start of the irrigation season, about April 1, unregulated runoff from tributaries downstream from the five reservoirs (Keechelus, Kachess, Cle Elum, Bumping, and Rimrock), 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 approximately June 24. Once these flows fail to meet diversion demands and Title XII instream target flows, Reclamation releases water from the reservoirs, depleting the stored water. 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 Yakima Project diversions, mostly from Roza Diversion Dam downstream, including Roza Division, Wapato Irrigation Project, and Sunnyside Division. A peak flow of about 3,600 cubic feet per second (cfs) for irrigation is moved through this reach of the river.

Starting in late August and continuing to about September 12, Reclamation reduces Cle Elum Reservoir releases substantially (from about 3,000 cfs or more to near 200 cfs) and increases releases substantially from Rimrock Reservoir to meet the September and October irrigation

[2] Title XII flows were authorized under Phase II of the Yakima River Basin Water Enhancement Project Act of 1994. See Section 3.3.1.4 for additional information.

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 allow Reclamation to release less stored water during the spring Chinook salmon egg incubation period to protect spawning nests (redds) in the Cle Elum and Yakima Rivers. The flip-flop would prevent redds from being dewatered, while providing increased flows in the Tieton River to meet late season irrigation demand. 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 from June to mid-August. Beginning in late August, Reclamation gradually switches the releases between the two reservoirs. By mid-September, reservoir releases from Keechelus Reservoir are reduced to 100 cfs (or 80 cfs in dry years), and releases from Kachess Reservoir are increased to 1,000 to 1,200 cfs. Prior to 1996, before the Kachess outlet works and channel were improved to increase outlet capacity, Reclamation could not always reduce flows to the target level from Keechelus Reservoir because it needed to continue to supply downstream users during this time, and sometimes more water was needed from Keechelus Reservoir. This may occur in unique situations in the future but has not been an issue since 1996.

#### *2.2.1.1 Keechelus Reservoir*

Reclamation fills the Keechelus Reservoir and tries to limit winter 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. As early as mid-April, when Kittitas Reclamation District (KRD) starts diverting water from Lake Easton, the flow from Keechelus Reservoir may start to increase as needed with the natural drop in local inflows, and eventually rise to about 1,100 to 1,300 cfs in June and July. In August, Reclamation decreases flows again as described previously.

#### *2.2.1.2 Kachess Reservoir*

Kachess Reservoir operations are similar to the Keechelus Reservoir operations described previously. Reclamation fills Kachess Reservoir from mid-October to June or July with reservoir releases typically in the 35 to 60 cfs range. This saves the water supply for flip-flop operations, as explained in Section 2.2.1. From the beginning of storage control through August, Reclamation spills inflows or makes 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 from Kachess Reservoir to meet demands. Diversions from the reservoir decline from the end of September to mid-October, and the cycle starts over again, as previously described. Current maximum pool elevation is elevation 2,262.0 and minimum pool elevation is elevation 2,192.75, an approximate 69 foot variation.

## 2.3 Alternative 2 – KDRPP East Shore Pumping Plant

KDRPP consists 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 2,112.75, approximately 80 feet lower than the current outlet (elevation 2,192.75) and 149.25 feet below full pool (elevation 2,262), 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 gravity outlet (elevation 2,192.75).

The pumping plant would be used to deliver up to 200,000 acre-feet of water, lowering the reservoir elevation by up to 80 feet, during drought years to participating downstream Yakima Project Proratable Entities, which may include Roza, KRD, and Wapato Irrigation Project (WIP)[3]. Reclamation and Ecology define a drought year as a year when water supply falls below 70 percent of proratable water entitlements[4]. KDRPP would contribute to increasing prorationing up to 70 percent for the participating Proratable Entities. As described in Section 1.3 of the Integrated Plan PEIS (Reclamation and Ecology, 2012), 70 percent would provide a water supply sufficient to prevent severe economic losses to proratable water entitlement users (Reclamation and Ecology, 2012).

The participating Proratable Entities would use the pumping plant during drought years and could possibly use it in following years as the reservoir refills to a level above the existing gravity outlet. To use the inactive storage, the reservoir would typically be drawn down to the gravity outlet level (elevation 2,192.75) by about August in drought years. The reservoir could be drawn down as early as June in severe drought years that are late in a multi-year drought sequence such as 1994. 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. Not all drought years would require the entire 200,000 acre-feet of stored water to provide the desired improved proration level. Section 4.3 (Surface Water Resources) discusses expected reservoir levels under operation of KDRPP.

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

[3] KID has also expressed interest in participating.

[4] This number was reached following extensive discussions with stakeholders regarding the lowest level of water supply that could be accommodated without catastrophic losses to crops, assuming aggressive water management techniques were employed. This 70 percent threshold is similar to the State of Washington's definition of a drought condition contained in RCW 43.83B.400, which recognizes a drought when water supply for a significant portion of a geographic area falls below 75 percent of normal and is likely to cause undue hardship for various water uses and users. (Reclamation and Ecology, 2012).

description of the project design is included in the KDRPP Draft Design Report (Reclamation and Ecology, 2017d).

This section describes the proposed facilities and construction methods for *Alternative 2*. Figure 2-1, Figure 2-2, and Figure 2-3 illustrate the facilities.

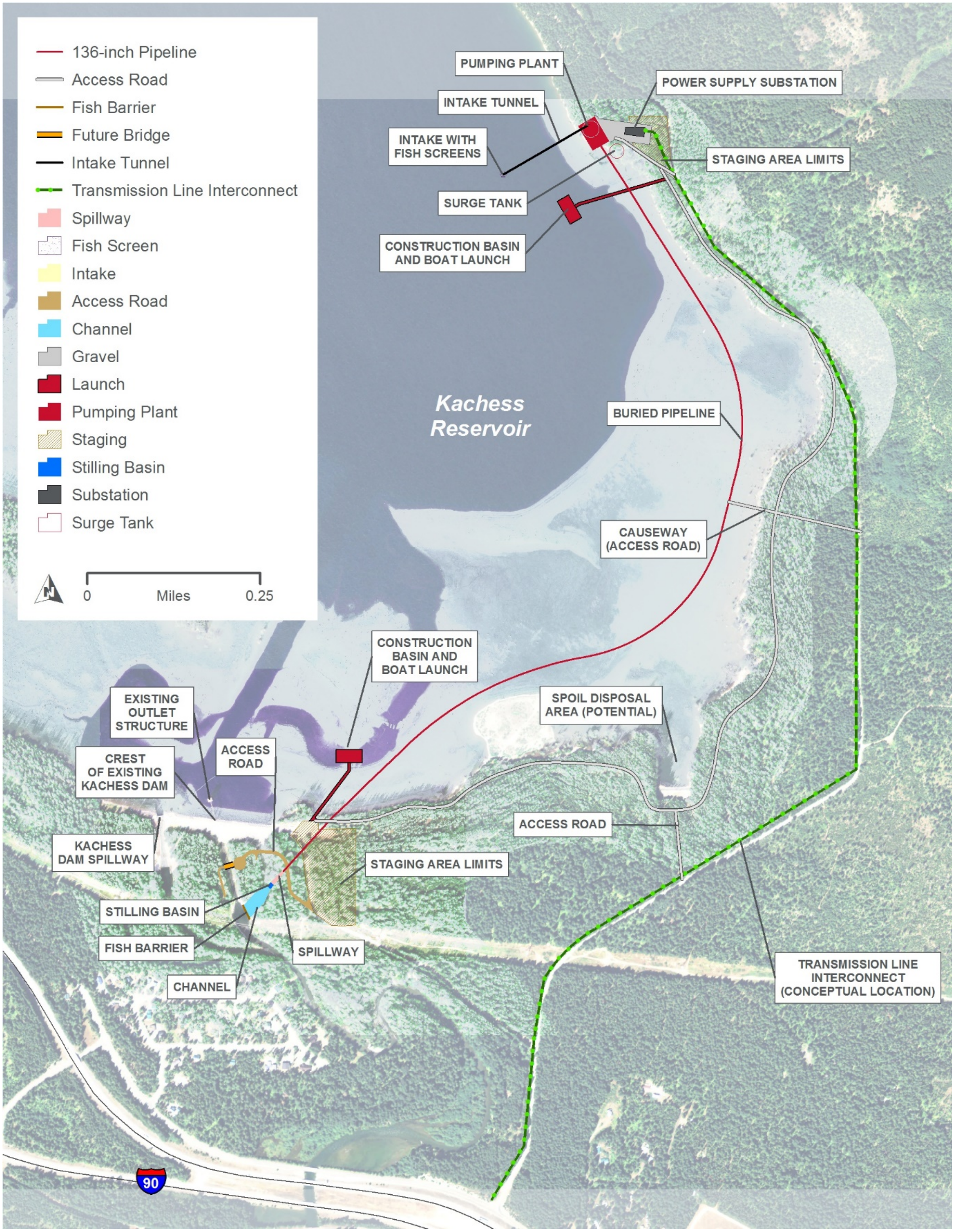



**Figure 2-1.** ***Alternative 2 – KDRPP East Shore Pumping Plant Overview***

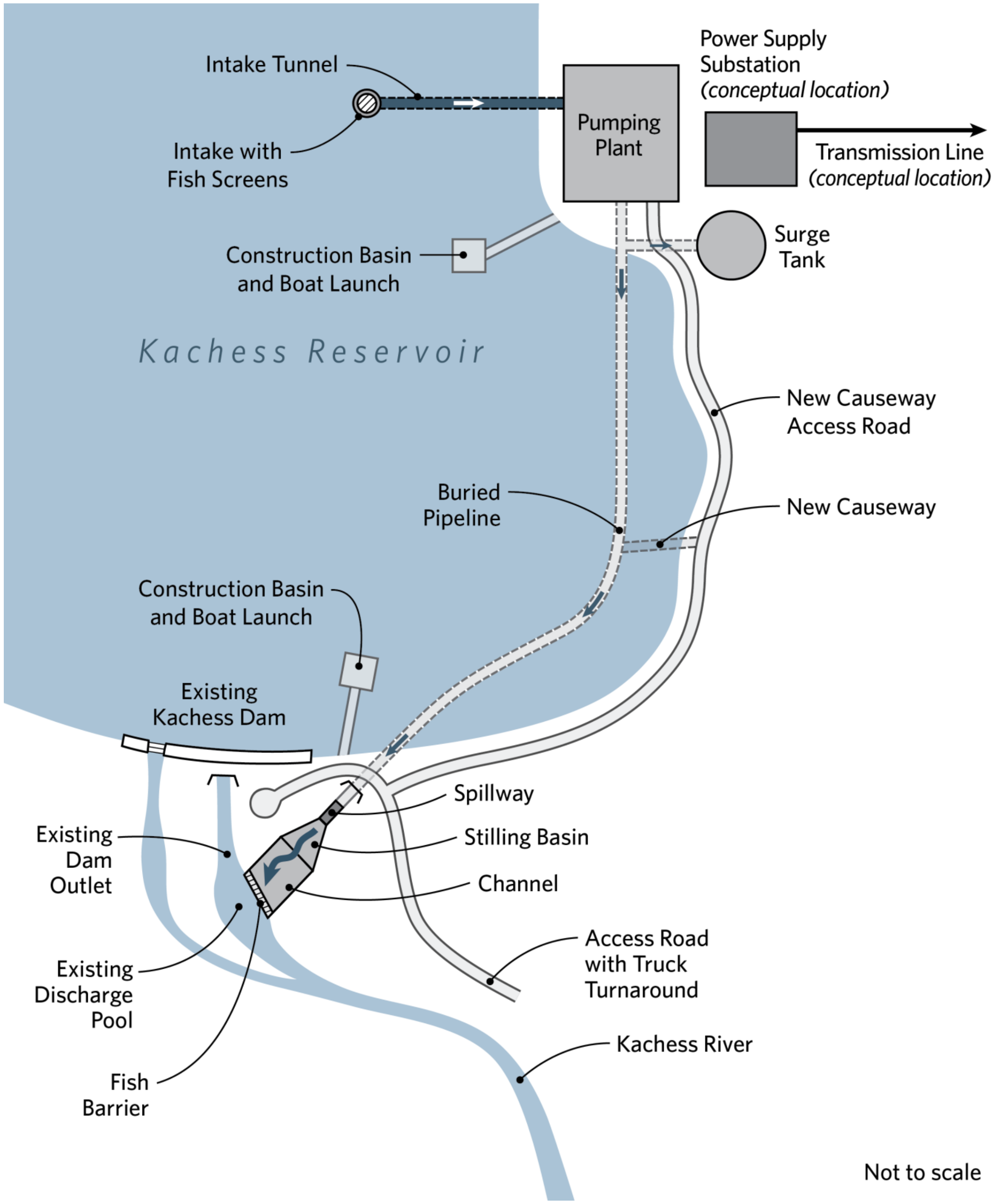



**Figure 2-2.** ***KDRPP East Shore Pumping Plant* Conceptual Site Plan**

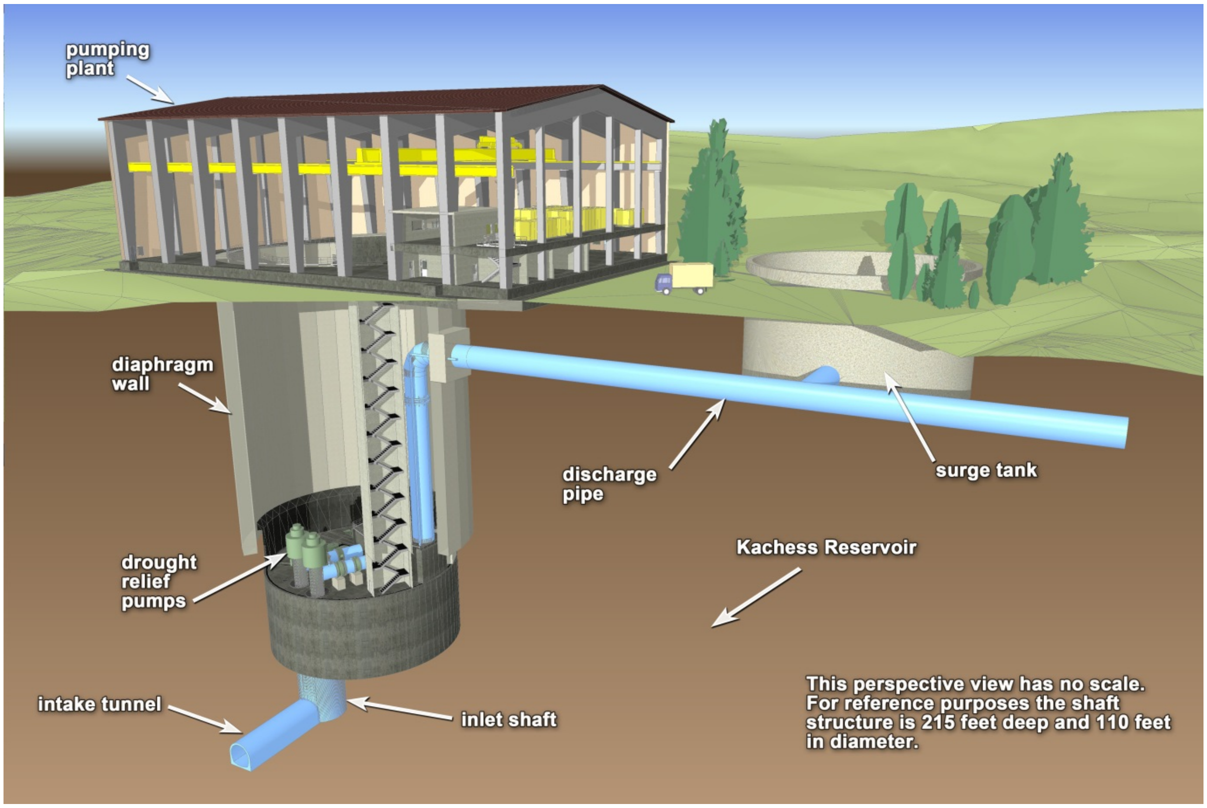



**Figure 2-3. *KDRPP East Shore Pumping Plant* Conceptual Rendering**

## 2.3.1 Facilities

### *2.3.1.1 Reservoir Intake and Tunnel*

For *Alternative 2*, the reservoir intake structure would include a 15-foot-diameter steel-lined intake installed on the reservoir floor at elevation 1,989. The intake would be located 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 would include a fish screen structure consisting of cylindrical 7-foot by 10-foot stainless steel screens. An approximately 711-foot-long, 15-foot-diameter intake tunnel would connect the intake to the pumping plant on the shore of the reservoir.

### *2.3.1.2 Pumping Plant*

**Pumping Plant Shaft**. The pumps would be housed near the bottom of a below-ground circular shaft made of reinforced concrete (approximately 215 feet deep and 110 feet in diameter) on the east shore of the reservoir. 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 and 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 220 feet long by 150 feet wide and 65 feet high) would house the ancillary systems for the pumping plant. Systems would include access and operating space; heating, ventilation, and air conditioning (HVAC) equipment; pump instrumentation and controls (I&C); 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.

#### *2.3.1.3 Pipeline*

As part of *Alternative 2*, a single 136-inch (11.33 feet)-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 reservoir's shoreline, just below the reservoir high pool level at approximate elevation 2,240. The pipeline corridor would be underwater when the reservoir is at full pool. Soil (approximately 7 feet deep) would cover the pipeline to keep it submerged. The pipeline would exit the pumping plant shaft at invert elevation 2,212 and would 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 existing dam.

During drawdowns, a 25-foot-wide gravel access road on the reservoir floor alongside the entire pipeline alignment would provide permanent access to the pipeline for inspection and maintenance. The pipeline would include three access points: at the pumping plant shaft, at the midway point (accessed through a causeway shown in Figure 2-1), 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 reservoir's normal full pool elevation. The causeway would be 1,080 feet long with a 50-foot-radius truck turn-around at the reservoir end.

#### *2.3.1.4 Surge Tank*

A 110-foot-diameter 43-foot-deep surge tank connected to the pipeline immediately downstream from the pumping plant would protect against hydraulic surge. The surge tank would be fully fenced and uncovered with approximately 3 feet extending above ground.

#### *2.3.1.5 Outlet Works and Kachess River Discharge*

The pipeline for *Alternative 2* would terminate at a new discharge spillway near the top of the dam’s left abutment. 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 toward Lake Easton Reservoir.

#### *2.3.1.6 Permanent Access Roads*

In addition to the permanent pipeline access road and causeway described in Section 2.3.1.3, 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 length of new access roads would be about 2,425 feet.

#### *2.3.1.7 Power Supply Substation and Transmission Line*

A transmission interconnection to the Puget Sound Energy (PSE) supply would be required to provide electric power for KDRPP pump operations. The power supply system would consist of four primary features: (1) an interconnection from the existing Puget Sound Energy transmission line near Easton, WA; (2) installation of a substation on Reclamation property adjacent to the Lake Easton outlet; (3) twin, buried, 34.5 kV transmission lines from the new Lake Easton substation to the Kachess Dam area; and (4) a new on-site Kachess Reservoir substation.

**Interconnection to Existing PSE 115 kV Transmission Line**

Puget Sound Energy (PSE) owns and operates an existing 115 kV power transmission line that runs through the upper Yakima River basin through to the community of Easton, WA. The overhead transmission line skirts the southwest shore of Lake Easton. An overhead interconnection would be installed to connect this transmission line to a new substation. The 650-foot interconnection line would cross over the downstream end of Lake Easton, situated near the lake outlet.

**Lake Easton Substation**

The overhead 115 kV power line would lead to a new substation constructed on Reclamation property in the vicinity of the lake outlet. The substation will have a footprint of approximately one half acre. Power transformers at the substation would step the voltage down to 34.5 kV.

**Buried Power Lines to Kachess Reservoir**

Twin, buried power lines rated at 34.5 kV would be routed along Reclamation property and public rights of way from the new substation at Lake Easton to a new substation at Kachess Reservoir. The lines will be installed using cut and cover excavation methods, in a trench approximately 3 feet wide and 3 feet deep, either by direct burial in existing roadways or within a 20-foot wide cleared corridor. Horizontal directional drilling will be used where the buried power lines beneath I-90. The total length of the buried line will be approximately 2 miles. Right-of -way used for the line would include portions of the Kachess Dam Road (USFR 4818). The buried lines will cross a BPA transmission line right-of-way near Kachess Dam, and continue along USFR 4818 to the site of the east shore pumping plant.

**New Onsite Kachess Reservoir Substation**

A new on-site Kachess Reservoir substation would be constructed near the pumping plant and would be surrounded by a security fence. 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 of no less than 35 MVA. This substation would be gravel-surfaced and would contain a grounding grid, switch gear, step down transformers (34.5 kV to 4,160 volt), transformer oil spill containment structures, meters, emergency diesel generator and fuel storage, and associated electrical I&C equipment. The diesel-powered generator would provide an emergency backup power supply for mission critical equipment, but would not be sized for operation of the pumping units themselves.

### 2.3.2 Construction

Construction of *Alternative 2* 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 sections describe general construction activities.

#### *2.3.2.1 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, and staging and material storage. Approximately 75.5 acres would be cleared for construction of *Alternative 2*; of this, approximately 57.5 acres would be restored after construction with native vegetation.

#### *2.3.2.2 Reservoir Intake and Tunnel*

The reservoir 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 dredging. Rock would be blasted or split and the material clam shelled out of the excavation, progressively enlarging the hole until reaching 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 poured through a pipe from the surface (barge or platform), filling the space underwater.

The intake would include a prefabricated fish screen, which would be manufactured offsite 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 would be lowered from a barge into place above the intake as the reservoir draws down.

The intake tunnel would be mined through rock from the pumping plant shaft on shore out to the intake. The mining process includes ground excavation using the drill-and-blast method. Excavated material would be removed through the tunnel and shaft and hauled to the spoils disposal area. Temporary rock support would be installed at the tunnel and shaft until the permanent walls were constructed. Interior reinforced concrete walls would then be installed.

#### *2.3.2.3 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 to a designated location near old Kachess Reservoir spillway. Following shaft excavation, construction would include the following two sets of tasks:

- Mine a tunnel from the pumping plant shaft 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

#### *2.3.2.4 Pipeline*

A 300-foot-wide construction corridor along the reservoir shore would facilitate pipeline installation. The pipeline corridor would be on the reservoir bed; therefore, no clearing would be required during site preparation. The steel pipeline would be constructed using open trench, cut, and cover technique. Where the steel pipeline first leaves the pumping plant shaft and where the pipeline crosses through the left abutment of the dam, the required excavation depth is up to approximately 40 feet deep. Special trench excavation or shoring measures, or both, would be required in these deeper areas of excavation.

#### *2.3.2.5 Outlet Works and Kachess River Discharge*

An ogee-, or curve-shaped-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. These structures would likely be constructed using a reinforced concrete ground slab with reinforced concrete sidewalls. These features would be constructed using conventional construction equipment.

#### *2.3.2.6 Surge Tank*

The surge tank would be constructed in an open excavation after the pipeline is completed. Following excavation, a reinforced concrete ground slab would be placed, and then reinforced concrete sidewalls would be constructed.

#### *2.3.2.7 Power Supply Substation and Transmission Line*

The power supply substation would be adjacent to the East Shore Pumping Plant on a flat bench. Approximately 0.6 acre 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 the growth of vegetation that may interfere with the transmission line. New transmission line would be constructed along the USFS Road 4818 alignment and then to the proposed East Shore Pumping Plant location. The substation and transmission line would be constructed using conventional construction equipment.

#### *2.3.2.8 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 phase of design, but are expected to be generally consistent with the locations identified in this FEIS.

**Access Roads, Staging Areas, and Construction Parking**. Primary construction access would be provided by 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, three new gravel-surfaced access roads would connect to the existing gravel Kachess Dam Road. The roads would provide access to the spoil disposal area, the pipeline causeway, and the pumping plant area. Approximately 0.4 mile would be cleared for construction of the access roads. The new access roads would be constructed using conventional construction equipment.

The primary construction staging area for temporary storage of equipment and materials and for 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 temporary 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 2.3.2.2). 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 near the East Shore Pumping Plant site. It would be usable year-round, including when the reservoir is drawn down. The reservoir floor would be graded to a constant slope at the location of the boat ramp. 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 at the southeast corner of Kachess Reservoir. The spoils disposal area would be approximately 148,000 square feet (3.4 acres) 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 offsite. For the FEIS 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 whether 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 side cast to the reservoir floor adjacent to the excavation.

**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. If electric power cannot be supplied from the existing power grid, diesel-powered electric generators would supply temporary power during the construction period. Generators would be located at the staging area, and power cables would be run to the construction equipment.

#### *2.3.2.9 Construction Scheduling and Sequencing*

Construction of all the facilities associated with *Alternative 2* is expected to last 3 years, (Table 2-1). The start date for construction is contingent on the proposals receiving congressional authorization and funding and on completion of all permitting and obtaining necessary regulatory approvals

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

- Mobilizing, clearing, grading, establishing 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)

**Table 2-1. *Alternative 2 – 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 the intake tunnel |

| |
|---|
| Construct transmission line and power supply 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 |
| Construct Narrows volitional fish passage roughened channel |
| **Subsequent years when reservoir is drawn down during drought relief pumping** |
| Extend Narrows roughened channel |

### 2.3.3 Typical Annual Operations

Typical operations of *Alternative 2* for drought relief and refill are described in the following sections.

#### *2.3.3.1 Drought Relief Operations*

*Alternative 2* would be operated by project proponents. In years when drought conditions cause Proratable Entities to receive less than 70 percent of their water supply entitlement, the participating Proratable Entities would decide, consistent with contractual operating provisions, how much water should be pumped to allow them to achieve up to a 70 percent prorationed level. As described in Section 1.3 of the Integrated Plan PEIS, 70 percent prorationing would provide a water supply sufficient to prevent severe economic losses to proratable water users (Reclamation and Ecology, 2012). Under Alternative 2, water would be pumped out of Kachess Reservoir that is below the existing gravity outlet (elevation 2,192.75). It would allow pumping of up to 200,000 acre-feet, lowering the reservoir by as much as 80 feet. The pumping plant would pump up to 1,000 cfs. Numerous factors would likely influence the participating Proratable Entities on how much water to pump, such as, how many participating entities need water, drought severity, cost to purchase power for pumping, value to retain water in Kachess Reservoir as insurance against future drought year(s), ability for farmers to implement aggressive water management techniques, and other integrated plan projects if implemented as provided for in the Final Programmatic EIS.

Figure 2-4 and Figure 2-5 display drawdown of Kachess Reservoir under two alternate operational conditions for illustration purposes. Figure 2-4shows drawdown for Roza only, at the end of a 1-year drought similar to the 2001 drought. In this case, a drawdown of approximately 30 feet would be expected, representing 73,000 acre-feet of withdrawal from the inactive pool instead of 200,000 acre-feet. Figure 2-5 shows drawdown at the end of severe, multi-year drought assuming the participating Proratable Entities include Roza, KRD and WIP. The maximum drawdown of 80 feet is shown, representing 200,000 acre-feet withdrawn from the inactive pool.

Under these or any drawdown scenario, Reclamation would continue to meet its obligations to water users and would continue to manage releases to achieve stream flow and fish habitat objectives. If KDRPP is constructed, Reclamation would adjust its calculation of TWSA to account for the additional withdrawal of water by participating Proratable Entities from Kachess Reservoir inactive pool. The adjusted calculation will include pumping to meet the needs of other Yakima Project users, such that TWSA with KDRPP would be the same as it would have been without KDRPP. This is necessary in order to protect Yakima Project users besides the participating Proratable Entities, and to assure Reclamation can provide required instream flows and target flow at Parker Gage.

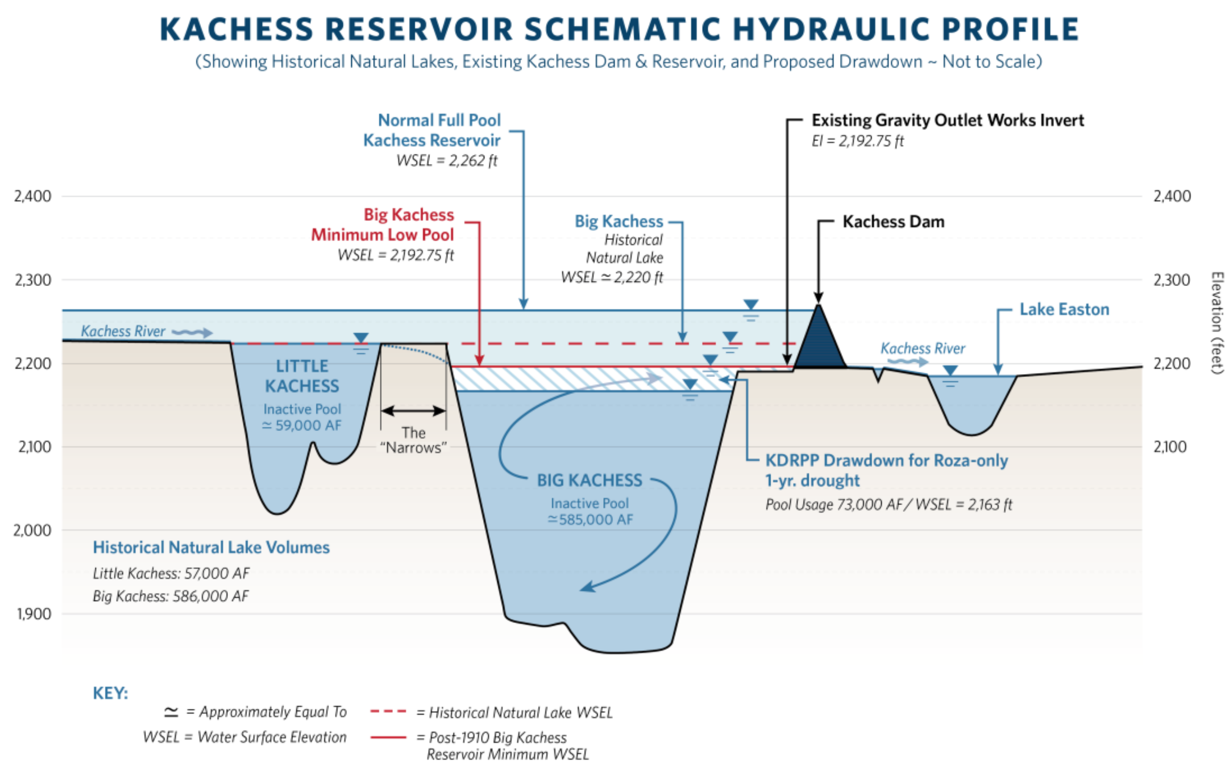



**Figure 2-4. Drawdown at End of 1-year Drought with Use of 73,000 acre-feet**

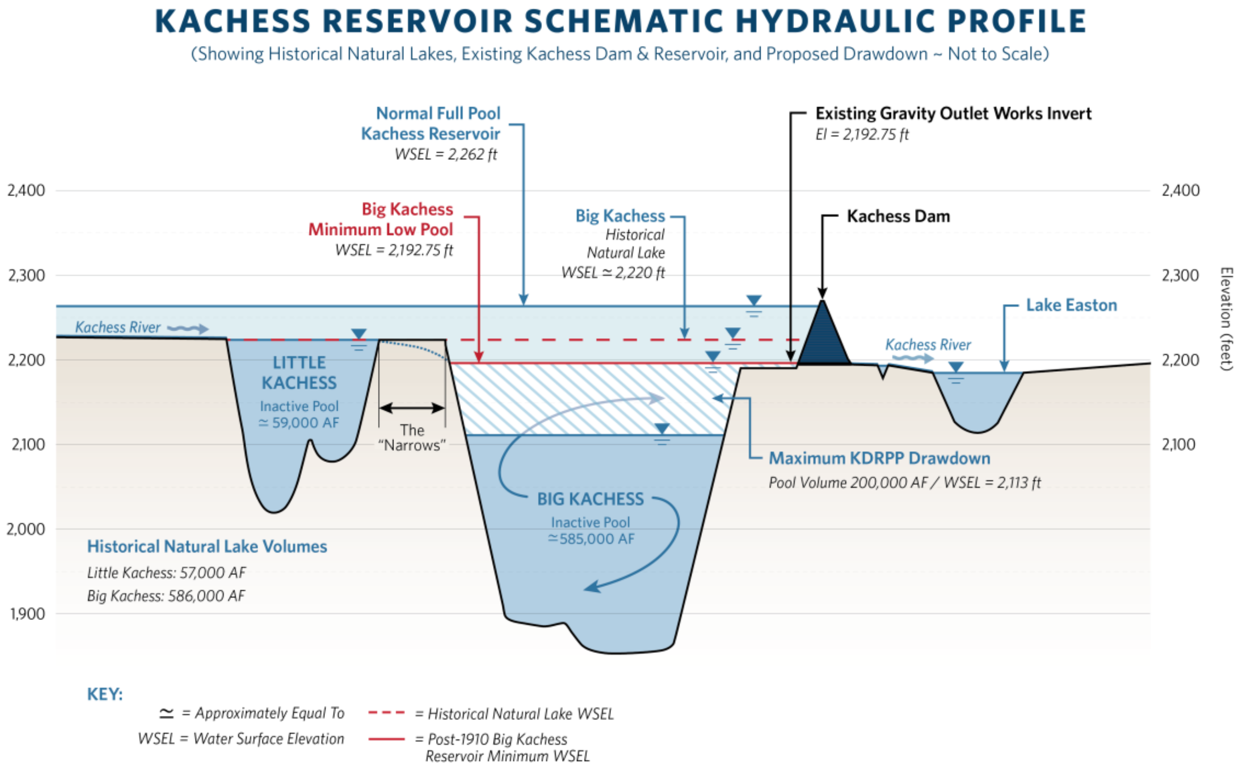



**Figure 2-5. Drawdown at End of Multi-year Drought with Maximum Use of 200,000 acre-feet**

Kachess Reservoir's contribution to TWSA is currently calculated as the volume of water stored above the existing gravity outlet on April 1 of each year (the normal active conservation pool). If KDRPP is constructed, then an adjustment to the calculation would be made to account for the participating Proratable Entities' use of water below the gravity outlet. This adjustment would apply following a year that KDRPP was used and the system has not fully recovered. The adjusted calculation would be designed to ensure that TWSA with KDRPP will be the same as it would have been without KDRPP

If KDRPP is constructed, then Reclamation's contracted operating agreement with the participating Proratable Entities would need to require that they pump water as necessary to assure that Kachess Reservoir's contribution to TWSA can be fulfilled. This will sometimes require reserving and pumping additional inactive pool supply in years following drought-relief operations. Reclamation would continue to manage Kachess Reservoir and the other four reservoirs as a system after consulting with the System Operations Advisory Committee.

KID is a proratable district, but has historically relied upon return flows from upstream users instead of storage releases specifically for its benefit. During drought years when participating Proratable Entities pump water from KDRPP, their return flows could be higher than without KDRPP, so KID may receive an improved supply with KDRPP. During refill years, return flows could be the same or less depending on choices made by the participating Proratable Entities. In a refill year without prorationing, KID would receive its full entitlement just as it would have without KDRPP. In a refill year with prorationing, KID would continue to receive at least its prorated entitlement, but its ability to divert available water in excess of its prorated entitlement may be impacted by any decrease in return flows.

At the beginning of a drought, Kachess Reservoir would store the same amount of water as under existing conditions. Kachess Reservoir water levels would be lowered starting early in the irrigation season (e.g. in April). This would result in the reservoir being drawn down to the existing gravity outlet level by sometime in August. Pumping under *Alternative 2* would then be initiated, typically beginning in August and ending in late September or early October. Depending on the drought's duration and severity, *Alternative 2* would be operated for that 10- to 18-week period during the drought year's irrigation season and would continue to pump while the reservoir is below the outlet works to meet flow obligations. Multi-year droughts could see recurrent use of KDRPP for drought-relief operations in consecutive years, and pumping could begin earlier in the irrigation season. As discussed above, pumping would also continue in subsequent non-drought years when needed to ensure that TWSA is not impacted by KDRPP.

During prorated years, in general, and particularly when KDRPP is being used, the reservoir system would be managed to meet demands and make efficient use of reservoir storage with attention to effectively using all available storage from each of the reservoirs by the end of the irrigation season, retaining a sufficient amount for winter flow obligations. In keeping with the goals of the Integrated Plan, under the Proposed Action during Kachess Reservoir refill, Reclamation would operate the Yakima Project to ensure spring (March 1 through May 31) flows in the following year are at least what they would be under current operating conditions without KDRPP. Current operating conditions vary by year depending on hydrologic conditions.

#### *2.3.3.2 Refill Operations*

After an irrigation season when drought-relief pumping has occurred, the amount of runoff from rain and snow in the Kachess River drainage area would determine how quickly the pool in Kachess Reservoir refills. Rain and snow vary from year to year, so the rate of the pool recovery would also vary. The length of time that pool levels stay below current conditions would depend on: 1) how much water was pumped out during the drought and 2) how quickly the pool level rises in response to runoff.

Under conditions where Yakima Project supplies recover during the first winter following a drought, pumping would not resume until another drought occurs. This includes years when the reservoir does not rise to its maximum pool level, but rises high enough that pumping is not necessary to ensure that TWSA is the same as it would have been without KDRPP.

Under conditions where runoff is inadequate in the first winter following a drought, pumping would be needed again in the subsequent year to ensure that TWSA is not impacted.

If low runoff conditions occurred again in the second year or additional years following a drought, then the need for refill-operations pumping could be prolonged into additional irrigation seasons. Pumping operations will still be limited to the KDRPP's 80-foot drawdown capacity, and water would still remain in Kachess Reservoir below that level at all times.

Since the participating Proratable Entities would pay for power necessary to pump water at pool levels below the existing gravity outlet, they would have an incentive to refill Kachess Reservoir as fast as possible following a drought year. This incentive may lead them to use less water than their full entitlement during non-drought years while refill is in progress. For example, they could choose to use 85 percent of their entitlement rather than 100 percent in a refill year. This would tend to raise pool levels faster during refill and shorten the duration of drawn-down conditions. Section 4.3 (Surface Water Resources) includes information about expected reservoir levels during drought-relief and refill operations.

### 2.3.4 Maintenance Activities

For *Alternative 2*, the project proponents would perform ongoing maintenance activities associated with the pumping equipment and operable mechanical equipment to ensure that the equipment is fully operational when needed. Periodic inspection and testing of all civil, mechanical, and electrical features would occur in accordance with its existing Reclamation standards and directives. Additional maintenance practices will be developed 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.

### 2.3.5 Volitional Bull Trout Passage Improvements

When operation of the KDRPP East Shore Pumping Plant reduces the pool elevation of Kachess Reservoir below a pool elevation of approximately 2,226, access to tributaries in the Little Kachess begins to be affected. At pool elevation of approximately 2,223, the reservoir begins to separate into an upper pool (Little Kachess) and a lower pool (Big Kachess) at a location known as the Kachess Narrows. Water continues to flow from Little Kachess into Big Kachess through a natural channel. As the pool elevation of Big Kachess is drawn below 2,200 a steep shelf is exposed that impedes passage for resident bull trout in Big Kachess. To encourage resident bull trout migration through the Narrows during drought relief pumping and refill, the project proponent(s) would construct a fish passage facility between Little Kachess and Big Kachess. Figure 2-6 provides a conceptual site plan for the proposed Volitional Bull Trout Passage Improvements at the Narrows. The construction elements include a roughened channel, flow weir, isolation berm and slope stabilization soldier pile wall. Additional technical details are included in Kachess Narrows Fish Passage Concept Development Technical Memorandum (Reclamation and Ecology, 2017a).

The roughened channel would be approximately 5.5 feet deep and 28 feet wide. The depth of the channel will accommodate a maximum hydraulic depth of 2.5 feet at 100 cfs with 3 additional vertical feet of freeboard. The channel would function as intended whenever Big Kachess is below a pool elevation of 2,208. It would remain in operation while the pool is drawn down to the minimum drought relief pool elevation of 2,112.75 and while the pool refills again to an elevation of 2,208. The roughened channel would be a 3-foot-thick layer of engineered streambed material consisting of a well-graded, compacted matrix of cobbles and soil. This would be underlain by a bentonite mat to limit water loss through the channel bottom. Construction of the channel is anticipated to occur using open cut excavation techniques up to a depth of 15 feet. Along the existing reservoir shoreline, bank stabilization would be required and would consist of soldier pile walls or h-piles, depending on whether soil or bedrock is encountered. Construction of the roughened channel is anticipated to take 5 months for all work above the 2,192.75 elevation. Portions of the roughened channel reaches below 2,192.75-foot elevation would be installed incrementally beginning in the first year KDRPP is activated, and in subsequent years when the reservoir is drawn down to successively lower elevations. Completion to the new minimum pool elevation would occur in the first year the reservoir is fully drawn down to that level. Construction duration would vary by the amount of exposed reservoir bed in those years and would be limited to the period of time when reservoir levels are conducive for construction (i.e., drawn down).

A fixed concrete flow weir would be integrated into the upstream inlet of the proposed roughened channel. The weir would limit the volume of water conveyed to the roughened channel. It would direct flows in excess of 100 cfs into the main channel of the Narrows. The weir would be approximately 175 feet wide and composed of grouted rock, engineered streambed material, and earth fill.

An isolation berm would be installed downstream of the flow weir to isolate high flows conveyed down the Narrows. The isolation berm would be installed along the waterside of the bank of the roughened channel. This feature would be 4 to 6 feet high, with a top width of 8 feet, and a total width of 24 to 32 feet. The isolation berm would begin at the most upstream end of the roughened channel and would extend approximately 240 feet downstream until it reaches elevation contour at 2,204 feet.

Volitional fish passage would be operated and maintained in a manner to ensure the original design criteria would be met.

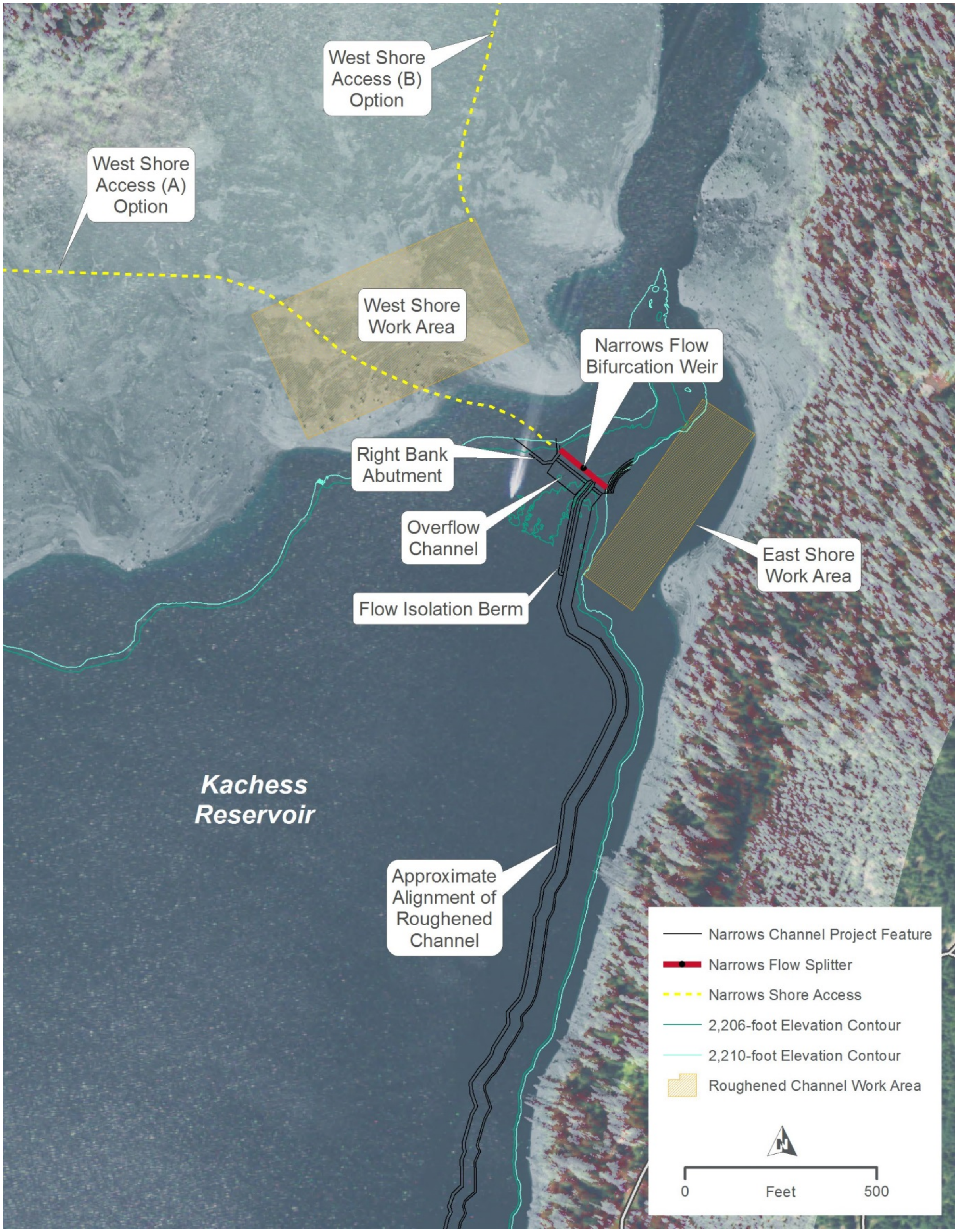



**Figure 2-6. Proposed Volitional Bull Trout Passage Improvements at the Kachess Narrows**

### 2.3.6 Avoidance, Minimization, and Mitigation Measures Common to All Action Alternatives

The Council on Environmental Quality's 5 categories of mitigation are to avoid, minimize, rectify, reduce or eliminate, and compensate (40 CFR 1508.20). Most avoidance, minimization, and mitigation measures described in this chapter are designed to avoid or minimize environmental effect. Final decisions on who is responsible for implementing mitigating measures and/or reporting on them will be described in the ROD. Project proponents would coordinate to implement any measures necessary to mitigate for an adverse impact.

Chapter 4 describes specific avoidance, minimization, and mitigation measures for project impacts for each resource. The following summarizes major environmental commitments for the project that would occur under any of the action alternatives.

- Obtain all applicable Federal, State, and local permits.
- Prior to construction, conduct geotechnical studies to identify subsurface issues, unstable slopes, and other local factors that could contribute to slope instability and increase erosion potential.
- Implement best management practices, when appropriate, to enhance resource protection and avoid additional potential affects to surface and groundwater quality, earth resources, fish, wildlife, and their habitats.
- Restore areas disturbed during construction to pre-construction conditions or better.
- Conduct continued monitoring of site conditions and erosion potential.
- Continue a surface water quality monitoring program to support design efforts and minimize and avoid water quality impacts.
- Monitor a representative group of wells near Kachess Reservoir to determine whether groundwater levels are lowered by additional reservoir drawdown attributable to the action alternatives and will coordinate with affected parties on a case-by-case basis. If well water levels fall and water yields in specific wells are adversely affected to the point that property uses are compromised, then mitigation will be applied.
- Pursuant to the 2013 Integrated Plan ROD, Reclamation, Ecology, the Yakama Nation, the U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, and the USFS (BTE parties) are developing and implementing improvements to bull trout habitat within the Yakima River basin as described in the BTE framework (Appendix C). Consistent with environmental commitments in this section, Reclamation and Ecology will continue to support and fulfill roles in implementation of specific BTE improvement actions. Support general bull trout 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. Implement specific mitigation for listed fish and wildlife species that the agencies require as part of consultation. Update WDFW preconstruction surveys prior to construction. Reclamation would implement the conservation measures and recommendations provided by the Service in the Fish and Wildlife Coordination Report.
- Monitor for infestations of invasive plant species associated with project ground disturbances and periods of prolonged drawdown of the reservoirs and implement suppression strategies using best management practices to control invasive plant populations.
- Extend boat ramps at Kachess Reservoir when the reservoir is drawn down during drought years, if feasible, and construct new east shore ramp that would be available at all reservoir elevations.
- Implement a public communication strategy to prepare recreation users for the 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 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 and to restore service, if needed, for utilities disrupted by construction.
- Design facilities according to applicable standards and codes; having construction crews comply with all applicable guidelines and standards of construction practices for installing facilities; and limiting access to authorized and trained personnel.

## 2.4 Alternative 3 – KDRPP South Pumping Plant

*Alternative 3 – KDRPP South Pumping Plant* is similar to *Alternative 2* 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 2-7). 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 2-7 shows the major facilities associated with *Alternative 3*. More detailed technical description of the project design is included in the KDRPP Feasibility-Level Design Report (Reclamation and Ecology, 2017d).

This section describes the proposed facilities and construction methods for *Alternative 3*. Figure 2-7, Figure 2-8, and Figure 2-9 illustrate the facilities. Volitional Bull Trout Passage Improvements at the Narrows is described in Section 2.3.5.

### 2.4.1 Facilities

#### *2.4.1.1 Reservoir Intake and Tunnel*

For *Alternative 3*, a new intake would be installed on the floor of the reservoir at approximately elevation 2,088. 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 2* (Section 2.3.1.1). For *Alternative 3*, the intake and tunnel would be sited in soft surface soils on the reservoir bottom. The intake tunnel, which would convey water from the intake to the pumping plant, would be approximately 3,275 feet long and 13 feet in diameter.

#### *2.4.1.2 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 2* except the shaft would be only 145 feet deep. Because the pumping plant would be in a different location for *Alternative 3*, the pumping unit configurations and the pumping lift, locations, and discharges inside the pumping plant would differ.

*Alternative 3* would include pumps similar to those in *Alternative 2*. The four vertical turbine pumps with suction inlets would be located at approximate elevation 2,115. As described for *Alternative 2*, 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).

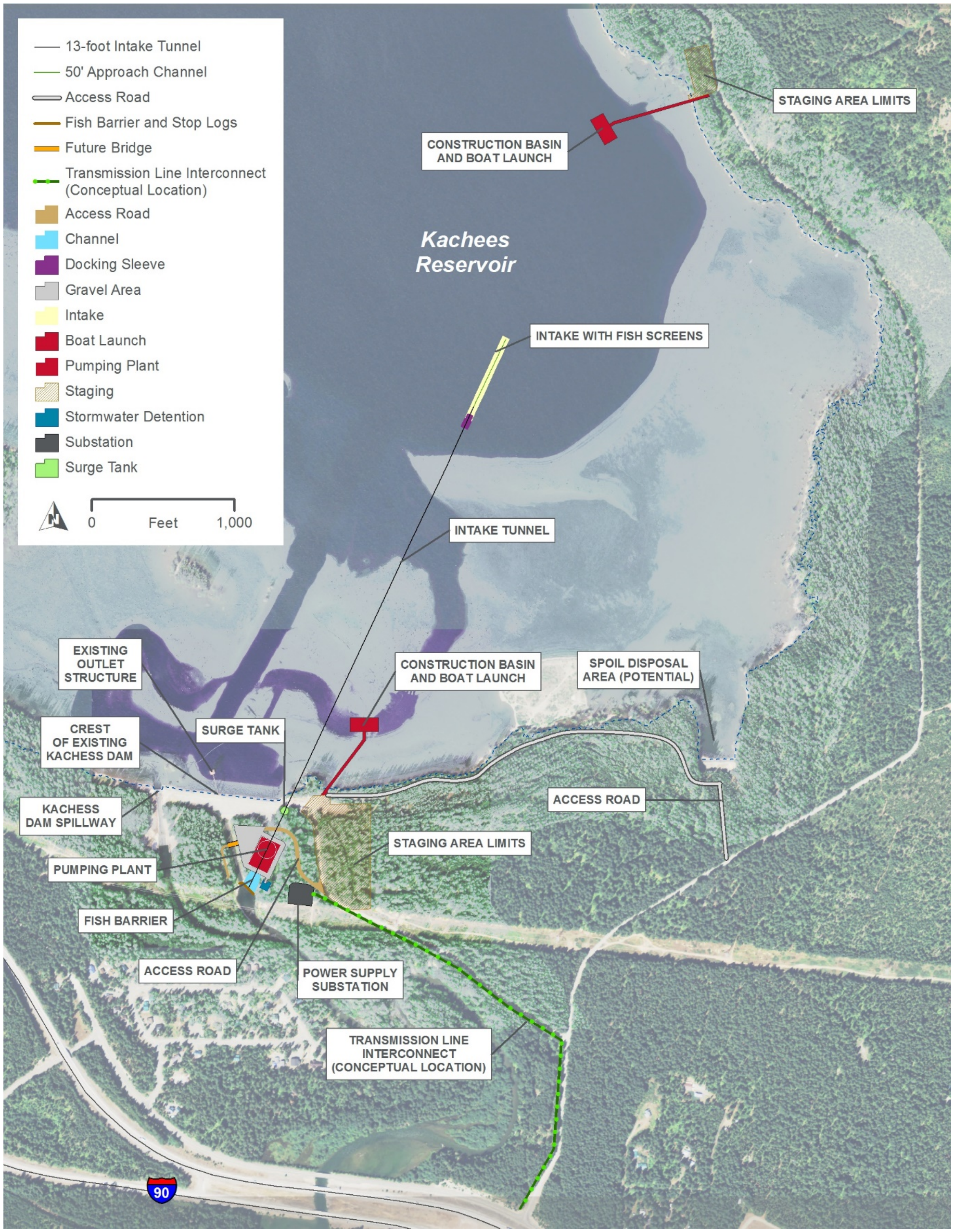



**Figure 2-7.** ***Alternative 3 – KDRPP South Pumping Plant*** **Overview**

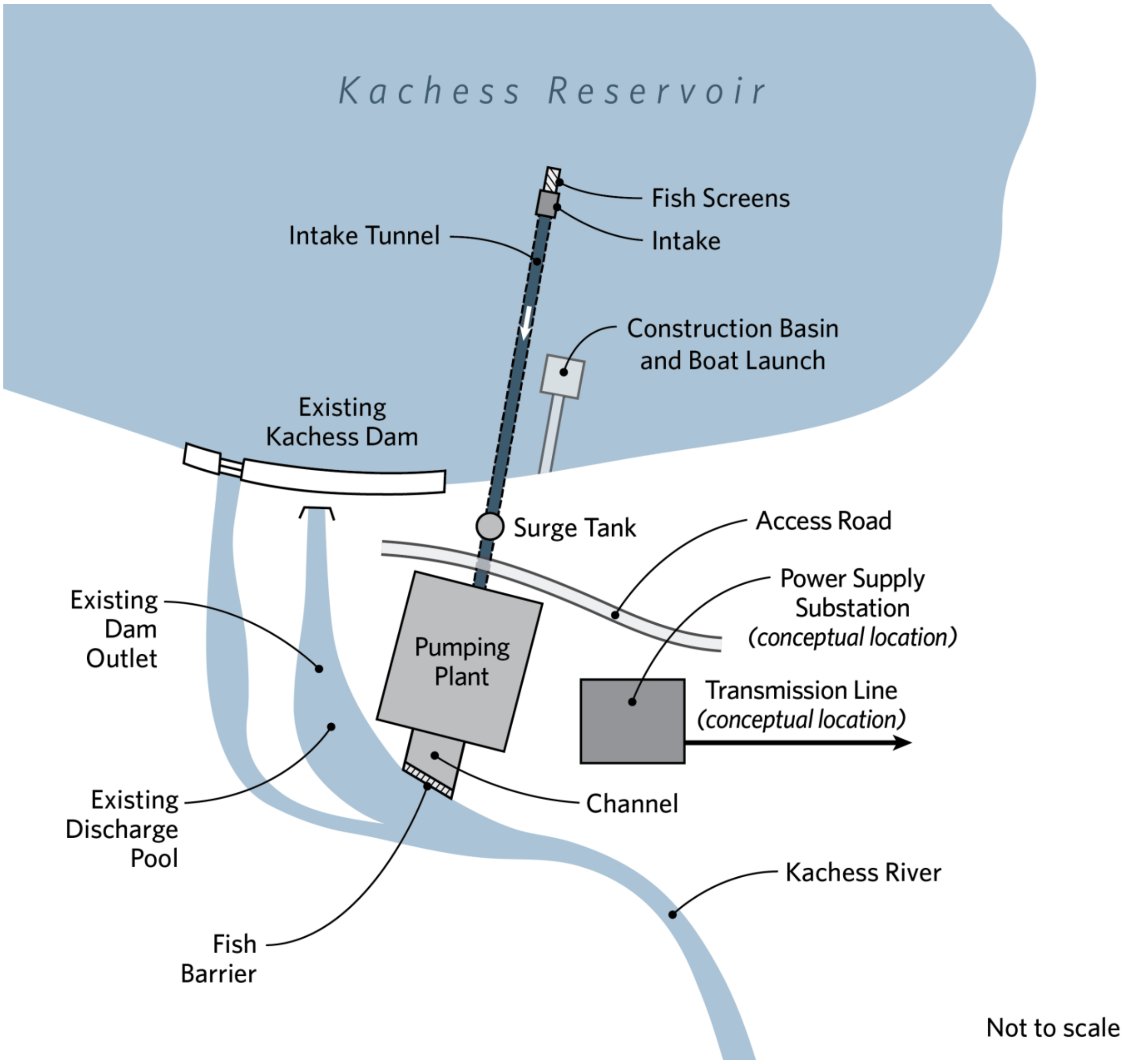



**Figure 2-8.** ***KDRPP South Pumping Plant*** **Conceptual Site Plan**

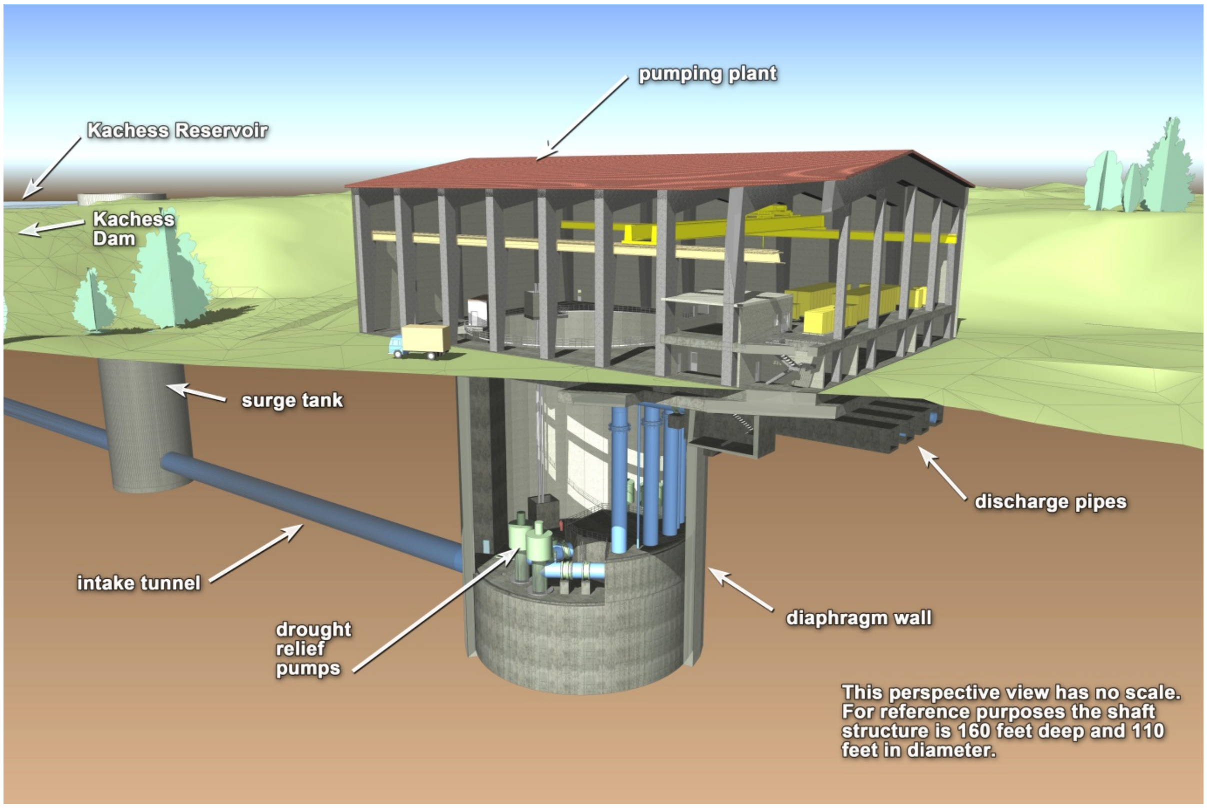



**Figure 2-9.** ***KDRPP South Pumping Plant* Conceptual Rendering**

### *2.4.1.3 Surge Tank*

A surge tank shaft would be a 50-foot interior diameter concrete-lined shaft that is approximately 200 feet deep. It would be just upstream of the pumping plant. *Alternative 3* 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.

### *2.4.1.4 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 discharge pool on the Kachess River.

### *2.4.1.5 Permanent Access Road*

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 USFS Road NF-4818.

### *2.4.1.6 Power Supply Substation and Transmission Line*

The power supply requirements for *Alternative 3* are the same as those for *Alternative 2*. The interconnection to the existing PSE 115 kV transmission line and Lake Easton Substation would be the same as described for *Alternative 3*. The power supply features for *Alternative 3* differ from those of *Alternative 2* as follows:

**New On-site Kachess Reservoir Substation**

The new on-site Kachess Reservoir substation would be located adjacent to the south pumping plant. The dimensions of the substation site would be about 125 feet by 150 feet (about 0.4 acre). 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.

**115 KV Transmission Line**

From the Easton substation to Kachess Dam Road, the transmission-line route would be the same as proposed for *Alternative 2* (Figure 2-8). However, when the transmission line reaches the Kachess Dam Access Road, it would remain on the existing transmission line right-of-way and cross over to the new on-site Kachess Reservoir substation; therefore, no new transmission line corridor and associated clearing would be needed for *Alternative 3*.

### 2.4.2 Construction

Construction of *Alternative 3* is expected to be completed over three construction seasons. For most facilities, construction would be similar to the description for *Alternative 2* (Section 2.3.2). Differing construction methods are described below.

#### *2.4.2.1 Site Preparation*

Site preparation activity would be similar to that described for *Alternative 2*. *Alternative 3* would involve clearing and grading approximately 44.5 acres for pumping plant construction, 36.5 acres of which would be restored to preconstruction conditions after construction is completed. Reclamation would decide how cleared trees would be handled after they have been cleared from the site. Most of the clearing would be for temporary roads, construction staging, and parking.

#### *2.4.2.2 Reservoir Intake and Tunnel*

The reservoir intake and tunnel would be constructed using a tunnel boring machine (TBM), which is similar to a large-diameter drill that excavates a circular tunnel and avoids surface disturbance and blasting. A TBM is typically built on site and 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 concrete and segmented 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 farther 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 would excavate to docking sleeve
- Disassemble and salvage TBM pumping plant

For *Alternative 3*, 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 hydromill with continuous excavation and slurry wall construction technique, where the excavated trench is filled first with a slurry and then with concrete (displacing the slurry) to construct the wall. The pumping shaft would be 145 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

#### *2.4.2.3 Surge Tank*

The surge tank shaft would be constructed using a hydromill 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 using grout injection to provide a relatively watertight permanent structure.

#### *2.4.2.4 Outlet Works and Kachess River Discharge*

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

#### *2.4.2.5 Power Supply Substation and Transmission Line*

Construction of the power supply substation and transmission line would be similar to *Alternative 2* (Section 2.3.2.7). However, a steep slope exists between the proposed substation and the south pumping plant, and thus a directional drill may be used to install casing to carry transmission and communication wires.

#### *2.4.2.6 Temporary Construction Facilities*

The temporary construction facilities would be constructed using the same methods described for *Alternative 2* (Section 2.3.2.8), but in different locations.

**Access Roads, Staging Areas, and Construction Parking**. Primary construction access would be from local roads to and from the I-90 Sparks Road Interchange at milepost 70. In addition to the existing dam access road, two new construction access roads would connect 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 mile 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 temporary concrete batch plant as described for *Alternative 2* 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 2.3.2.8).

**Construction Basin and Boat Launch**. The shallow and deep-water construction basins and boat launches described for *Alternative 2* (Section 2.3.2.8) are also being considered for *Alternative 3* (Figure 2-7).

**Spoils Disposal Area**. Similar to *Alternative 2*, two options for disposal of spoils from construction are considered (Section 2.3.2.8).

**Temporary Power Supply**. The local power grid or onsite generators would supply temporary power for construction of *Alternative 3*. An existing PSE power source is available near the south end of Kachess Reservoir. If electric power cannot be supplied from the existing power grid, generators would supply temporary construction power.

#### *2.4.2.7 Construction Scheduling and Sequencing*

Construction of *Alternative 3* is expected to last 3 years (see Table 2-2). The start date for construction is contingent on the proposals receiving congressional authorization and funding and completion of all permitting and obtaining necessary regulatory approvals.

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

- Mobilizing, clearing, grading, establishing construction facilities (7 months)
- Intake and fish screens (8 months)
- Intake tunnel (12 months)
- Surge tank (8 months)
- Pumping plant (12 months)
- Pumping plant building and equipment (9 months)
- Outlet works and discharge structure (6 months)
- Power supply substation and transmission line (15 months)

**Table 2-2. *Alternative 3 – 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 drilling for intake construction |
| Begin surge tank construction |
| **Year 2** |
| Finish intake construction |
| Add fish screens |
| Complete surge tank |
| Construct tunnel to intake |
| Construct pumping plant |
| Construct tunnel access shaft and begin construction 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 |
| Construct Narrows volitional fish passage roughened channel |
| **Subsequent years when reservoir is drawn down during drought relief pumping** |
| Extend Narrows roughened channel |

### 2.4.3 Typical Annual Operations

Operations would be the same as described for *Alternative 2* (Section 2.3.3).

### 2.4.4 Maintenance Activities

Maintenance would be the same as described for Alternative 2 (Section 2.3.4).

### 2.4.5 Volitional Bull Trout Passage Improvements

*Alternative 3* includes Volitional Bull Trout Passage Improvements at the Narrows identified for *Alternative 2*, Section 2.3.5. Construction and operation would be the same as described for *Alternative 2*.

### 2.4.6 Avoidance, Minimization, and Mitigation Measures

Project proponents would provide avoidance, minimization, and mitigation for impacts associated with *Alternative 3*. Specific measures are described in Section 2.3.6 above and in Chapter 4 at the end of each resource section.

## 2.5 Alternative 4 (Preferred Alternative) – Floating Pumping Plant

*Alternative 4 (Preferred Alternative) – KDRPP Floating Pumping Plant* differs from *Alternative 2* and *Alternative 3* in that the intake and pumping plant would be located on a floating barge and support facilities would be located at the south end of the reservoir, adjacent to Kachess Dam (Figure 2-10). For purposes of this environmental review, *Alternative 4* is identified as the Preferred Alternative (see Section 2.11). Roza and potentially other Proratable Entities would fund, design, construct, operate and maintain the Floating Pumping Plant.

The proposed floating pumping plant would be moored at the upstream end of the existing outlet channel in Kachess Reservoir. The floating pumping plant would discharge water to the existing outlet channel to be released through the existing Kachess Dam outlet structure. Pipelines from the floating pumping plant to the outlet channel would allow the use of the existing outlet works for release of pumped water into the Kachess River.

This section describes the proposed facilities and construction methods for *Alternative 4 (Preferred Alternative)*. More detailed technical description of the project design is included in the Proposed Kachess Drought Relief Pumping Plant, Floating Pumping Plant Project Features, Construction, Operations, and Maintenance technical memorandum (Reclamation and Ecology, 2017b). Figure 2-10 illustrates the facilities. Figure 2-11 provides a conceptual site plan of the floating pumping plant facilities. Volitional Bull Trout Passage Improvements at the Narrows is described in Section 2.5.5.

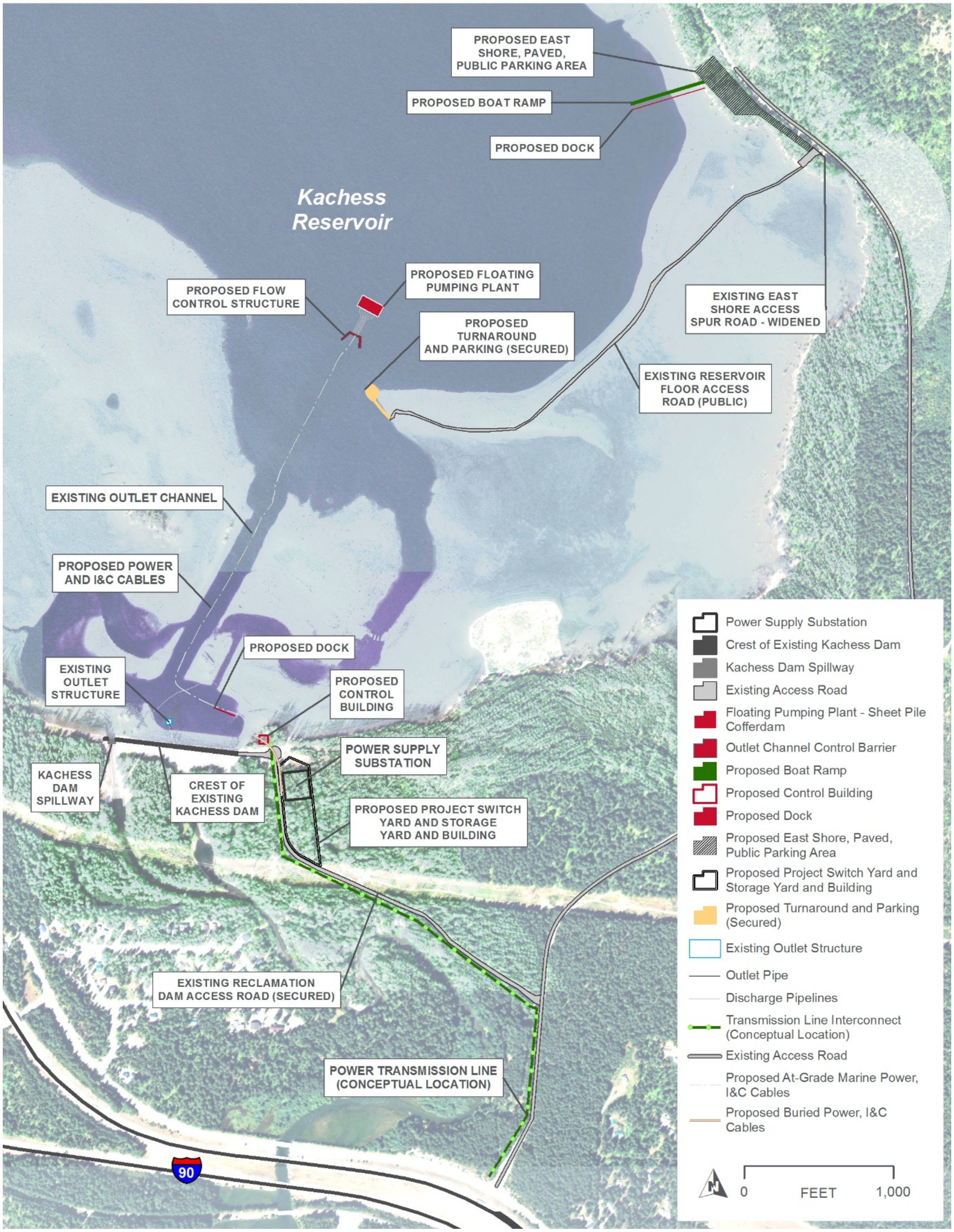



**Figure 2-10.** ***Alternative 4 – KDRPP Floating Pumping Plant* Overview**

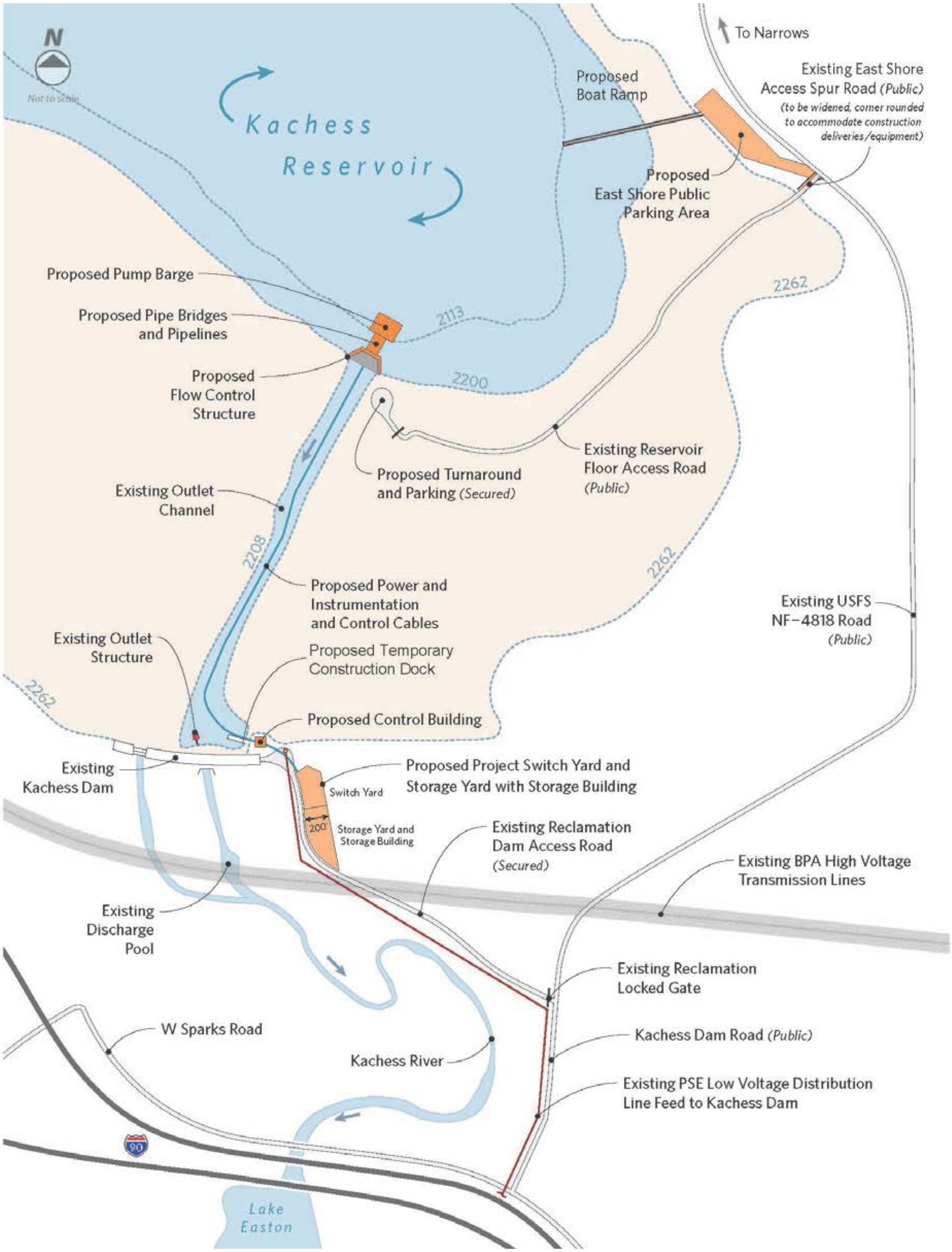



**Figure 2-11. Conceptual Site Plan - *Alternative 4 – KDRPP Floating Pumping Plant***

### 2.5.1 Facilities

#### *2.5.1.1 Pump Barge and Pumping Plant*

**Pump Barge and Anchorage.** The pumping plant would be located on a barge floating on the reservoir adjacent to the end of the existing outlet channel. The pump barge is a permanent project feature that would float on the surface of the reservoir fluctuating between maximum pool elevation and minimum pool during drought relief pumping, when occurring, see Figure 2-12, Figure 2-13, and Figure 2-14. The rectangular pump barge would consist of multiple metal pontoons and would have approximate dimensions of 80 feet wide by 90 feet long by 7 feet deep. The pump barge would be anchored to the reservoir floor by four anchorage lines attached to winches located in each of the four corners of the pump barge. The two anchorage chains on the south end of the pump barge would have anchorage points located immediately east and west of the flow control structure. The south end anchor points would be drilled, concrete-filled, steel pipe piles approximately 3 feet in diameter and drilled 60 feet deep into the reservoir floor. The two anchorage cables on the north end of the pump barge would terminate at a single, heavy manufactured steel anchor located approximately 3,000 feet to the north of the pump barge on the floor of the reservoir.

The pump barge would have a rigid structural deck that would support the pumps, motors, on-barge pipelines, anchorage winches, and associated power, and I&C equipment. The barge would also support the barge ends of the flexible pipe bridges. The pipe bridges and pipelines would convey discharge water from the south end of the pump barge to the flow control structure (Figure 2-10). The barge would support fish exclusion netting activities as well.

The pumps would be powered by an electric power supply from the proposed on-site Kachess Reservoir substation located adjacent to the existing Kachess Dam.

**Pumping Units.** Three vertical turbine pumps located on the pump barge would lift water from Kachess Reservoir to the existing outlet channel. These vertical turbine pumps would provide minimum flows in the Kachess River whenever the reservoir pool level falls below sufficient gravity flow elevation to meet downstream obligations. Upon initiation of drought relief pumping (at a reservoir water surface elevation of 2,200), the vertical turbine pumps on the pump barge would have the capacity to operate at approximately 1,500 cfs. At the full drawdown depth associated with withdrawal of up to 200,000 acre-feet of water from the reservoir at elevation 2,112.75, these pumps would have the capacity to operate at approximately 1,000 cfs. This pumping rate differential is attributable to the increasing height the pumps are required to lift the water as the reservoir water surface elevation drops during drought relief pumping. The pump intakes would be about 18 feet below the surface of the water (approximately 22 feet below the top of the pump barge deck).

A net to preclude fish from entering or becoming entrained in the pump intake would be attached to the perimeter of the underside of the pump barge. The net would be made of woven nylon and would have approximately quarter-inch (6.34 mm) openings. Weights secured to the net would cause the net to drape symmetrically beneath the pump barge and the pump intakes. The maximum flow velocity at the face of the fish net would be approximately 0.4 feet per second[5].

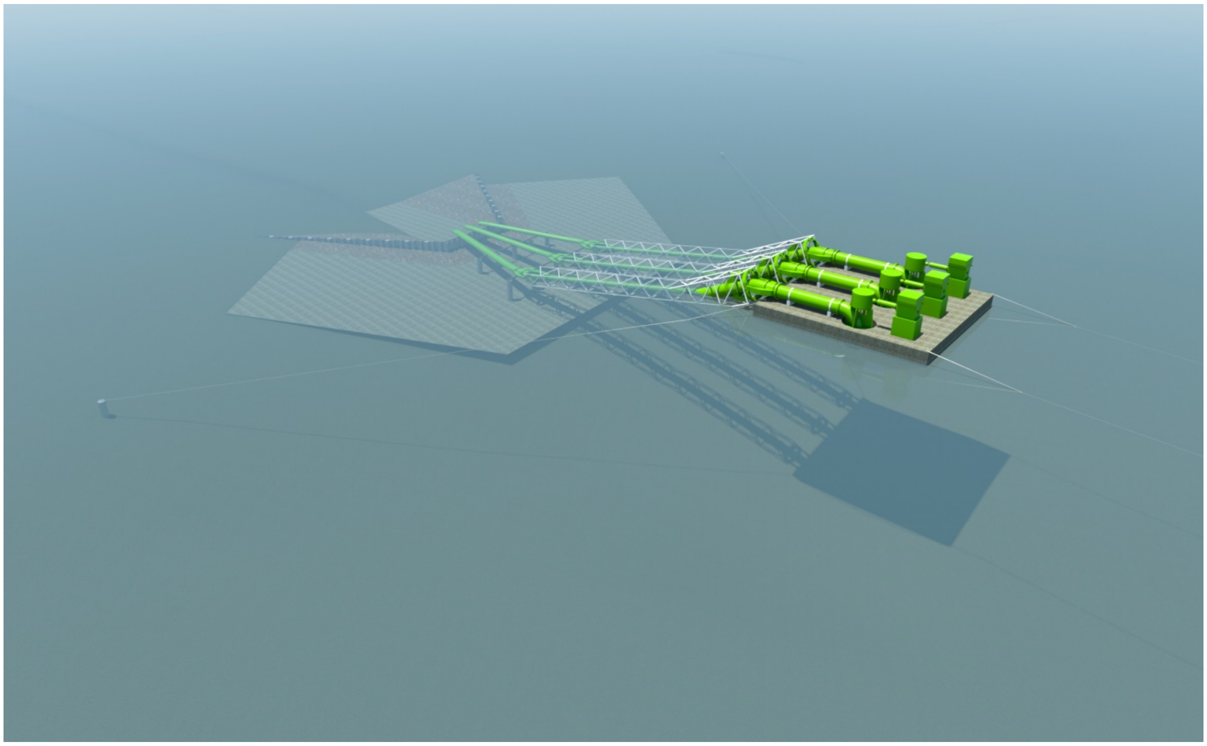


**Figure 2-12.** ***Alternative 4 – Floating Pumping Plant Conceptual Rendering – Maximum Pool***

[5] This velocity is consistent with NMFS fish screen criteria

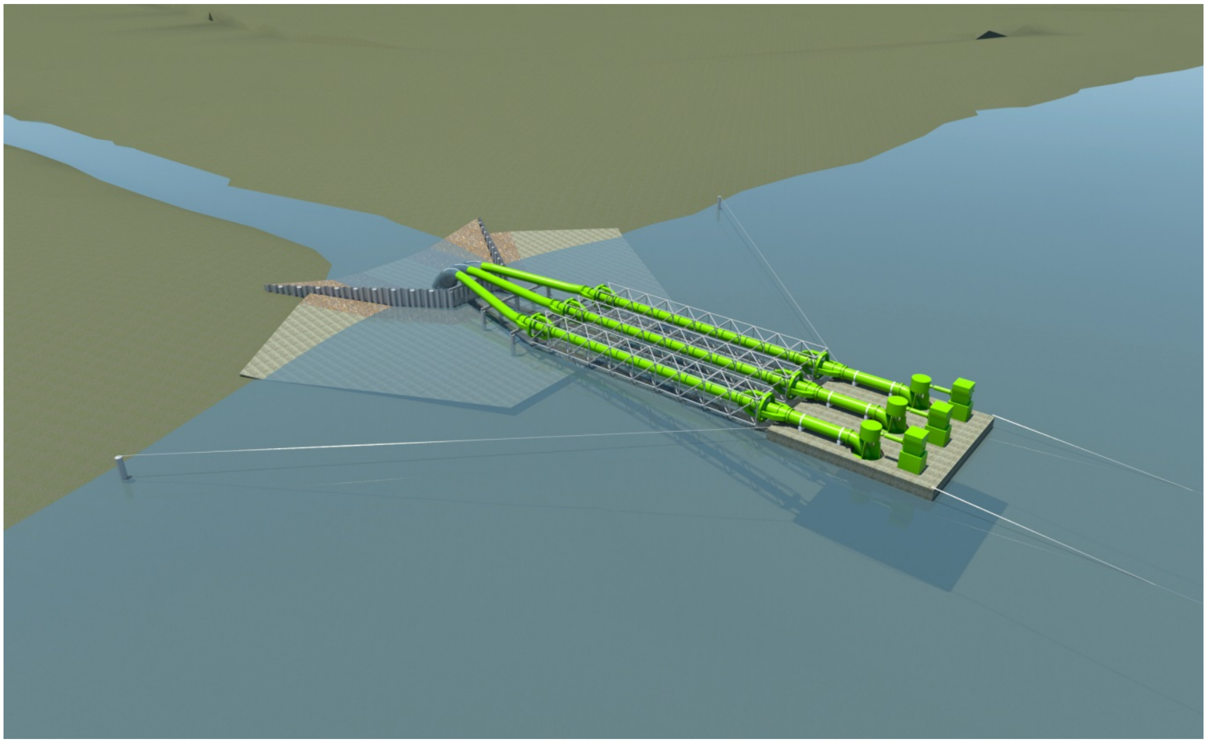


**Figure 2-13.** ***Alternative 4 – Floating Pumping Plant Conceptual Rendering – Start of Drought Relief Pumping***

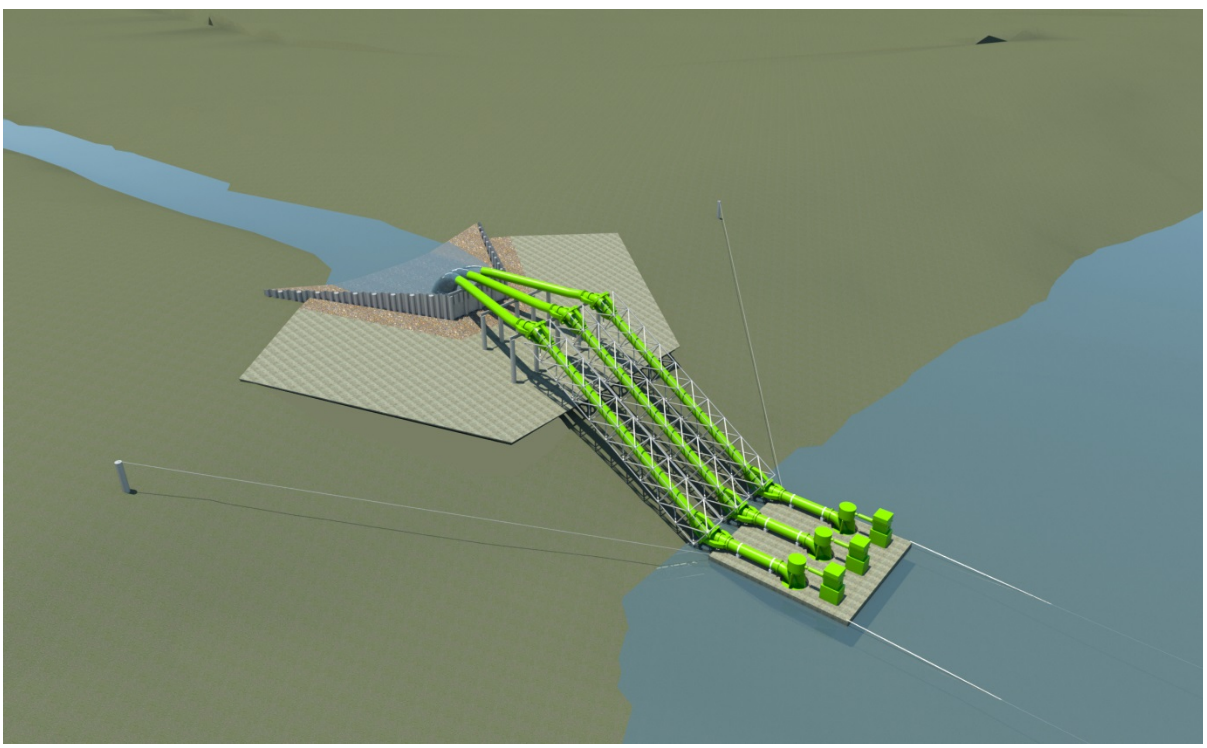


**Figure 2-14.** ***Alternative 4 – Floating Pumping Plant Conceptual Rendering – Minimum Drought Relief Pool***

#### 2.5.1.2 Discharge Pipelines and Pipe Bridges

**Discharge Pipelines.** Three approximately 6-foot-diameter, 300-foot-long discharge pipelines would connect to the vertical turbine pumps. The three pipelines would discharge into the existing outlet channel. The pipeline discharge location would have a concrete armored floor and sidewalls to dissipate the energy of the water released from the pipelines to avoid scour, erosion, and turbidity in the outlet channel. Water released to the existing outlet channel would flow by gravity to the existing Kachess Dam outlet structure for release into the Kachess River.

**Pipe Bridge.** The discharge pipelines would be supported by a pipe bridge. The pipe bridge would consist of a rigid portion and a flexible portion.

The 160-foot-long, flexible trussed pipe bridge would span from the south side of the pump barge to the north side of the rigid pipe bridge. A cardanic joint located at each end of the pipe bridge would connect each flexible trussed pipe bridge to the pump barge and rigid pipe bridge. This would allow the pump barge to move vertically through the full range of water surface elevations from the normal full pool elevation of 2,262 to the maximum drawdown pool elevation of 2,112.75 (a vertical range of 149 feet). The cardanic joints would also allow the pump barge to move modestly horizontally (in the east-west direction) to accommodate wind, wave, and ice loadings on the pump barge.

The 70-foot-long rigid pipe bridge would span from the south side of the flexible trussed pipe bridge to the north side of the flow control structure. Two sets of support columns (central and north) would each consist of five drilled, 3-foot-diameter pipe piles.

#### 2.5.1.3 Flow Control Structure

The 300-foot-long, 18-foot-tall flow control structure would be located across the north (upstream) end of the existing outlet channel at Kachess Dam. The flow control structure would have four large gates or steel stop log panels (each approximately 10 feet tall by 8 feet wide) to allow reservoir water to pass through the flow control structure when reservoir levels are above the elevation of the Kachess Dam outlet structure. The combined total flow area of these four openings (when fully opened) would be approximately 3,200 square feet. The gates or stop log panels would be located on the downstream (south) side of the flow control structure. These gates or stop log panels would be closed prior to initiating operation of the pumping unit for drought relief pumping operations to prevent water that is pumped from the reservoir into the outlet channel from flowing back into the reservoir. Thus, the flow control structure would serve as a barrier across the end of the outlet channel during operation of the floating pumping plant for drought relief pumping operations. The discharge pipelines described above would terminate at the top of the flow control structure and discharge directly into the existing outlet channel. The flow control structure would serve as both a cofferdam during construction for dewatering and as a permanent structure for project operation. With the flow control structure closed, the pool of water held within the discharge channel would be about 38 million gallons (117 acre-feet).

#### *2.5.1.4 Erosion Protection Features*

**Reservoir Floor Scour Protection.** The reservoir floor scour protection features would be located on the north side of the flow control structure and would prevent erosion near the flow control structure and the rigid pipe bridge foundations. The scour protection features would consist of articulated concrete mats that extend approximately 80 feet out from the toe of the flow control structure on the reservoir floor, from elevation 2,183 to approximate elevation 2,156. Approximately 20 feet of riprap would be located on the floor of the reservoir between the upper edge of the concrete mats and the flow control structure (approximate elevation 2,190).

**Outlet Channel Erosion Protection**. An approximately 18-inch-thick, 40-foot-wide, 100-foot-long concrete slab would be located on the floor of the outlet channel on the south side of the flow control structure. Appropriately sized riprap would be located on the floor and side slopes of the outlet channel to the east and west of the concrete slab. The riprap and slab would protect the floor of the outlet channel from erosion caused by the water discharged from each of the three discharge pipelines.

#### *2.5.1.5 Control Building and I&C Cables*

A single-story, approximately 3,200-square-foot concrete building would be located on the shoreline of Kachess Reservoir on the point of land near the left abutment of Kachess Dam. The control building would house the switch gear, instrumentation, and variable frequency drives for the pump motors and associated I&C and communication equipment.

Four power and I&C cable bundles would extend approximately 2,500 feet from the control building to the flow control structure along the floor of the outlet channel. From the base of the flow control structure, the cable bundles would then come up the back (south) side of the flow control structure and be secured to and extend across the pipe bridge and terminate at each pump motor on the pump barge.

#### *2.5.1.6 Storage Building and Yard*

The storage building and yard would be adjacent to the *Alternative 4 (Preferred Alternative)* switchyard. The single-story metal storage building would be approximately 10,000 square feet. The 3-acre storage yard would have a gravel surface. A 7-foot-tall, top-barbed, chain link fence would surround the storage yard and storage building.

#### *2.5.1.7 Boat Ramp and Dock*

*Alternative 4 (Preferred Alternative)* would include two marina facilities built for use during construction. Only one of the two would continue to be used for long-term operation upon completion of construction.

**East Shore Boat Ramp and Dock.** The east shore marina would consist of a 600-foot-long, 20-foot-wide boat ramp and adjacent dock. The boat ramp would be useable over the full range of reservoir operations (i.e., from a high pool reservoir elevation of 2,262 to a low pool elevation of 2,112.75). The boat ramp would remain as a permanent installation open to the public following construction of KDRPP.

**Temporary Outlet Channel Dock.** The temporary outlet channel dock would be about 200 feet long and 8 feet wide and would be adjacent to the control building. It would be located on the point of land immediately adjacent to the left abutment of Kachess Dam. This dock would be used during construction to gain access to the flow control structure, pipe bridges, and floating pumping plant barge. This dock would be removed upon completion of construction.

#### *2.5.1.8 Permanent Access Roads and Parking Lot*

**Reservoir Floor Access Road.** The existing 0.5-mile-long reservoir floor access road was established by recreational vehicles that enter the reservoir floor by way of the existing East Shore Access Spur Road. The road has a variable width ranging from about 12 to 20 feet wide. In 2015, the Yakama Nation cultural resource experts established an alignment along the existing reservoir floor access road that would avoid impacts on identified potential sensitive cultural and historical sites located along the alignment. In 2015, this alignment was surveyed and an acceptable permanent road alignment was identified. This alignment would be used to access *Alternative 4 (Preferred Alternative)*. A proposed new secured turnaround and parking area would be located at the far end of the reservoir floor access road, adjacent to the existing outlet channel. The road and turnaround and parking area would be used during construction and for ongoing floating pumping plant operation, maintenance, and repair activities whenever the reservoir water surface elevation is low enough to expose these features and allow their use. Access roads and the parking lot are identified in Figure 2-11.

**East Shore Boat Ramp Parking Area and Access Road.** A 1.5-acre gravel-surfaced parking area would be adjacent to and uphill from the boat ramp. Access to the proposed parking area for the east shore boat ramp would be provided by the existing, but widened, East Shore Access Spur Road by means of a new gravel surfaced road approximately 300 feet long and 30 feet wide running from the existing USFS Road NF-4818 to the proposed new parking area. The proposed new access road and parking area would initially be used for project construction. Once construction of *Alternative 4 (Preferred Alternative)* is complete, the parking area and boat ramp would be accessible to the public. Within the footprint of the parking area, additional facilities for the public may be installed, including a vault toilet and an informational kiosk. This parking area would also be used for ongoing floating pumping plant operation, maintenance, and repair activities.

**Proposed Narrows Access.** Access to the Volitional Bull Trout Passage Improvements would be the same as proposed for *Alternative 2* (Section 2.3.1.6).

#### *2.5.1.9 Power Supply Substation and Transmission Line*

The power supply requirements for *Alternative 4 (Preferred Alternative)* are nearly identical to the features required for Alternative 3, with the exception of having slightly smaller power requirement. The interconnection to the existing PSE 115 kV transmission line, Lake Easton Substation, and buried power lines to Kachess Dam would be the same as described for *Alternative 3*. The differences include that the new on-site Kachess Reservoir substation would be located adjacent to the existing Dam Access Road just south of the reservoir itself. And, buried power cables would transmit power from the Kachess Reservoir substation step-down transformers to the control building (approximately 200 linear feet), and from there to the individual barge-mounted pumping units.

#### *2.5.1.10 Volitional Bull Trout Fish Passage Improvements*

The Volitional Bull Trout Passage Improvements would be the same as proposed for *Alternative 2* (Section 2.3.5).

### 2.5.2 Construction

Construction of *Alternative 4 (Preferred Alternative)* would take approximately 1 year to complete.

#### *2.5.2.1 Floating Barge and Pumping Plant*

**Pump Barge.** At the minimum reservoir drawdown pool elevation (approximately 2,112.75), the pump intake and fishnet would be near the floor of the reservoir. To allow sufficient clearance for the pump intakes and fishnet, the floor of the reservoir beneath the floating pumping plant would be dredged. Dredging would involve leveling the reservoir floor beneath the floating pumping plant so that it had a constant, flat elevation, free of undulations or obstacles. Dredging would be accomplished using hydraulic suction dredges. Dredged material would be relocated to a nearby depression on the floor of the reservoir. A silt curtain would be used to reduce the turbidity associated with discharge of the dredged material.

Concurrent with dredging operations, prefabricated sections of the pump barge would be assembled on the exposed reservoir shore and welded together into three pump barge modules. Each module would be launched onto the surface of the reservoir. The three modules would then be joined together to form the completed pump barge. The pumping plant pumps, motors, pipelines, and ancillary equipment would be fitted onto the barge.

**Anchorage.** Tracked impact pile driving equipment would be used to install the two pipe pile bents for the anchorage structures on the south side of the pump barge. These two pile bents would be installed after the reservoir water surface elevation has been drawn down below approximate elevation 2,205. To install the eastern pile bent, the tracked impact pile driving equipment would be walked across the existing outlet channel just inside the downstream cofferdams used to construct the flow control structure. These pile bents would serve as the anchor point for each chain anchorage line. Once the anchorage structures have been installed and the anchors placed on the floor of the reservoir, the pump barge would be floated out to its final anchorage location and secured by the anchorage lines.

#### *2.5.2.2 Discharge Pipelines and Pipe Bridges*

The rigid portion of the pipe bridge would be supported by pipe piles. These pipe piles would be installed in the floor of the reservoir using barge-mounted vibratory pile driving equipment. Once installed, the tops of the pipe pile would be cut off at the required height and angle. Thick steel cap plates would be welded to the top of each pipe pile. Structural steel beams would be welded to the cap plates to form the rigid portion of the pipe bridge. The pipelines would be attached to the rigid portion of the pipe bridge and the cardanic joints located on the upstream end of each pipeline. The prefabricated sections of the flexible truss pipe bridge would be assembled on the east shore of the reservoir. Barge-mounted cranes would be used to position the flexible truss pipe bridge sections. These sections would be attached to the cardanic joints on the pump barge and the rigid pipe bridge.

#### *2.5.2.3 Flow Control Structure*

The flow control structure would be built across the upstream end of the existing Kachess Dam outlet channel and would consist of a vertical cantilever structure, referred to as a Combi-Wall system, made up of continuous, interlocking, alternating pipe pile and sheet pile panels. The pipe pile and sheet pile panels would be driven deep into the floor of the reservoir using barge-mounted vibratory pile driving equipment. During this phase of construction, reservoir water would be able to enter the existing outlet channel. The final panels would be installed when the reservoir water surface elevation is close to the existing minimum pool elevation of 2,192.75. Openings would be incorporated into the Combi-Wall structure to allow for installation of temporary flumes that would allow water to continuously flow out of the reservoir and through the flow control structure construction zone for release into the Yakima River system.

Two temporary cofferdams would be placed across the outlet channel upstream and downstream of the flow control structure during installation of the four flow control structure gates or stop log panels and the outlet channel erosion protection. The cofferdams would consist of sand bags that would be filled in the uplands and then be transported to the flow control structure location. The upstream cofferdam would be located approximately 10 feet north of the flow control structure and would have a crest elevation of about 2,195. The downstream cofferdam would be built approximately 125 feet south of the flow control structure and would have a crest elevation of about 2,192. To maintain minimum instream flows in Kachess River during this construction phase, a temporary flume capable of conveying up to 50 cfs would be installed to transport water from the reservoir to the outlet channel downstream of the construction site.

#### 2.5.2.4 Erosion Protection Features

**Reservoir Floor Scour Protection.** After the flow control structure gates or stop log panels have been installed, the reservoir floor scour-protection features would be placed on the north side of the flow control structure. Barge-mounted cranes would be used to place precast, preassembled articulated concrete mats on the reservoir floor. The mats would be placed around the pipe piles that support the rigid pipe bridge. Riprap would be placed on the floor of the reservoir between the upper edge of the concrete mats and the flow control structure.

**Outlet Channel Erosion Protection**. The erosion protection feature for the outlet channel would consist of a cast-in-place concrete slab. The slab would be placed on the floor of the outlet channel on the south side of the flow control structure. Appropriately sized riprap would be placed on both the floor and side slopes of the outlet channel to the east and west of the concrete slab. Premix concrete and riprap would be transported to the outlet channel by means of the existing spur and reservoir floor access roads.

#### 2.5.2.5 Control Building and I&C Cables

The control building would have cement masonry unit walls. The roof of the control building would have large, removable weatherproof hatches. These hatches would be located over each variable frequency drive to facilitate installation and maintenance of these features. A large road-drivable crane would be used to install the variable frequency drives and for maintenance activities.

Conduits would be buried along the outlet channel from the control building to the pump barge. The utilities and power supply cable bundles would be fed into the conduits. Once fully installed, each I&C cable bundle would be either contained within protective conduit or located permanently underwater on the floor of the outlet channel.

#### 2.5.2.6 Storage Building and Yard

The storage building would be an unheated, pre-engineered steel structure. The foundation and building would be installed later in the construction sequence after the area for staging is no longer needed.

#### 2.5.2.7 Boat Ramp and Dock

*Alternative 4 (Preferred Alternative)* would involve construction of one temporary boat dock. The temporary outlet channel boat dock would be secured to pipe pile, which would allow the docks to rise and fall along with the reservoir's water surface. This temporary boat dock near the control building would have approximately three pipe piles driven by barge-mounted vibratory pile driving equipment.

After the marine construction activities have been completed and the marine construction equipment demobilized from the site, the reservoir floor would be graded to a constant slope at the location of the east shore boat ramp. The lower portion of the boat ramp would extend from approximate elevation 2,195 up to 2,265 (a few feet higher than normal pool elevation).

This portion would be constructed using precast concrete grade beams 20 feet in length. The beams would be placed on the graded slope of the reservoir floor when the reservoir is drawn down. Crushed rock would be placed in the open spaces between each grade beam to prevent movement of individual grade beams. The upper end of the boat ramp would connect to the gravel parking lot area. The portion of the boat ramp below the existing low pool elevation would be constructed in subsequent years when the reservoir is drawn down during actual drought relief pumping.

#### *2.5.2.8 Permanent Access Roads*

**East Shore Access Road and Parking Lot Area.** The east shore access road and parking lot area would be the primary access and staging area for the marine construction activities. Marine construction equipment and materials would be transported to this area along the existing USFS Road NF-4818 and the new east shore access road, which would be approximately 26 feet wide and 300 to 500 feet long and have a gentle gradient. The new east shore access road would lead to the temporary staging area that would become the parking lot once construction is complete. This area would include appropriate temporary construction and permanent stormwater collection and detention facilities.

**Reservoir Floor Access Road.** Vehicle access across the floor of the reservoir would be required for construction of the anchorage pile bents, flow-control structure gates, and erosion protection features. Construction vehicles would access these features using the existing reservoir floor access road that extends from the spur access road to the east side of the existing outlet channel.

#### *2.5.2.9 Power Supply Substation and Transmission Line*

The grounding mat and foundations for the facilities in the switchyard would be constructed, and the high-voltage and ancillary equipment set in place. The grounding mat and foundations for the switchyard facilities and the high-voltage and ancillary equipment would be installed later in the construction sequence, after the area is no longer needed for laydown and staging. Construction of the transmission line would be similar to *Alternative 2* (Section 2.3.2.7).

#### *2.5.2.10 Temporary Construction Facilities*

**Temporary Access Roads, Staging Areas, and Construction Parking**. Primary construction access would be from local roads to and from the I-90 Sparks Road Interchange at milepost 70 and the Kachess Dam Road. Site preparation for construction would include establishing erosion and sedimentation control measures and clearing and grubbing. Clearing, grubbing, and rough-grading would be required for the switchyard, storage yard, operations building, east shore parking lot, access road, and the Narrows fish passage areas. Once grading has been completed, gravel surfacing would be placed, and perimeter security fences and gates (temporary or permanent, as appropriate) would be installed. The approximately 2.5-acre east shore access road and parking lot area would be used for laydown and staging of the large construction equipment needed for marine construction. The approximately

4-acre storage yard and switchyard area would be used for laydown and staging during construction of the other project features. Most deliveries arriving on highway-capable vehicles would be dropped off at the storage yard and switchyard area and stored until needed at specific onsite construction locations.

**Spoils Disposal Area**. Similar to *Alternative 2*, Reclamation is considering two options for disposal of spoils from construction (Section 2.3.2.8).

**Temporary Power Supply.** Temporary power supply during construction would be the same as proposed for *Alternative 2* (Section 2.3.2.8).

#### *2.5.2.11 Construction Scheduling and Sequencing*

Construction of *Alternative 4 (Preferred Alternative)* is expected to last 1 year and consist of four phases (Table 2-3). Features unnecessary for operating the floating pumping plant (i.e., extending the boat ramp and extending the Narrows roughened channel) would be completed in subsequent years, when the reservoir is drawn down further during drought-relief pumping. The start date for construction is contingent on the proposals receiving congressional authorization and funding, and completion of permitting and obtaining necessary regulatory approvals. It would be essential for Reclamation to modify operation of Kachess Reservoir during the 1-year construction period, and critical to the successful completion of marine elements and actions within the reservoir. Hydrologic conditions must be favorable to start construction within the reservoir. Upland construction activities would likely begin in March. Marine and reservoir floor construction activities would likely occur from April through October as the reservoir level is drawn down. Some construction activities would occur simultaneously.

**Table 2-3. Alternative 4 (*Preferred Alternative*) – KDRPP Floating Pumping Plant Approximate Construction Schedule**

| Year 1 |
|---|
| Phase 1 – Preconstruction |
| Order long lead-time equipment and other materials |
| Off-site fabrication of steel items and precasting of concrete structures |
| Phase 2 – Upland Construction (above elevation 2,262) |
| Clear and grade access roads and staging areas |
| Lay down temporary gravel surfacing in staging areas |
| Construct control building |
| Phase 3 – Marine Construction (between elevations 2,262 and 2,212.75) |
| Construct flow control structure |
| Install flow control structure vertical slide gates or stop log panels |
| Place reservoir floor erosion protection features |
| Construct pipe bridges |
| Dredge reservoir floor below the location of the pump barge |

| Year 1 |
|---|
| Assemble prefabricated sections of the pump barge |
| Install pumping and ancillary equipment on the pump barge |
| Install outlet channel boat dock |
| Bury conduits containing the I&C cables |
| Phase 4 – Reservoir Floor Construction (between elevation 2,212.75 and 2,192.75) |
| Install anchorage pile bents |
| Move the pump barge into position and anchor |
| Construct outlet channel erosion protection features |
| Construct east shore boat ramp |
| Construct Narrows volitional fish passage roughened channel |
| Construct storage building and switchyard |
| Complete site cleanup and restoration |
| **Subsequent years when reservoir is drawn down during drought relief pumping** |
| Extend boat ramp |
| Extend Narrows roughened channel |

### 2.5.3 Typical Annual Operations

Operations would be similar to those described for *Alternative 2* (Section 2.3.3). However, *Alternative 4 (Preferred Alternative)* could pump up to 1,500 cfs and would use the main pumping units to meet the minimum instream flow needs (instead of having separate, smaller pumps as used in *Alternatives 2* and *3*).

Water pumped into the outlet channel would create a large pool of water that can be slowly released at the required minimum instream flow rates through the existing gravity outlet works. This would be capable of maintaining minimum instream flows in the Kachess River between Kachess Dam and Lake Easton without the need for dedicated minimum instream flow pumps. During periods when the only release needed from Kachess Reservoir is for minimum instream flows, one of the primary pumps will be operated to periodically refill the outlet channel pool. The pool stored within the outlet channel would hold enough water to continue releasing minimum instream flows throughout a typical power failure.

### 2.5.4 Maintenance Activities

Maintenance would be similar to that as described for *Alternative 2* (Section 2.3.4); however, *Alternative 4 (Preferred Alternative)* would involve maintenance of the fish netting (instead of the trashrack and fish screens used for *Alternatives 2* and *3*), which would be inspected annually and repaired or replaced as needed.

### 2.5.5 Volitional Bull Trout Passage Improvements

*Alternative 4 (Preferred Alternative)* would include Volitional Bull Trout Passage Improvements at the Narrows identified for *Alternative 2*, Section 2.3.5. Construction and operation would be the same as described for *Alternative 2*.

### 2.5.6 Avoidance, Minimization, and Mitigation Measures

Project proponents would provide avoidance, minimization, and mitigation for impacts associated with *Alternative 4 (Preferred Alternative).* Specific measures are described in Section 2.3.6 and in Chapter 4 at the end of each resource section.

## 2.6 Alternative 5 – KDRPP with KKC North Tunnel Alignment

This FEIS evaluates three KDRPP alternatives that include the KKC North Tunnel alignment:

- *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* (Section 2.6.1)
- *Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment* (Section 2.6.2)
- *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment* (Section 2.6.3)

### 2.6.1 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

KDRPP East Shore Pumping Plant would be the same as described in Section 2.3, including Volitional Bull Trout Passage Improvements. In addition, *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* would include the Keechelus-to-Kachess conveyance to enhance refill of Kachess Reservoir during and following use of drought-relief pumping and manage flows for fish in the Keechelus Reach of the Yakima River (Figure 2-15).

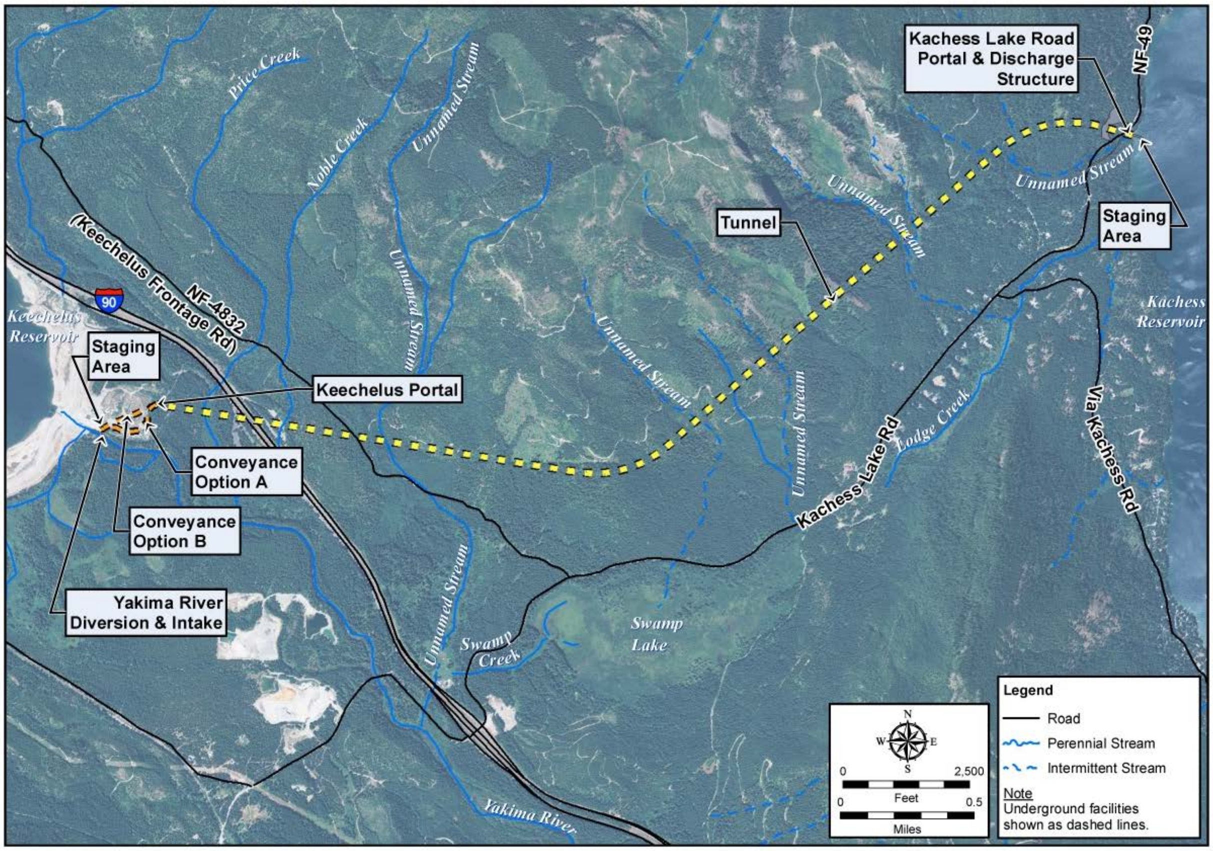



**Figure 2-15. KKC North Tunnel Alignment Overview**

KKC would consist 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 would extend east from the Keechelus Dam outlet and would discharge on the west shore of Kachess Reservoir. A more detailed technical description of the project design is included in the KKC Feasibility- Level Design Report (Reclamation and Ecology, 2015e).

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 its target pool elevation.

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

The KKC North Tunnel Alignment would extend east from the Keechelus Dam area to an outlet on the west shore of Kachess Reservoir (Figure 2-16). A single segment tunnel would be excavated upgradient from a portal at Kachess Reservoir. The tunnel design evaluated in this FEIS would curve slightly to the south to avoid a rock formation and would require deep excavation. Additional geotechnical information was considered in selecting the tunnel route. This FEIS assumes the curved tunnel alignment because it represents a worst-case scenario for environmental analysis. A straight tunnel alignment is also under consideration. All facilities would be the same regardless of whether the curved or straight tunnel alignment is selected.

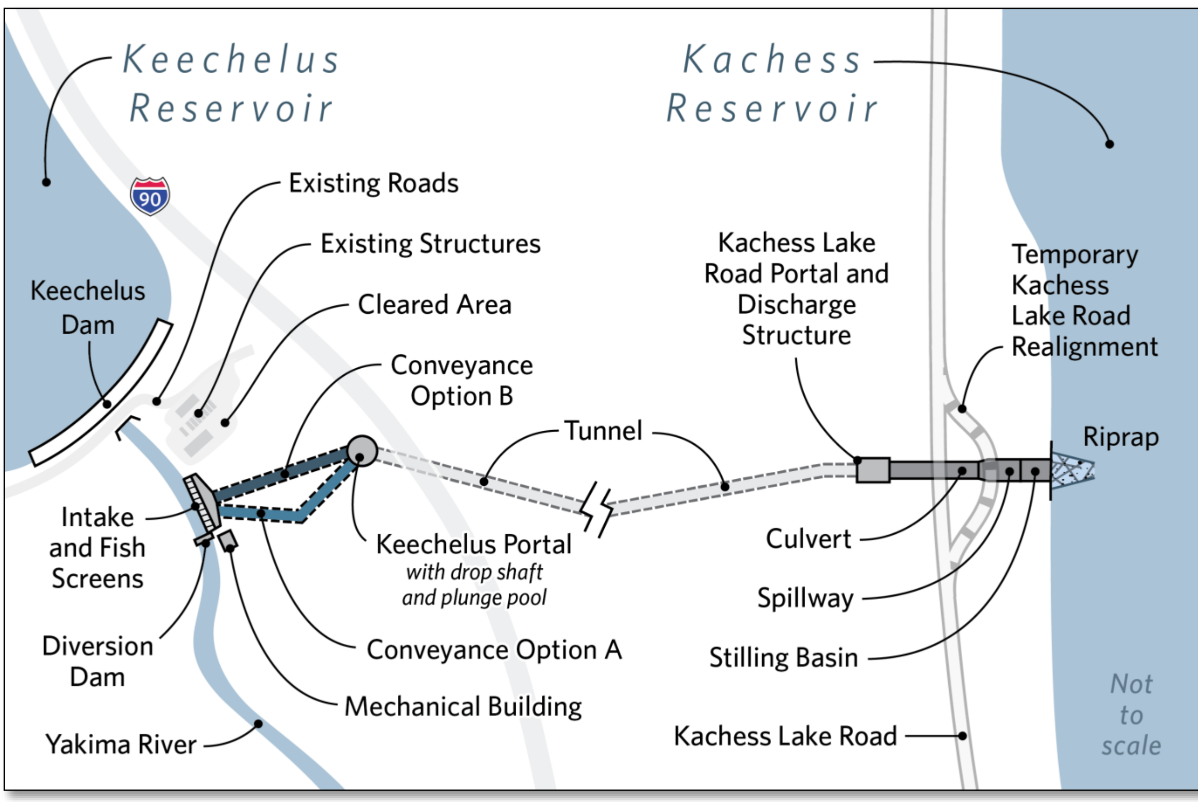



**Figure 2-16. KKC North Tunnel Alignment Conceptual Site Plan**

#### 2.6.1.1 Facilities

**Yakima River Diversion and Intake**

A new diversion dam and intake structure 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 on flow from the Keechelus, the desired flow to Kachess Reservoir, and the desired flow in this reach (Figure 2-16).

**Mechanical Building**

An approximately 18- 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 would be 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.

**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 2-16): 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). The pipeline would have an inside diameter of 8 feet and would be steel for Option B, but could be either steel or concrete for Option A. Either pipeline option would be approximately 30 to 50 feet below ground surface (bgs) at approximate elevation 2,415. Additional geotechnical testing would be conducted prior to final design to determine the feasibility of the tunneling option.

**Keechelus Portal**

The Keechelus portal would connect the conveyance pipeline to the western terminus of the tunnel (Figure 2-16). 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, 40 feet long, and 130 feet deep to accommodate pipe jacking equipment and 30-foot pipe sections during construction. Water from the conveyance pipeline would then flow freely into the plunge pool. Flow energy caused by the elevation difference between Keechelus and Kachess reservoirs would be dissipated through the drop shaft and plunge pool. The potential for hydropower generation was evaluated when developing the tunnel alternative, but it was

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

determined economically infeasible because of factors that included infrequent operation; variable flow rates; the need to add surge mitigation, a substation, and electrical transmission lines; and the need to continually maintain the hydropower facility. The tunnel to Kachess Reservoir would exit the drop shaft at approximately 120 feet bgs (elevation 2,330), at the top of the plunge pool.

**Tunnel from Keechelus Portal to Kachess Lake Road Portal**

The tunnel for KKC would be approximately 21,400 feet (4 miles) long and 12 feet in diameter. It would be a round, concrete-lined, gravity 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 2-16). The tunnel would have a slight downward slope to facilitate drainage.

**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 2-16). 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 visually 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 pass 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. 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 and safety purposes.

#### *2.6.1.2 Construction*

Construction of the KKC North Tunnel Alignment is expected to be completed in three construction seasons over three years. The following general construction activities would be included.

**Site Preparation**

Site preparation for construction would include establishing erosion and sedimentation control measures, clearing existing vegetation, and grubbing. Approximately 12.5 acres would be cleared near the proposed facilities for construction of KKC 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 to preconstruction conditions 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 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.

**Yakima River Diversion Fish Screens and Intake**

The Yakima River diversion dam, 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.

**Mechanical Building**

The 18-foot by 30-foot mechanical building would be constructed with concrete walls and a standing seam metal roof using conventional construction techniques. The existing gaging station would be removed and a new station would be installed downstream prior to construction of KKC.

**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 the trenchless method of installing 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 would 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 (8-foot)-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 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 on the pipeline’s final depth, 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 temporary 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.

**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.

**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 halfway 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.

**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 (Figure 2-16) for siting the tunnel power and ventilation support systems, and for receiving, storing, and loading tunnel muck onto trucks.

Approximately 1,200 feet of Kachess Lake Road would be temporarily realigned around the Kachess Lake Road portal area to maintain traffic access around the site during construction (Figure 2-16). The portal would be constructed using drill-and-blast methods and would be supported using rock bolts and shotcrete.

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 would be supported using rock bolts and shotcrete. The TBM and trailing gear would then be launched to bore the tunnel.

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

**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 on 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.

**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, would be used to stage tunnel mining equipment, and would 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 detoured around the Kachess Lake Road portal area 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 construction for realignment would take 3 to 6 months.

**Concrete Batch Plant**. A temporary concrete batch plant may be used during construction. The batch plant would be located at the 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 offsite location. Additional Kachess Lake Road portal cut-and-fill operations would be required for leveling the site, tunneling, and temporarily relocating Kachess Lake Road.

Disposal areas have yet to be identified; for this FEIS analysis, Reclamation assumed the offsite location would be within 10 miles of the Keechelus Reservoir. An existing quarry near Keechelus Dam may be available for disposing of the crushed material excavated from the tunnel. Depending on construction timing, WSDOT could potentially use the material as fill for the I-90 improvement project.

#### Construction Scheduling and Sequencing

The sequence of construction activity would depend on construction start dates, reservoir water surface elevations, contractor resources, weather, and construction activities associated with the proposed I-90 Phase 2 project. Table 2-4 presents one of the possible construction sequencing scenarios; more details are available in the KKC *Feasibility-Level Design Report* (Reclamation and Ecology, 2015e). Construction is expected to last approximately 3 years. The start date for construction is contingent on the proposals receiving congressional authorization and funding, and completion of all permitting and obtaining necessary regulatory approvals.

**Table 2-4. 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, and 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 |
| Complete installation of pipe between Yakima River intake |
| 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 |

#### *2.6.1.3 Typical Annual Operations*

Reclamation would operate KKC by releasing water from Keechelus Reservoir and diverting it from the Yakima River 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 on 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 mid to late irrigation season. This would enable Reclamation to maintain lower flows in the Keechelus Reach while still using Keechelus stored water to meet 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.

KKC would be operated in all years when Keechelus Reservoir has adequate water (i.e., it is above its target pool elevation) and when Kachess Reservoir has adequate space (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.

#### *2.6.1.4 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. A low-pressure air bubbler would be used to release a small constant air flow across the intake to reduce anchor ice and to assist in keeping floating debris moving across the screens.

For flow control, a programmable logic control (PLC) would be 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 and inspection 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.

#### *2.6.1.5 Volitional Bull Trout Passage Improvements*

*Alternative 5A* would include Volitional Bull Trout Passage Improvements at the Narrows identified for *Alternative 2*, Section 2.3.5. Construction and operation would be the same as described for *Alternative 2*.

#### *2.6.1.6 Avoidance, Minimization, and Mitigation Measures*

Project proponents would provide measures to avoid, minimize, and mitigate impacts associated with KDRPP and KKC. Specific measures are described in Section 2.3.6 and in Chapter 4 at the end of each resource section.

### 2.6.2 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

*Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment* would be the same as described in Section 2.6.1; however, KDRPP would be constructed at the south location, as described in Section 2.4, rather than at the east shore location.

### 2.6.3 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

*Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment* would be the same as described in Section 2.6.1; however, KDRPP would be constructed as a floating pumping plant as described in Section 2.5 rather than at the east shore location.

## 2.7 Estimated Cost of Alternatives

This section summarizes estimated costs of *Alternatives 2*, *3, 4* and of the KKC component of *Alternatives 5A, 5B,* and *5C* included in the KDRPP and KKC *Feasibility-Level Design Reports* (Reclamation and Ecology, 2017d; 2015e) , as well as the *Feasibility Planning Report KDRPP and Feasibility Planning Report KKC* (Reclamation and Ecology 2016b; 2016c). These estimates were prepared for those alternatives and include field costs, noncontract costs, interest during construction, operations, maintenance, replacement, and power costs. The cost estimate for *Alternative 4 (Preferred Alternative)* presented in this section is based on preliminary engineering and professional judgment.

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.

All of the costs discussed in this section have been expressed in present value terms. Values for Alternatives 2, 3 and 5 are expressed in uninflated, 2014 dollars. Values for *Alternative 4 (Preferred Alternative)* are expressed in inflated, 2020 dollars.

### 2.7.1 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 KDRPP nor KKC 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.

### 2.7.2 Estimated Costs for Action Alternatives

Table 2-5 lists the estimated total 100-year costs for the pumping plant in *Alternatives 2*, *3*, *and 4*. Table 2-6 lists the estimated total 100-year costs for the KKC North Tunnel Alignment element of *Alternatives 5A*, *5B*, and *5C*. All the action alternatives used the same assumptions and unit prices. Estimated costs presented represent a midpoint in a range of potential low and high costs; costs for *Alternatives 2* and *3* may vary by up to 15 percent lower or 30 percent higher and costs for *Alternative 4 (Preferred Alternative)* may vary by up to 30 percent lower or 50 percent higher.

**Table 2-5. Estimated Costs of KDRPP Alternatives**

| **Cost Categories** | ***Alternative 2 – KDRPP East Shore Pumping Plant***[a] | ***Alternative 3 – KDRPP South Pumping Plant***[a] | ***Alternative 4 – KDRPP Floating Pumping Plant***[b] |
|---|---|---|---|
| Field cost | 318,920,000 | 317,301,000 | 121,190,000 |
| Noncontract cost | 66,000,000 | 66,000,000 | 45,000,000 |
| **Subtotal: construction cost** | **384,920,000** | **383,301,000** | **166,190,000** |
| **Interest during construction** | 26,761,000 | 26,648,000 | **6,000,000** |
| Operations and maintenance cost (100 years) | 8,121,000 | 7,925,000 | 25,000,000 |
| Power costs (100 years) | 14,078,000 | 8,448,000 | 5,000,000 |
| Replacement cost (100 years) | 11,885,000 | 10,780,000 | 50,000,000 |
| **Subtotal: OMR&P** | **34,084,000** | **27,153,000** | **80,000,000** |
| **Total** | **445,765,000** | **437,102,000** | **252,190,000** |

[a] Reclamation and Ecology 2016b. Values in 2014 dollars.
[b] Field cost from Reclamation and Ecology 2017. Values in 2020 dollars. Noncontract and OMR&P costs based on professional judgment and comparison with equivalent costs for Alternatives 2 and 3.
O&M costs discounted at 3.375 percent
O&M = operations and maintenance

**Table 2-6. Estimated Cost of KKC**

| Cost Categories | KKC North Tunnel Alignment[a] |
|---|---|
| Field cost | 206,413,000 |
| Noncontract cost | 34,400,000 |
| **Subtotal: construction cost** | **240,813,000** |
| **Interest during construction** | **12,421,000** |
| Operations and maintenance cost (100 years) | 4,031,000 |
| Power costs (100 years) | 257,000 |
| Replacement cost (100 years) | 734,000 |
| **Subtotal: OMR&P** | **5,022,000** |
| **Total** | **258,256,000** |

[a] Reclamation and Ecology, 2016c.

All of the action alternatives include the volitional fish passage at Kachess Reservoir. Preliminary cost estimates range up to $23 million and will depend on the quality of bedrock at the lower end of the Narrows. This cost is additional to the costs listed above. Construction will be staged over a period of time when drawdown occurs and the reservoir bed is exposed at elevations that enable construction of the fish passage facility.

## 2.8 Other Alternatives Considered but Eliminated from Detailed Study

Reclamation and Ecology considered other alternatives and designs for both KDRPP and KKC prior to issuing the DEIS. 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.

### 2.8.1 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 II and the gravity tunnel that was one of the options proposed in the Integrated Plan PEIS.

#### *2.8.1.1 YRBWEP Phase 1 Proposals*

Reclamation evaluated proposals for accessing the inactive storage water at Kachess Reservoir in the 1980s. These proposals included a floating pump station, a deep-cavity pump station, and a siphon intake, each of which was technically infeasible.

#### *2.8.1.2 Gravity Tunnel*

The Yakima River Basin Study and 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 because of 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.

#### *2.8.1.3 Prior Consideration of Floating Pumping Plant*

As described in Section 1.5.1, a floating pumping plant was considered initially in a 2014 value planning study, but was rejected as an infeasible alternative in the DEIS. Roza's subsequent analysis of a temporary drought emergency floating pumping plant in the fall of 2015, performed in cooperation with Reclamation and Ecology, indicated that, due to advancements in the technology, a floating pumping plant could be a feasible alternative to achieve the KDRPP purposes and should be reconsidered as a feasible alternative that would provide the same benefits to the Yakima Basin as the South and East Shore KDRPP projects described in the DEIS.

### 2.8.2 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 and two other pipeline alignments and three tunnel alignments, as summarized below (Reclamation and Ecology, 2013c).

### Integrated Plan Pipeline Alternative

The pipeline alternative proposed in the Integrated Plan PEIS 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).

### 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 requiring 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 would 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 would 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.

### Tunnel Alternatives

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*. Reclamation and Ecology consider T2 as a viable alternative that could potentially be developed.

*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.

A south tunnel alternative was evaluated and presented in the DEIS as a reasonable KKC alternative. However, based on further consideration and input from resource management agencies, Reclamation and Ecology eliminated the south tunnel alternative from further consideration because, since the release of the DEIS, ongoing and planned construction of the WSDOT I-90 Snoqualmie Pass East Project has restricted the property and access that would be necessary to construct the KKC south alignment tunnel and portal at exit 62. This would prevent this alternative from being accomplished as described in the DEIS and within the schedule that is necessary for project implementation. In addition, this tunnel alignment would be longer and cost substantially more to implement than the KKC North Tunnel Alignment.

## 2.9 Comparison of Alternatives

Table 2-7 summarizes the facilities and construction requirements of *Alternatives 2, 3*, and *4 (Preferred Alternative)*. Figure 2-17 illustrates the locations of the KDRPP facilities for *Alternatives 2, 3,* and *4 (Preferred Alternative)*. Facilities and construction requirements for *Alternatives 5A, 5B*, and *5C* would be the same for the respective pumping plant component, but would also include the requirements of the KKC North Tunnel Alignment presented in Table 2-8.

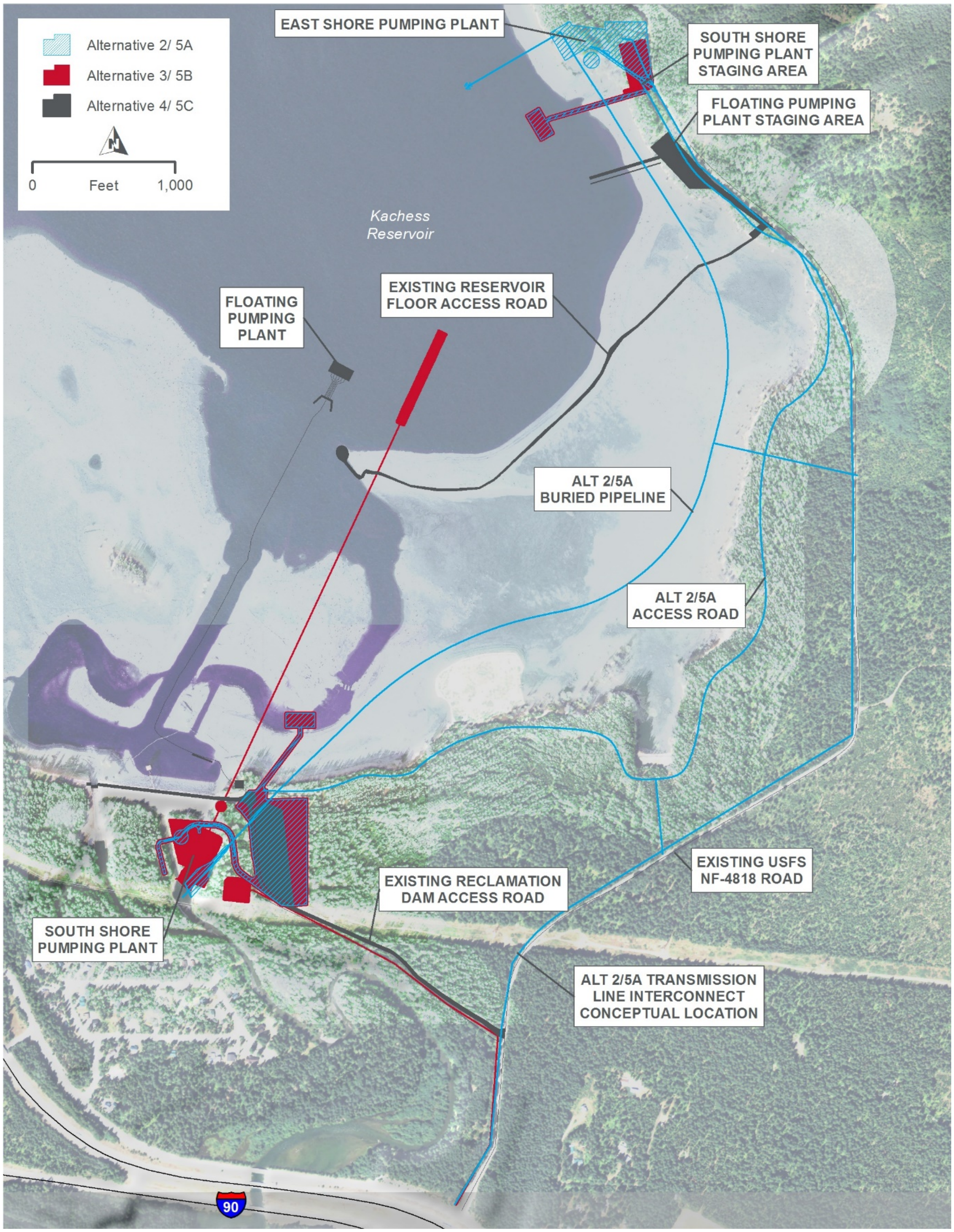



**Figure 2-17. Locations of the KDRPP Facilities for *Alternatives 2, 3, 4, 5A, 5B,* and *5C***

**Table 2-7. Summary of KDRPP *Alternatives 2, 3,* and *4:* Facilities and Construction**

| Component | *Alternative 2* | *Alternative 3* | *Alternative 4 (Preferred Alternative)* |
|---|---|---|---|
| Plant location | East shore of Kachess Reservoir | South of Kachess Dam | Barge at south end of Kachess Reservoir |
| Intake elevation | 1,989 feet | 2,110 feet | Variable based on water surface elevation |
| Intake distance from dam (approximate) | 5,000 feet | 3,200 feet | 3,000 feet |
| Intake tunnel size | 610 feet long, 15 feet in diameter | 3,250 feet long, 15 feet in diameter | Not applicable |
| Tunnel construction method | Rock mining | Tunnel boring machine | Not applicable |
| Primary pump unit elevation | 2,088 feet | 2,115 feet | Variable based on water surface elevation |
| Total area of disturbance | 75.5 acres (57.5 acres restored) | 44.5 acres (36.5 acres restored) | 7 acres (all permanent) |
| Surge tank size | 110 feet in diameter, 30 feet deep | 50 feet in diameter, 200 feet deep | Not applicable |
| Buried pipeline | 7,755 feet long | None | None |
| Length of new access roads | 2,425 feet | 690 feet | 300 feet |

**Table 2-8. Summary of KKC North Tunnel Alignment Facilities and Construction**

| Component | KKC North Tunnel Alignment |
|---|---|
| Size of tunnel | 21,400 feet (4 miles) long, 12 feet in diameter |
| Number of portals | 2 |
| Total area of disturbance | Option A – 12.5 acres (8.5 acres restored)<br>Option B – 8.5 acres (4.5 acres restored) |
| Portal and discharge structure location | Downstream of Keechelus Dam; and at Kachess Lake Road adjacent to Kachess Reservoir |
| Tunnel construction method | Tunnel boring machine |
| Tunnel construction access | Kachess Lake Road portal |
| Length of new permanent access roads | None |

## 2.10 Summary Comparison of Environmental Impacts of Alternatives

Table 2-9 compares the impacts associated with each of the alternatives. Chapter 4 provides additional information about potential impacts of all the alternatives.

**Table 2-9. Summary Comparison of Impacts**

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| **4.2 Earth** | | |
| Erosion associated with construction | Acres of land associated with ground disturbance | Ground Disturbance:<br>• *Alternative 1* – no ground disturbance<br>• *Alternative 2* – up to 75.5 acres<br>• *Alternative 3* – up to 44.5 acres<br>• *Alternative 4* – up to 7 acres<br>• *Alternative 5A* – up to 88 acres<br>• *Alternative 5B* – up to 57 acres<br>• *Alternative 5C* – up to 19.5 acres |
| Long-term reservoir rim stability and erosion associated with drawdown of Kachess Reservoir | Acres of exposed reservoir bed at elevation 2,112.75 | Under all action alternatives, drawdown associated with the operation of KDRPP would result in exposure of up to about 628 acres of reservoir bed at Kachess Reservoir. If reservoir rim stability or erosion is identified following drawdown, Reclamation would implement erosion control measures to minimize the impacts. |
| **4.3 Surface Water** | | |
| Water Supply | Years with prorationing below 70% out of 90 total years (more years is negative impact) | *Alternative 1* – 15 years below 70% proration<br>*Alternatives 2, 3,* and *4* – 13 years below 70% proration<br>*Alternatives 5A, 5B*, and *5C* – 13 years below 70% proration |
| Water Supply | Change in proration (higher proration is positive impact) | *Alternative 1* – No change<br>*Alternatives 2, 3,* and *4* – 4 years 70% proration reached; 2 years proration dropped below 70% (66% and 68% proration); up to 22% improvement in proration levels<br>*Alternatives 5A, 5B*, and *5C* – 4 years 70% proration reached; 2 years proration dropped below 70% (66% and 69% proration); up to 22% improvement in proration levels |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| Kachess Reservoir below gravity outlet operation | Days Kachess Reservoir below elevation 2,192.75 out of 91 years modeled (more days is negative impact) | *Alternative 1* – 0 days<br>*Alternatives 2, 3*, and *4* – 6,225 days (occurs in 34 years, 183 days average per year)<br>*Alternatives 5A, 5B*, and *5C* – 4,976 days (occurs in 32 years, 156 days average per year) |
| Kachess Reservoir below gravity outlet operation | Days Kachess Reservoir below elevation 2,150 (representing drought relief pumping of about 110,000 AF) out of 91 years modeled (more days is negative impact) | *Alternative 1* – 0 days<br>*Alternatives 2, 3*, and *4* – 2,075 days (occurs in 18 years, 115 days average per year)<br>*Alternatives 5A, 5B*, and *5C* – 1,557 days (occurs in 12 years, 130 days average per year) |
| Big and Little Kachess separation | Days Kachess Reservoir below elevation 2,220 out of 91 years modeled (more days is negative impact) | *Alternative 1* – 5,681 days (occurs in 73 years, 78 days average per year)<br>*Alternatives* 2, *3*, and *4* – 11,692 days (occurs in 76 years, 154 days average per year)<br>*Alternatives 5A, 5B,* and *5C* – 10,626 days (occurs in 76 years, 140 days average per year) |
| Bull trout tributary access | Days Kachess Reservoir below elevation 2,226 out of 91 years modeled (more days is negative impact) | *Alternative 1* – 9,196 days (occurs in 83 years, 111 days average per year)<br>*Alternatives* 2, *3*, and *4* – 14,551 days (occurs in 85 years, 171 days average per year)<br>*Alternatives 5A, 5B,* and *5C* – 12,838 days (occurs in 82 years, 157 days average per year) |
| Bull trout tributary access | Days Keechelus Reservoir below 2,466 feet out of 91 years modeled (more days is negative impact) | *Alternative 1* – 10,301 days (occurs in 80 years, 129 days average per year)<br>*Alternatives* 2, *3*, and *4* – 10,596 days (occurs in 81 years, 131 days average per year)<br>*Alternatives 5A, 5B,* and *5C* – 9,269 days (occurs in 69 years, 134 days average per year) |
| Keechelus Reach of Yakima River stream flow | Days in July that the Keechelus Reach of the Yakima River is at or below 500 cfs out of the period modeled (more days is positive impact) | *Alternative 1* – 42 days (occurs in 13 years, 3 days average per year)<br>*Alternatives* 2, *3*, and *4* – 110 days (occurs in 16 years, 7 days average per year)<br>*Alternatives 5A, 5B,* and *5C* – 2,677 days (occurs in 89 years, 30 days average per year) |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| **4.4 Surface Water Quality** | | |
| Increasing turbidity or temperature in the Kachess Reservoir pool | When the Kachess Reservoir pool level falls below the existing gravity outlet, turbidity or temperature exceeds State water quality standards | State water temperature criterion: 16°C (60.8°F)<br>*Alternative 1*: No change<br>All action alternatives: are less than 16°C(60.8°F)State turbidity criterion: State standard is maximum of 5 NTUs over background<br>*Alternative 1*: No change<br>All action alternatives: Localized, short-term exceedance of the standard |
| Increasing temperature in the Keechelus Reservoir pool | When the Keechelus Reservoir pool level is lowered due to water transfers to Kachess Reservoir, temperature exceeds State water quality standards | State water temperature criterion: 16°C(60.8°F)<br>*Alternatives 1*, *2, 3*, and *4:* No change<br>*Alternatives 5A*, *5B*, and *5C* are less than 16°C(60.8°F) |
| Increasing temperature downstream of Keechelus Dam or Kachess Dam | When water in the Yakima River or the Kachess River downstream from the dams exceeds the State water quality standard for temperature | State Water Temperature Criterion: 16°C(60.8°F)<br>*Alternative 1*: No change<br>All action alternatives: are less than 16°C(60.8°F) |
| **4.5 Groundwater Quantity and Quality** | | |
| Potential reduced access to groundwater supply due to change in water table impacted by Kachess pool level | Loss of groundwater supply at a level compromising property use due to a change in Kachess Reservoir pool level below elevation 2,192.75 at potentially affected wells | *Alternative 1* would not affect groundwater contributions to wells.<br>Construction of *Alternatives 2* and *3* may require minor dewatering and is not expected to decrease the water supply to wells.<br>Construction of *Alternative 4* is not expected to require dewatering or negatively affect groundwater contributions to wells.<br>Operation of *Alternatives 2, 3, 4, 5A, 5B,* and *5C* may result in temporary decreased groundwater levels in shallow aquifers adjacent to the reservoir, potentially decreasing the groundwater supply to some wetlands, springs, streams, or wells. |
| KKC construction activities lowering groundwater elevation levels | Groundwater elevations not returning to preconstruction groundwater levels | Construction of *Alternatives 5A, 5B,* and *5C* would require substantial dewatering and could result in temporary impacts on groundwater levels. |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| **4.6 Fish** | | |
| Water temperature | Increase in Kachess Reservoir and Kachess River water temperatures | *Alternative 1*– No change<br>*Alternatives 2*, *3*, , *5A,* and *5B,*– Decrease Kachess Reservoir surface temperatures 1 to2°C (2 to 4°F) in mid-August, increase surface temperatures up to 1.5°C (3°F) in late September<br>Alternatives 4 and 5C – Decrease Kachess Reservoir surface temperatures 1 to 2 °C (2 to 4 °F) in August-September<br>*Alternatives 2*, *3*, 4, *5A, 5B,* and *5C* – Decrease Kachess River water temperature |
| River flow | Seasonal decrease in Keechelus reach flow (spring 50% exceedance) | *Alternative 1* – 350 cfs<br>*Alternatives 2*, *3,* and *4* – 357 cfs<br>*Alternatives 5A*, *5B,* and *5C* – 288 cfs |
| River flow | Seasonal increase in Easton reach flow (summer 50% exceedance) | *Alternative 1* – 534 and 694 cfs in drought years (1994 and 2001)<br>*Alternatives 2*, *3* and *4* – 784 and 918 cfs in drought years<br>*Alternatives 5A*, *5B* and *5C* – 794 and 984 cfs in drought years |
| Increase in turbidity | Change in turbidity over State water quality standard (5 NTUs) | State turbidity criterion: State standard is maximum of 5 NTUs over background<br>*Alternative 1*: No change<br>All action alternatives: Localized, short-term exceedance of the standard |
| Decrease in hydraulic residence time | Reduction in food-base | *Alternative 1* – Baseline<br>*Alternatives 2*, *3, 4, 5A, 5B* and *5C* – Decreased hydraulic residence time and lower minimum reservoir levels would reduce available prey in Kachess Reservoir |
| Reduction in reservoir volume | Concentration of predatory fish and their prey in a smaller space causing predation rate and competition between predators to increase | *Alternative 1* – Baseline<br>*Alternatives 2*, *3, 4, 5A, 5B* and *5C* – lower minimum reservoir levels would cause more overlap between predator and prey species |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| Reduction in habitat complexity | Reduction in habitat complexity that substantially limits or eliminates habitat features used by native fish species at different life history stages (e.g., incubation, rearing, or spawning). Habitat features can be lost due to removal of riparian vegetation, inwater structures, or preventing natural habitat-forming processes | *Alternative 1* – Baseline<br>*Alternatives 2*, *3, 4, 5A, 5B* and *5C* – Construction of new facilities, staging areas and roads would reduce shoreline vegetation adjacent to Kachess Reservoir.<br>Lower minimum reservoir levels 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 measures to ensure no net loss of wetlands. |
| Disturbance from construction or operations | Increases in noise levels or vibrations that cause injury or displace fish from rearing, spawning, foraging, or using migratory corridor habitats | *Alternative 1* – Baseline<br>*Alternatives 2, 3, 4, 5A, 5B,* and 5C – during project construction increased noise levels may affect fish in Kachess Reservoir<br>*Alternatives 4* and *5C* – Operations of pumps may disturb fish near the floating pumping plant barge |
| Entrainment of fish during operations | Increased rate of entrainment of resident fishes from reservoir habitats into downstream habitats | *Alternative 1* – Baseline<br>*Alternatives 2, 3, 4, 5A, 5B,* and *5C* – increase risk of entrainment of juvenile or small resident fish (other than salmon and trout) |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| **4.7 Vegetation and Wetlands** | | |
| Changes to upland and riparian vegetation | Loss of native vegetation that decreases the extent, connectivity, or integrity of riparian or upland habitat in the watershed<br><br>Establishment of invasive plant species that decreases the extent, connectivity, or integrity of native riparian and upland habitat in the watershed<br><br>Loss of USFS Survey and Manage individual plants or suitable habitat<br><br>Loss of State sensitive individual plants or suitable habitat<br><br>Increase in extent, connectivity, or integrity of native riparian and upland habitat | *Alternatives 2, 3,* 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 implementation of invasive species monitoring and control.<br><br>*Alternatives 5A, 5B,* and *5C* would have a beneficial impact on riparian vegetation on the Keechelus reach of the Yakima River because of reestablishment of flows that mimic an unregulated flow regime.<br><br>Temporary or permanent loss of riparian and upland vegetation would be minor under any alternative. |
| Changes to wetlands | Loss of wetland acreage or impairment of wetland functions that cannot be mitigated.<br><br>Enhancement, restoration, or increase in extent of wetland habitat | *Alternatives 2* and *3* would cause a permanent loss of 0.7 acre and 0.5 acre, respectively, of wetlands and would be mitigated to ensure no net loss of wetlands.<br><br>*Alternatives 2, 3*, and *4* would cause prolonged drawdown of Kachess Reservoir, which may change wetland hydrology and vegetation communities along the reservoir shoreline during drought years. This impact would offset with the implementation of wetland monitoring and appropriate mitigation to ensure no net loss of wetlands.<br><br>Construction of the KKC North Tunnel under *Alternatives 5A*, *5B*, and *5C* is anticipated to result in minor impacts on wetlands. |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| **4.8 Wildlife** | | |
| Loss of wildlife habitat (forest and wetland) | Loss of ability to support activities of local species including habitation, breeding, foraging, or transient movements | *Alternative 2* would result in greater permanent habitat loss (18 acres) than *Alternative 3* (8 acres) and greater temporary habitat loss (57.5 acres compared with 36.5 acres).<br>*Alternative 4* would result in the smallest area of impact on wildlife habitat at 7 acres, similar to *Alternative 3* but with no temporary habitat loss because of the pumping plant being on the reservoir.<br>*Alternative 5A* would result in the greatest amount of permanent habitat loss (22 acres). *Alternative 5B* would result in loss of 12 acres, and *Alternative 5C* would result in loss of 11acres. |
| Alteration of shoreline habitat (littoral fringe) | Loss of shoreline habitat's ability to support local wildlife species including habitation, breeding, foraging, or transient movements | Shoreline vegetation could be altered under *Alternatives 2, 3* and *4* by changes in hydrologic conditions. |
| Disturbance of wildlife species from construction noise | Zones of impact for construction noise | *Alternatives 2, 3, 4, 5A, 5B,* and *5C* could result in direct harm or harassment of wildlife using habitat within or near the construction areas. |
| Disturbance of wildlife species from operational noise | Zones of impact for operations noise | *Alternatives 2, 3*, and *4* would create noise, light, and daily human activity in the vicinity of the pumping plant locations. *Alternative 4* would also have human activity at the east shore boat ramp and dock.<br>*Alternatives 5A*, *5B,* and *5C* would create noise, light, daily human activity in the vicinity of the KKC discharge. |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| **4.9 Threatened and Endangered Species** | | |
| **Bull Trout and MCR Steelhead** | | |
| Change in reservoir levels in Kachess low pool gravity outlet operation reducing growth of benthic invertebrates (invert) | Number of days at or below elevation 2,192.75 | *Alternative 1* – 0 days<br>*Alternatives 2, 3*, and *4* – 6,225 days (occurs in 34 years, 183 days average per year)<br>*Alternatives 5A, 5B*, and *5C* – 4,976 days (occurs in 32 years, 156 days average per year) |
| Change in reservoir levels in Kachess impeding fish passage (bull trout) | Number of days at or below elevation 2,220 (the elevation of separation of Big and Little Kachess) | *Alternative 1* – 5,681 days (occurs in 73 years of 91 modeled), 78 days average per year)<br>*Alternatives* 2, *3*, and *4* – 11,692 days (occurs in 76 years of 91 modeled), 154 days average per year)<br>*Alternatives 5A, 5B,* and *5C* – 10,626 days (occurs in 76 years of 91 modeled), 140 days average per year) |
| Increasing water temperatures affecting bull trout | Frequency and duration of water temperature increases in Kachess Reservoir | *Alternative 1*– no change.<br>*Alternatives 2*, *3*, 4, *5A, 5B, and 5C* – decrease Kachess Reservoir surface temperatures 1-2°C in mid-August, increase surface temperatures approximately 1°C in late September |
| Flows supporting spring MCR steelhead smolt out migration | Beneficial water temperature downstream of Kachess Dam | *Alternative 1*– no change.<br>*Alternatives 2*, *3*, 4, *5A, 5B and 5C* – decrease Kachess River temperatures from mid-August to early October |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| **Northern Spotted Owl** | | |
| Finding of effect per Endangered Species Act (50 CFR 402.02) | Blasting (92 dBA or higher) between March 1 to September 30 within 1 mile to nesting, foraging, or roosting areas used by northern spotted owl<br><br>Other construction noise disturbance between March 1 to July 15 within a quarter-mile of areas used by northern spotted owl including nest sites | All action alternatives would result in increased noise and human activity. No alternatives are expected to result in noise that would harm or injure threatened or endangered terrestrial species; however, noise exceeding the noise-only disturbance threshold may occur, resulting in adverse impacts under all action alternatives. *Alternatives 2* and *5A* would have construction activities closer to habitat potentially occupied by northern spotted owls and, therefore, would have the highest potential for noise impacts. |
| Loss or degradation of habitat that supports northern spotted owl | Acres of suitable habitat lost, including degraded during recovery from temporary impacts | Although there is critical habitat within the project area, project impacts on habitat would be considered to have no potential effects on northern spotted owls.<br>For Alternatives 2, 3, and 4, the amount of permanent vegetation removal within suitable habitat would be 18, 8, and 7 acres, respectively. Alternative 5A would have the largest area of vegetation removal (22 acres). |
| **4.10 Visual Quality** | | |
| 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. | Construction of the KDRPP East Shore Pumping Plant under *Alternatives 2* and *5A* and KDRPP Floating Pumping Plant under *Alternatives 4* and *5C* would substantially contrast with and 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. | Increased Kachess Reservoir drawdowns during drought years under *Alternatives 2, 3, 4, 5A, 5B,* and *5C* would change the overall landscape character and desirability from a recreation perspective. |
| Changes to instream flows (downstream effects) | Erosion of riverbanks or creation of flow pathways outside the range of existing flows. | None of the alternatives would have significant impacts; instream flows would be within the existing flow range. |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| 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). | Kachess Reservoir drawdowns during drought years under *Alternatives 2, 3, 4, 5A, 5B,* and *5C* could conflict with the established SIL/VQO. |
| **4.11 Air Quality** | | |
| Increased vehicle and equipment emissions and fugitive dust during construction or reservoir drawdown | Exceedance of EPA General Conformity *de minimis* thresholds | Construction would increase emissions and fugitive dust as stated below:<br>Alternative 2 – 2.5 to 22.6 tons per year<br>Alternative 3 – 1.1 to 13.1 tons per year<br>Alternative 4 – 0.1 to 6.0 tons per year<br>Alternative 5 – 2.1 to 34.4 tons per year |
| **4.12 Climate Change** | | |
| GHG emissions | GHG emissions >25,000 metric tons per year (Ecology, 2011) | 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 water supply to proratable water users | Percentage change in water supply metrics between historic hydrology and adverse scenario of climate change hydrology | Under all alternatives, climate change under the adverse scenario modeled would decrease proratable water supply during the high-demand period.<br><br>*Alternative 1*: Climate change would reduce water deliveries to proratable water users. A significant impact is not anticipated because water deliveries to proratable water users under *Alternative 1* would still be within the current operating range. However, climate change would increase the need for the action alternatives to meet water supply demands.<br><br>*Alternatives 2, 3,* and *4*: Climate changes under the adverse scenario modeled would result in decreased deliveries to proratable water users. However, climate change would result in increased demand for irrigation water. For this reason, there would be increased need for the extra storage and operational flexibility provided by KDRPP. A significant impact is not anticipated because KDRPP would continue contributing to supplying 70%of proratable water rights.<br><br>*Alternatives 5A, 5B,* and *5C*: Climate change impacts on the water supply benefits under the adverse scenario modeled would be similar to those described for *Alternative 1*. The impacts associated with KDRPP would be the same as described for *Alternatives 2*, *3*, and *4*. |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| Effect of climate change on stream flow | Percent change in stream flow metrics between historic hydrology and adverse scenario of climate change hydrology | Under all alternatives, the effects of climate change would reduce streamflows in the Keechelus reach, especially during the summer months. This reduction in flows would contribute to the goal of reducing the artificially high streamflows in the Keechelus reach during the summer.<br><br>*Alternative 1*: Climate change would reduce the achievement of streamflow targets in the Keechelus and Easton reaches, with the exception of increasing the achievement of streamflow targets in the Keechelus reach during the summer. A significant impact is not anticipated because streamflows would still be within the existing operating range.<br><br>*Alternatives 2, 3,* and *4*: Climate change would reduce the achievement of streamflow targets in the Keechelus and Easton reaches, with the exception of increasing the achievement of streamflow targets in the Keechelus reach during the summer. Compared with *Alternative 1*, during drought years summer flows in the Easton reach would be higher, while summer flows in the Keechelus reach would be lower. This is likely attributable to smaller proratable water supply deliveries during times of shortage and greater operational flexibility provided by the KDRPP. This reduction in flows would contribute to the goal of reducing the artificially high streamflows in the Keechelus reach during the summer. A significant impact is not anticipated because streamflows would still be within the existing operating range.<br><br>*Alternatives 5A, 5B,* and *5C*: Climate change would reduce the achievement of streamflow targets in the Keechelus and Easton reaches. However, July and August instream flow targets in the Keechelus reach would be met nearly 100 percent of the time. Therefore, a significant impact is not anticipated because operation of KKC is expected to continue to help reduce the artificially high summer Keechelus reach streamflows. The impacts associated with KDRPP would be the same as described for *Alternatives 2, 3,* and *4*. |
| **4.13 Noise** | | |
| Operation noise exceeding maximum permissible environmental noise levels | Increase in noise above maximum permissible environmental noise levels for residential and recreational uses (55 dBA) (WAC 173-60) | 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. |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| **4.14 Recreation** | | |
| Fishing opportunities | Loss of fishing access or reduction of fishing opportunities that exceeds current seasonal loss of use due to existing drawdown conditions | All alternatives would have impacts due to the effects of reservoir drawdown on fish in Kachess Reservoir and to the temporary loss of boating access during construction and increased distance from the shore for shore fishing at both reservoirs during drought and recovery years. |
| Usability of recreation at public and private sites | Reduction of usability of recreation 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 | All alternatives would have impacts on developed recreation at Kachess Reservoir because drawdown in drought years would reduce access to water and aesthetic quality. |
| **4.15 Land and Shoreline Use** | | |
| Change in land ownership | Lands acquired | Acquisition of private property could be necessary for the following action alternatives:<br>• *Alternative 2*: Construction of the pumping plant on the east shore of the Kachess Reservoir.<br>• *Alternative 3*: Construction of a small portion of the boat launch on the east shore of the Kachess Reservoir.<br>• *Alternative 4*: No or very minor acquisition of land.<br>Easements of land could be required for constructing the North Tunnel, portals, and connecting facilities for *Alternatives 5A, 5B,* and *5C*.<br>Additional acquisition of private real property or easements may be needed for access to the Volitional Bull Trout Passage Improvements at the Narrows. Reclamation would follow Federal guidelines for property acquisition. |
| Compatibility with applicable Federal, State, and local land use plans and regulations | Conflict or conformance with applicable land use plans or shoreline use designations | All alternatives would be compatible with applicable Federal, State, and local land use plans and regulations. |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| **4.16 Utilities** | | |
| Delivery of project electrical service | Total demand for pumping plant operations (up to approximately 30 MW) | Alternatives 2, 3, 4, 5A, 5B, and 5C would require approximately 30 MW of electrical power for operation of the pumping plant. For all alternatives, a transmission interconnection to the Puget Sound Energy (PSE) supply would be required to provide electric power for KDRPP pump operations. The power supply system would consist of four primary features: (1) an interconnection from the existing Puget Sound Energy transmission line near Easton, WA; (2) installation of a substation on Reclamation property adjacent to the Lake Easton outlet; (3) twin, buried, 34.5 kV transmission lines from the new Lake Easton substation to the Kachess Dam area; and (4) a new on-site Kachess Reservoir substation. This would not result in a substantial change to PSE's overall electrical power demand. Existing electrical systems are sufficient to supply the required electricity. The KKC North Tunnel with Alternatives 5A, 5B, and 5C would operate by gravity flow and would require no new power supply. Overhead PSE transmission lines and poles may need to be relocated for construction. |
| Interruption of existing utilities | Likely or anticipated interruption of any utility service during construction or operation | Interruption of services during construction is not anticipated for *Alternatives 2, 3, 4, 5A, 5B,* and *5C*. There would be no impacts on wastewater or telecommunications because construction and operation would not increase the demand for these utilities.<br>Construction of the KKC North Tunnel with *Alternatives 5A, 5B,* and *5C* would require temporarily relocating telecommunication lines in the Palouse to Cascades State Park Trail. This relocation would be temporary, short-term, and unlikely to interrupt or impact services. Any transmission line or pole relocation would be temporary, short-term, and unlikely to impact services. |
| **4.17 Transportation** | | |
| Increase in vehicle traffic levels or traffic flow disruptions | Increase of peak-period (am, pm, or both) construction roundtrips that could result in the delay or interruption of traffic or increase safety risks. | *Alternatives 2, 3, 4, 5A, 5B*, and *5C* – Impacts anticipated due to increased construction traffic; potential delay but no interruption to emergency service vehicle access; and minor increase in safety risk due to additional traffic |
| Construction vehicle traffic | Roadway deterioration | *Alternatives 2, 3, 4, 5A, 5B*, and *5C* – Potential deterioration of local roadways from construction traffic, restored following construction activities |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| **4.18 Cultural Resources** | | |
| Loss of integrity to historic property | Physical impact on an historic property, sacred site, or cultural resource through agents such as changes in shoreline drawdown and reservoir fluctuation (operation). | Additional 80-foot drawdown of Kachess Reservoir under *Alternatives 2, 3,* and *4* would expose portions of shoreline that are currently inundated, potentially exposing cultural resources to degradation, looting, or vandalism.<br>Under *Alternatives 5A, 5B,* and *5C* which results in additional drawdown at Keechelus Reservoir, additional shoreline impacts would be incurred. |
| Disturbance to a NAGPRA cultural item | 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 improvement activity (construction). | Construction at Kachess Reservoir under Alternatives 2, 3, and 4 could damage or alter one identified NRHP-eligible site and potentially additional sites.<br>Under Alternatives 5A, 5B, and 5C which adds construction at Keechelus Reservoir, additional impacts may be incurred to one identified NRHP-eligible site and potentially additional sites.<br>All of the Action Alternatives include construction of a volitional fish passage at the Kachess Narrows which has the potential to incur impacts to several historic properties. |
| Resources of tribal concern | An adverse effect would occur when a NAGPRA cultural item is displaced or removed.<br>An adverse effect would occur when an alternative would destroy or prevent access to an Indian Sacred Site. | No NAGPRA Items have been identified for any of the Alternatives.<br>No Indian Sacred Sites have been identified for any of the Alternatives. |
| **4.21 Socioeconomics** | | |
| Changes in output (the value of production) | Increase or decrease in sector output by 1% of overall economic activity | Improved water supply and agricultural output during drought years. |
| Changes in personal income | Increase or decrease in sector personal income by 1% of regional activity | For all action alternatives, impacts on income from construction and operation would be generally positive, but not significant. |
| Changes in employment | Increase or decrease in jobs in sector by 1% of regional activity | For all action alternatives, impacts on employment from construction and operation would be generally positive, but not significant. |

| Issue | Impact Indicator[1] | Impact Summary |
|---|---|---|
| Changes in demand or supply of temporary lodging | Availability of sufficient housing | For all action alternatives, sufficient housing is available. |
| **4.22 Environmental Justice** | | |
| Franklin County would experience high and adverse human health or environmental impacts | Disproportionate human health or environmental impacts | For all action alternatives:<br>• Earth and air quality- No impact<br>• Water resources, groundwater and water quality – No impact<br>• Socioeconomics - No data specific to Franklin County<br>• Health and safety – No impact |
| **4.23 Health and Safety** | | |
| Use, storage, or release of a hazardous substance or petroleum product | Evidence of presence of a hazardous substance or petroleum product in, on, or at a property | *Alternative 2* and *5A*. There is one location of concern, an underground storage tank, in the extended study area. Prior to acquiring land, a Phase I Environmental Site Assessment would be conducted to determine whether this is a REC or if whether other RECs are present.<br>*Alternative 3*, *4, 5B*, and *5C*. There are no known locations of concerns or RECs within the primary study area. |
| Safety during construction and operation | Risk of an accident | With all action alternatives, full drawdown would expose areas with steep slopes (greater than 20 degrees around Kachess Reservoir), which would present a safety hazard to people attempting to access the reservoir in those areas.<br>Exposure of formerly submerged boating hazards would have minor safety impact because boat launches would be above the reservoir pool elevation making access to the reservoir by boat difficult during low water periods. |
| Impacts to forest fire risk and firefighting capabilities. | Reducing access to water for firefighting. | For all action alternatives, operation of KDRPP would not increase fire risk in the area around Kachess Reservoir. The proposed new east shore boat ramp would provide year-round access to water in Kachess Reservoir for firefighting. |

[1] An impact indicator is a means of describing or quantifying the intensity of environmental effects to a resource or resource parameter.

| Resource | Impact Summary |
|---|---|
| **4.25 Cumulative Impacts Analysis** | |
| Surface Water, Reservoir Storage and Elevation, Allocations, Releases, Diversions | No cumulative impacts |
| Vegetation, Wetlands, Floodplains | Ongoing beneficial effect; no cumulative to wetlands or floodplains |
| ESA-listed Fish | No cumulative impacts |
| Land Use | No cumulative impacts |
| Transportation | Cumulative but temporary impact to traffic |
| Socioeconomics | Positive cumulative economic benefit |

## 2.11 Comparison of Alternatives and Selection of Preferred Alternative

Table 2-9 illustrates the differences among alternatives. The Preferred Alternative is Alternative 4. It incorporates a floating barge and support facilities located at the south end of the reservoir. The Preferred Alternative is the alternative Reclamation and Ecology believe would fulfill their statutory missions and responsibilities, giving consideration to environmental, technical, economic, and other factors described in Chapter 4, and best meets the purpose and need for action described in Section 1.3, which implements the preferred alternative from the PFEIS.

As part of identifying the preferred alternative, Reclamation and Ecology considered: (1) public, agency and tribal input during scoping, (2) comments received during the public comment periods for the DEIS and SDEIS, (3) technical information and analysis related to the proposal, and (4) cost associated with the alternatives. As shown in the table above, the resource impacts of the various Alternatives are both adverse and beneficial. In selecting the Preferred Alternative, Reclamation and Ecology gave special consideration to those resources with avoidance and minimization requirements under other laws, such as: Section 401, 402 and 404 of the CWA, ESA, and NHPA. While there are strengths and weaknesses for each alternative, on balance, Alternative 4 has the best balance of low-cost and fewest impacts to resources, while meeting the purpose and need. Therefore, Alternative 4 has been selected as the Preferred Alternative.

As noted in Section 1.4 Roza would fund, design, construct, operate, and maintain the Preferred Alternative. Roles and responsibilities of project proponents and partner agencies are described in Table 1-1.

In this FEIS the KKC north tunnel is not carried forward as part of the preferred alternative at this time. KDRPP can be implemented without KKC and at such time in the future it may be warranted KKC could be added to provide for greater operational flexibility.

# 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 action alternatives.  Chapter 4, Environmental Consequences, discusses the potential effects of the action alternatives 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, as appropriate.  Generally, the primary study area comprises the areas near the reservoirs 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 Integrated Plan FPEIS (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 action alternatives, web sites, published environmental and planning documents, books, journal articles, and communications with technical experts.  Information collected and provided by Reclamation, Ecology and other agencies since the release of the DEIS and SDEIS has been incorporated into this FEIS.

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 includes a description of Federal, State and local regulations and policies that relate to the primary study areas.  Section 1.10 and Chapter 5 describe other regulations with which Reclamation and Ecology must comply to implement the selected alternative.

# 3.2 Earth

Earth resources refer to geology and soil. For the purposes of this FEIS, 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
  - Kachess Reservoir from the current maximum pool elevation of 2,262 to the proposed operational minimum pool elevation of 2,112.75
  - Locations that would be affected by proposed facilities and other construction activities associated with KDRPP
  - The Narrows for construction of the Volitional Bull Trout Passage Improvements
- Keechelus Reservoir
  - Locations that would be affected by proposed facilities and other construction activities associated with KKC
- KKC North Tunnel Alignment
  - Areas overlying the proposed tunnel alignment, as described in Chapter 2

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 in this subsection relies on geotechnical memoranda prepared for this SDEIS, including summaries of geotechnical data collected in the area over the years (Reclamation and Ecology, 2014g, 2014h).

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). Additional information came from detailed mapping performed by Reclamation for areas south of Kachess Reservoir in 1911 (Reclamation, 1911a, 1911b) and south of Keechelus Reservoir in 2001 (Reclamation, 2001).

### 3.2.1 Regulatory Setting

The following subsections discuss applicable Federal, State, and local regulations that address earth resources in the study area.

#### *3.2.1.1 National Pollutant Discharge Elimination System – Construction Activity*

The 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) that disturb more than 1 acre of land 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 SWPPP before construction. The SWPPP typically contains BMPs, which include erosion control measures. Because the action alternatives 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 National Earthquake Hazards Reduction Act (NEHRPA) 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" (42 U.S.C. 7701). To accomplish this, the Act established the National Earthquake Hazards Reduction Program. The NEHRPA substantially 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 action alternatives 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 composed 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 sheared and disarranged 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 substantially affected the valleys by the movement of glacial ice and the deposition of materials as they advanced and then retreated. Advance deposits, such as glaciolacustrine, outwash and till, glacial deposits, and ice-contact sediment, are located throughout the area (Reclamation and Ecology, 2014h). The basement rock in the area is the Easton Schist, primarily composed 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, 2014h). 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.

Soil in the region consists largely of glacial deposits, post-glacial alluvial and 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 soil to erosion. For example, periods of heavy precipitation can create runoff patterns that greatly affect the amount and extent of erosion by concentrating runoff in areas of exposed soil.

#### *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 by Tabor et al. (2000). The glacial till is expected to have low permeability. Compact gravel and gravel are also present in the valley south of Kachess Reservoir and are likely glacial outwash (Reclamation, 1911a). Groundwater is expected to travel quickly through the very permeable glacial outwash.

South of Keechelus Dam, Reclamation mapping divides the alpine glacial deposits of Tabor et al. (2000) into 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. However, consolidation of these materials can result in lower permeability.

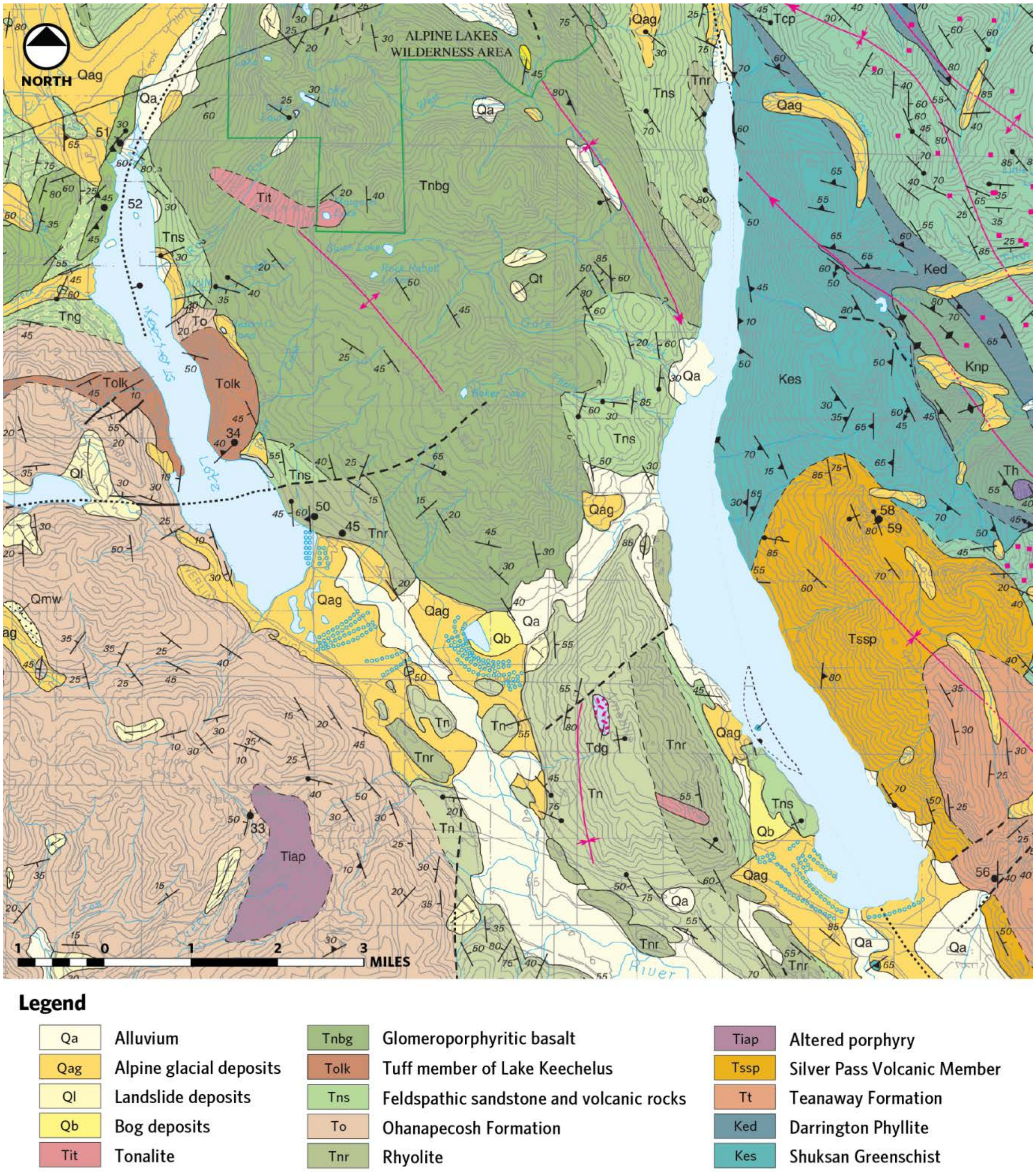



**Figure 3-1. Surface Geologic Units near Kachess and Keechelus Reservoirs (Source: Tabor et al., 2000)**

#### *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 bgs (elevation 2,413 to 2,435) and one boring drilled 500 feet east of the dam to a depth of 62 feet bgs (elevation 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 accounts for most of the 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 that 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 short length of shoreline. The bedrock on the east and northwest shorelines of Keechelus Reservoir is 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 makes up 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 substantial rates of groundwater flow, although locally higher permeability is possible in areas where weathering and fracturing have 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 makes up 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 substantial rates of groundwater flow, although locally higher permeability is possible in areas where weathering and fracturing have 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 makes up 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 substantial rates of groundwater flow, although locally higher permeability is possible in areas where weathering and fracturing have developed or where faulting and folding have occurred.

### 3.2.3 Kachess Reservoir Area

Kachess Reservoir was artificially impounded by Kachess Dam in 1911 at the site of a pre-existing natural lake situated behind 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 the fall of 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 Big 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 Kachess reach of the river have been exposed numerous times when the reservoir has been drawn down. Similarly, the side slopes around the remainder of Kachess Reservoir are routinely inundated and exposed on an annual cycle and have not exhibited notable erosion or slumping issues.

#### 3.2.3.1 Soil Deposits

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

Based on these sources, the following soils were identified in the Kachess Reservoir area:

- Glacial till – glacially compacted, dense to very dense, heterogeneous mixture of clay, silt, sand, gravel, and cobbles. This soil typically exhibits very low permeability with relatively high strength and is 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, 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 damsite indicate that a thick deposit of till underlies the damsite (Reclamation, 1996). Topography and geologic mapping indicate that other recessional moraines underlie the reservoir 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 and 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 consist of unstratified sediments (perhaps ice-contact deposits). Part of the slope may be underlain by stratified sediments (alluvium or outwash). A profile prepared by Shannon and 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 20 feet of very soft silt (lacustrine deposit) underlain by recessional lacustrine deposits occurs to a depth of 44 feet.

A Reclamation geologist inspected the surface geology of the Kachess Reservoir shoreline during low-pool conditions in November 2015, and found no evidence of substantial on-going erosion, such as rilling and gullying or steep wave-cut benches along the northwest and south shoreline areas inspected.

#### *3.2.3.2 Landslides and Slope Failure in the Kachess Reservoir 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 slope's geology, structure, and amount of groundwater affect its 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 substantial 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 Reservoir watershed, 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 substantially more 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 were 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 the reservoir or its operation.

No information is available for existing landslides within the rim of the reservoir and none have ever been reported. No information is available for the reservoir slopes between elevations 2,192.75 and 2,112.75 because the reservoir has not been drawn down that low since its original filling in 1911. Therefore, the materials assumed to make up 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 also originally a natural lake backed up behind a moraine 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 soil have been found adjacent to the reservoir (WSDOT and FHWA, 2005).

Bedrock near 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) dam abutment (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).

### 3.2.5 KKC North Tunnel Alignment

According to the preliminary technical memorandum (Reclamation and Ecology, 2014h), geologic mapping along the KKC North 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.

According to a search of records with the Washington Geological Survey, no coal mines are mapped near the project area (Reclamation and Ecology, 2014h). The nearest known coal mine is near Roslyn, approximately 12 miles east of the reservoir.

### 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 north 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. No historical North American accounts exist for 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.

In 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. The reported Richter magnitude for an earthquake represents the highest amplitude measured by the seismograph at a distance of 100 kilometers (approximately 62 miles) from the epicenter. Richter magnitudes vary logarithmically, with each whole number step representing a tenfold change in the amplitude of the recorded seismic waves. Earthquake magnitudes are also measured by their moment magnitude, 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 in 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 the Milton-Freewater area and in Walla Walla. Another notable earthquake for the Pacific 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, 2014g). The Straight Creek fault is not considered an active fault because there is no evidence for fault rupture and no definitive evidence for Quaternary activity anywhere along this structure (URS, 2012). However, other fault sources could potentially cause groundshaking in 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. Soil 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 action alternatives. It also describes the operations of Keechelus and Kachess reservoirs because they would be affected by the action alternatives. Operation of the remainder of the Yakima Project is described in detail in Section 3.3.5 of the Integrated Plan FPEIS (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.

Because the action alternatives could affect operations of Keechelus and Kachess reservoirs and flows in the mainstem Yakima and Kachess rivers, the primary study area is defined as the Kachess and Keechelus reservoir areas, the Kachess River, the Keechelus reach of the Yakima River (between Keechelus Dam and Easton), and Yakima River reaches between Easton and the Sunnyside Diversion Dam. The extended study area for surface water resources is the Yakima River basin as a whole due to Yakima Project operations (see Section 3.3.1 for additional details). The existing conditions in these water bodies are described below. River reaches discussed in this FEIS are listed in Table 3-1 and depicted in Figure 3-2.

### 3.3.1 Project Operations

Within the Yakima Project, Reclamation operates five reservoirs in a coordinated manner to provide for the surface water needs of irrigation entities entitled to project water, as well as to meet target flows at the Parker Gage and instream flow requirements at other locations. 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 Yakima River basin. No single reservoir is designated to supply the needs of any particular area, irrigation district, or Yakima Project division, although KRD is currently able to be served only by Keechelus and Kachess reservoirs since their headworks are upstream of the other reservoirs. The major storage facilities store runoff during the winter, spring, and early summer. This water is released 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 occurring in late June or early July but ranging more widely from early April to mid-August each year. KRD diverts flow at the diversion 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, 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.

**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/Umtanum 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 (Roza reach) | 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 Dam | 113.3 to 106.7 | 6.6 |
| Yakima River from Wapato Dam to Sunnyside Diversion Dam | 106.7 to 103.8 | 2.9 |
| Yakima River from Sunnyside Diversion Dam to Marion Drain (Wapato reach/Parker) | 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

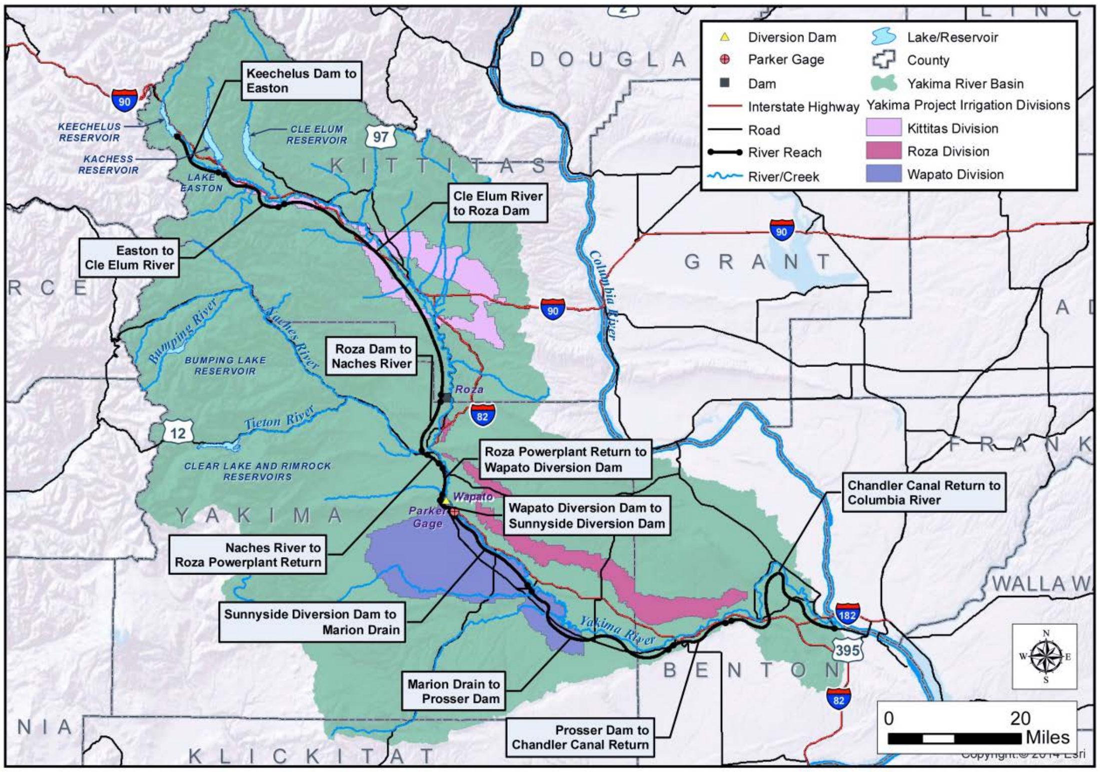



**Figure 3-2. Yakima River Reaches**

Figure 3-3 illustrates modeled flows for a typical year (November 2007 to October 2008) in the Yakima River Keechelus reach and Ellensburg reach (from Cle Elum River to Roza Dam). This period was chosen because it was near the average total water supply available (TWSA) for the period of record and generally shows the streamflow conditions that would occur resulting from reservoir operations in a typical (nondrought) year. The hydrographs shown in Figure 3-3 were obtained from the results of hydrologic modeling performed for the Integrated Plan PEIS (Reclamation and Ecology, 2012) 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 project alternatives. The hydrologic modeling is based on recent operations of the Yakima Project versus historical information, which has changed throughout the historic operation of the Yakima Project. Updated modeling information is further detailed in the *Hydrologic Modeling Report* (Reclamation and Ecology, 2017c).

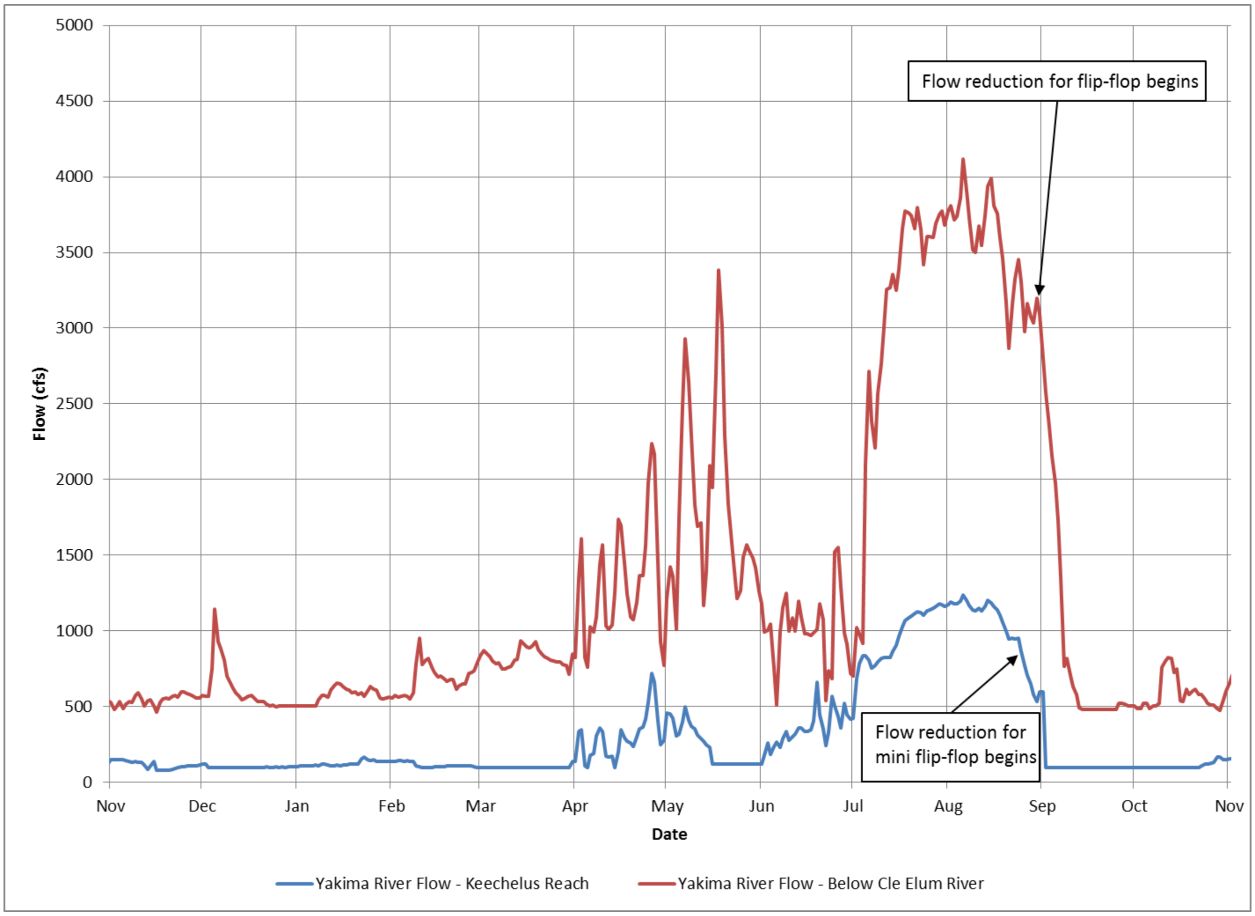



**Figure 3-3. Typical Streamflow Conditions in Upper Yakima River, November 2007 to October 2008**

### *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 in the Cle Elum River downstream from the dam and in the Yakima River downstream from the Cle Elum River to the city of Ellensburg, which requires Reclamation to release less stored water during the egg incubation period to protect spawning nests (redds). Figure 3-3 illustrates flow in the Yakima River downstream from the Cle Elum River during the flip-flop period. Flows decrease 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 for spring Chinook spawning in the Yakima River from Crystal Springs downstream to the Cle Elum River confluence. 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. Figure 3-3 illustrates the flow in the Keechelus reach during the mini flip-flop period. Flows decrease 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 reservoir 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 River basin storage system is designed to store runoff only from the current year and deliver it as needed for irrigation from April through October. In general, more carryover storage remaining in the system reservoirs on October 21 leads to better flow and water supply conditions during the following water year, particularly if the following year turns out to be a dry year. For example, relatively higher carryover storage generally improves spring Chinook incubation flow in the Yakima River below Keechelus and Kachess reservoirs.

#### *3.3.1.3 Target Flows*

The 1994 Title XII legislation (see Section 3.3.1.4) established formal target flows for the lower Yakima River during the irrigation season. Additionally, the Federal Court has directed Reclamation to consider fisheries in project operations, giving instream flows priority over storage. The System Operation Advisory Committee 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. Additionally, Table 3-2 includes model targets based on the BA that focus on spring pulses. All of the targets in Table 3-2 are minimum flows. Flows described at the Yakima River at Crystal Springs and at the 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] | Spring/Summer Minimum Target Flow and Dates |
|---|---|---|---|
| Keechelus Reservoir outflow | 80–120 cfs<br>Sep 1–Oct 20 | 80–120 cfs<br>Oct 21–Mar 31 | Pulse 300–500 cfs<br>Mid-Apr and mid-May |
| Yakima River – Crystal Springs to Lake Easton | 80–120 cfs<br>Sep 1–Oct 20 | 80–120 cfs<br>Oct 21–Mar 31 | Pulse 300–500 cfs<br>Mid-Apr and mid-May |
| Kachess Reservoir outflow | 1,400 cfs[2]<br>Sep 1–Oct 1 | 30–50 cfs<br>Oct 21–Mar 31 | 30 cfs<br>Apr 1–Jul 31 |
| Yakima River – Easton Dam to Cle Elum River | 190–300 cfs<br>Sep 10–Oct 20 | 190–300 cfs<br>Oct 21–Mar 31 | Pulse 520–1,220 cfs<br>Mid-Apr and mid-May[3] |
| Yakima River – Cle Elum River to Teanaway River | 400–800 cfs<br>Sep 10–Oct 20 | 300–700 cfs<br>Oct 21–Mar 31 | 1,020–2,715 cfs<br>Mid-Apr and mid-May[3] |
| Yakima River – Roza Dam to Wenas Creek | 300 cfs minimum<br>Jul 1–Oct 20 | 400–500 cfs<br>Power subordination target – all year | Not applicable[3,4] |
| Yakima River at Parker | 300–600 cfs<br>Jun 16–Oct 21<br>(irrigation season Title XII flow) | Not applicable | 300–600 cfs<br>Mar 15–Jun 15[3] |

Source: Reclamation, 2002 (modified by Lynch, 2014, and Reclamation and Ecology, 2017c)

1 Winter target flow would be carried past March 31 if supplemental flows are still needed to reach target.
2 Kachess Reservoir outflow is driven by downstream demand and reservoir levels. A flow of 1,400 cfs was used for modeling purposes.
3 Any added releases for pulse flows in April and May must not be diverted. These criteria have not been incorporated into the model yet. These changes will not impact storage or TWSA but would demonstrate better flows in this reach than shown in the model results.
4 Power subordination flows, since 2014, below Roza Dam have been revised upward to 1300 cfs. These changes will not impact storage or TWSA but would demonstrate better flows in this reach than shown in the model results.

#### 3.3.1.4 Title XII Target Flows

Phase II of the 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 TWSA. As shown in Table 3-3, Title XII streamflow targets range from 300 to 600 cfs depending on the estimated TWSA.

**Table 3-3. Title XII Target Flows**

| TWSA (million acre-feet) | | | Parker and Prosser Gage Flows (cfs) | |
|---|---|---|---|---|
| May–Sept | Jun–Sept | Jul–Sept | Title XII Minimum Flow Past Parker Gage July–September Demand (acre-feet) | |
| 2.90 | 2.4 | 1.9 | 600 | 117,000 |
| 2.65 | 2.2 | 1.7 | 500 | 100,000 |
| 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 increase 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 resulted in an increase of 85 cfs in Title XII target flows during nonprorated water years and an additional 30 cfs for YRBWEP POD change for a total increase of 115 cfs 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 |
|---|---|---|---|
| WIP | 305,613 | 350,000 | 655,613 |
| Sunnyside Division | 289,646 | 157,776 | 447,422 |
| Roza Irrigation District | 0 | 393,000 | 393,000 |
| KRD | 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

The Sunnyside Valley Irrigation District and the Yakima-Tieton Irrigation District have proratable entitlements, but have stated that they do not foresee needing additional water at this time (Reclamation and Ecology, 2011f). Roza, 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 affected to the same level as Roza, WIP, and KRD because it is downstream from the Parker gage near the downstream end of the Yakima River basin. Most of KID's water supply is derived from return flow from upstream irrigation districts, which improves the reliability of its 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). In 2015, proratable water users received a 47 percent supply (Reclamation, 2015).

### 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 just east of Snoqualmie Pass. Completed in 1917, this dam is 128 feet high and impounds 157,800 acre-feet at elevation 2,517 (Reclamation, 2002). Table 3-5 provides additional data on its size and operations.

**Table 3-5. Keechelus Dam and Reservoir Data**

| Dam Feature | Size/Amount |
|---|---|
| Reservoir drainage area (square miles) | 54.7 |
| Mean annual precipitation (inches) | 69.3 (1981-2010) |
| Maximum depth (feet) | 310 |
| Mean depth (feet) | 96 |
| Total volume at maximum pool level (acre-feet) | 162,000 (approximate) |
| Active storage capacity (acre-feet)[1] | 157,800 (1926-2015) |
| Average annual runoff (acre-feet) | 244,000 |
| Ratio of runoff to capacity | 1.55 to 1 |
| Sept 30 minimum historical storage (acre-feet)[2] | 4,800 (1931) |
| Sept 30 average historical storage (acre-feet)[2] | 41,000 |
| Sept 30 maximum historical storage (acre-feet)[2] | 126,900 (1949) |

Note: Mean depth calculated by dividing total storage capacity by surface area of reservoir
[1]Active storage capacity is the water accessible to the gravity outlet.
[2]Historical storage refers only to active storage, not the full volume of water in the 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 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 late August 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 reservoir. 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 existing condition (historic modeled flows with current operating conditions) water level in Keechelus Reservoir for the period of November 1, 1998, to November 1, 2003. This period includes the drought year of 2001 and years more representative of average and wet runoff conditions, illustrating typical operations over different types of years (drought, average, and wet). Pool levels fluctuated 85 feet between approximate elevations 2,517 and 2,432 during this period, with the lowest level occurring during the 2001 drought year. Table 3-6 provides data on reservoir elevations from 1926 to 2015 and for two recent drought years (1994 and 2001). Those two years represent reservoir elevations that occur at the end of an extended drought (1994) and a single-year drought (2001).

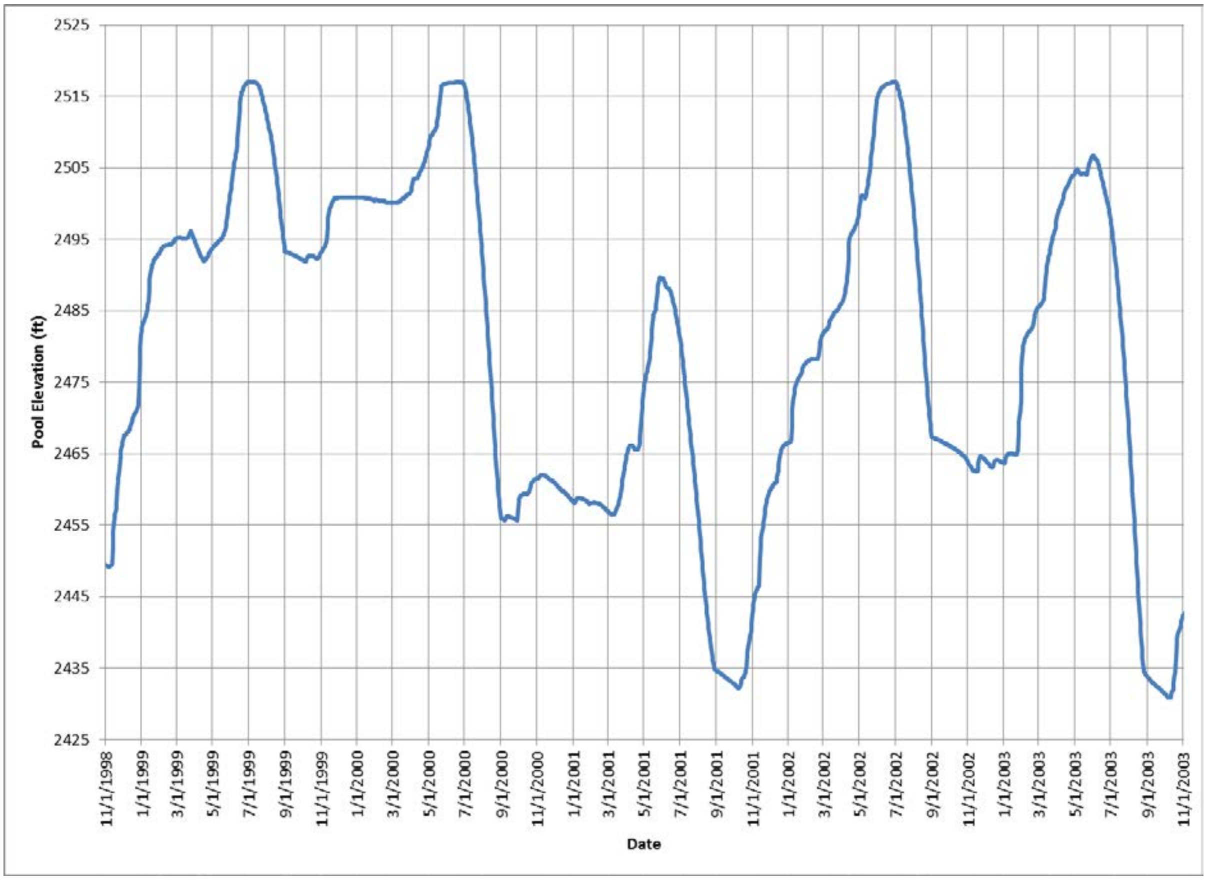



**Figure 3-4. Modeled Keechelus Reservoir Operating Elevations, November 1998 to October 2003**

**Table 3-6. Keechelus Reservoir Operating Elevations**

| Existing Condition | Elevation (feet) |
|---|---|
| Mean (1926–2015) | 2,479.5 |
| Mean of annual maximum (1926–2015) | 2,509.1 |
| Mean of annual minimum (1926–2015) | 2,445.8 |
| **Drought Years** | |
| Mean (1994) | 2,453.4 |
| Maximum (1994) | 2,487.3 |
| Minimum (1994) | 2,430.7 |
| Mean (2001) | 2,459.5 |
| Maximum (2001) | 2,489.6 |
| Minimum (2001) | 2,432.2 |

### 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, and Stampede creeks and other smaller streams) recedes. Figure 3-5 illustrates the flow in the Keechelus reach of the Yakima River for November 1, 1998, to November 1, 2003. This period includes the drought year of 2001 and years more representative of average and wet runoff conditions, illustrating typical operations over different types of years (drought, average, and wet).

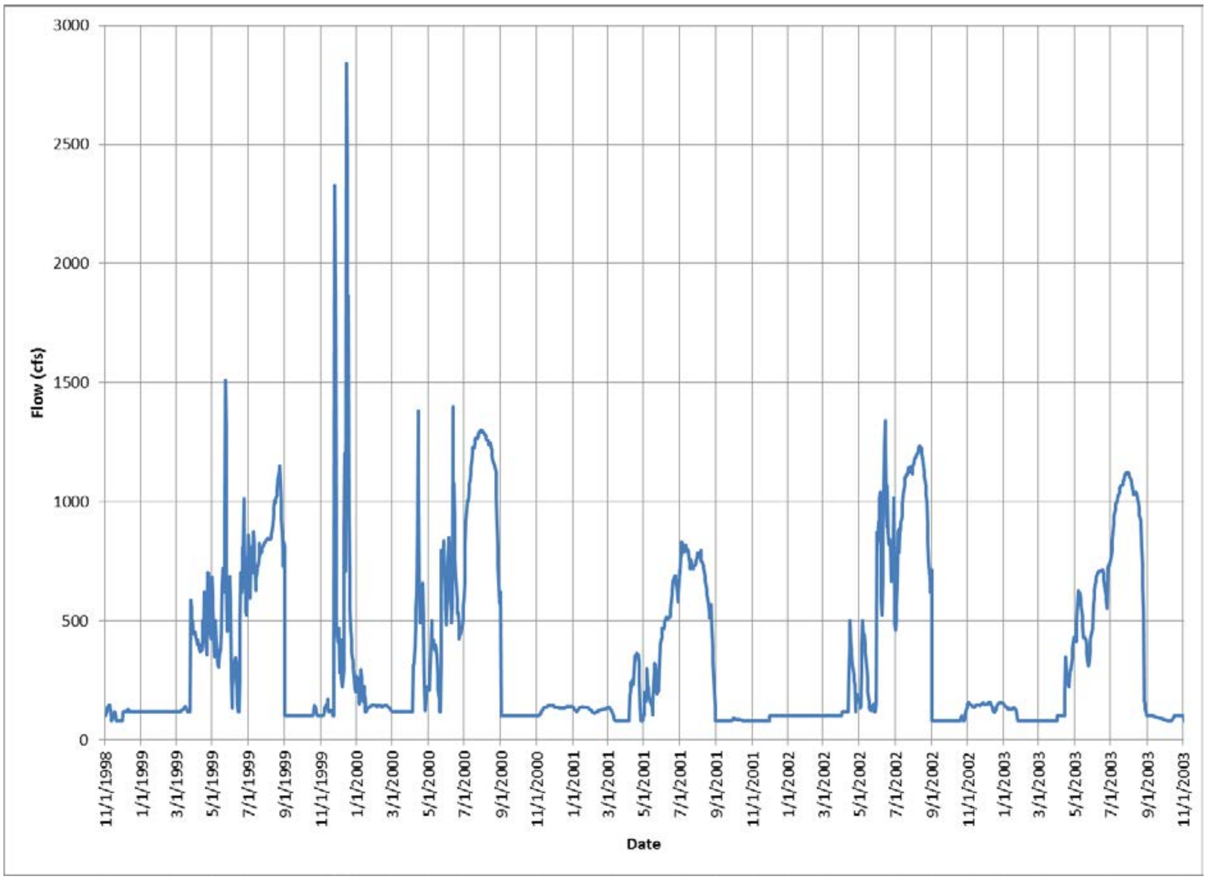



**Figure 3-5. Modeled Flow Patterns in the Keechelus Reach of the Yakima, November 1998 to October 2003**

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 to 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.

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 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 pre-existing 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**

| Dam Feature | Size/Amount |
|---|---|
| Reservoir drainage area (square miles) | 63.6 |
| Mean annual precipitation (inches) | 48.4 (1981-2010) |
| Depth (feet) | Max – 430 |
| Total volume at maximum pool level (acre-feet) | 883,000 |
| Active storage capacity (acre-feet)[1] | 239,000 |
| Average annual runoff (acre-feet) | 213,398 (1926-2015) |
| Ratio of runoff to capacity | 0.9:1 |
| Sept 30 minimum historical storage (acre-feet)[2] | 20,100 |
| Sept 30 average historical storage (acre-feet)[2] | 107,200 (1926-2015) |
| Sept 30 maximum historical storage (acre-feet)[2] | 227,200 |

[1]Active storage capacity is the water accessible to the existing gravity outlet.
[2]Historical storage refers only to active storage, not the full volume of water in the reservoir.

The reservoir impoundment inundated two lakes: the downstream historical Big 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 about 27 feet below this elevation, at elevation 2,192.75.

Kachess Reservoir is operated primarily to meet irrigation demands, while also providing flood control in the winter and spring and storing water for instream flows for fish in summer. Water releases from Kachess Reservoir are greatest in September and October, reaching a maximum that ranges from about 1,200 to 1,500 cfs depending on supply and demand. The highest discharge occurs during that 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 the irrigation season to 35 cfs.

Kachess Reservoir typically reaches its lowest elevation at the end of the irrigation season ends. In the winter and spring, water is stored in the reservoir for irrigation demands later in the next irrigation season. 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 water level conditions in Kachess Reservoir for the period of November 1, 1998, to November 1, 2003. This period includes the drought year of 2001 and years more representative of average and wet runoff conditions, illustrating typical operations over different types of years (drought, average, and wet). During this period, pool levels fluctuated 60 feet between approximate elevations 2,262 and 2,202, with the lowest level occurring during the 2001 drought year. Table 3-8 provides data on reservoir elevations for 1926 to 2015 and for two recent drought years (1994 and 2001).

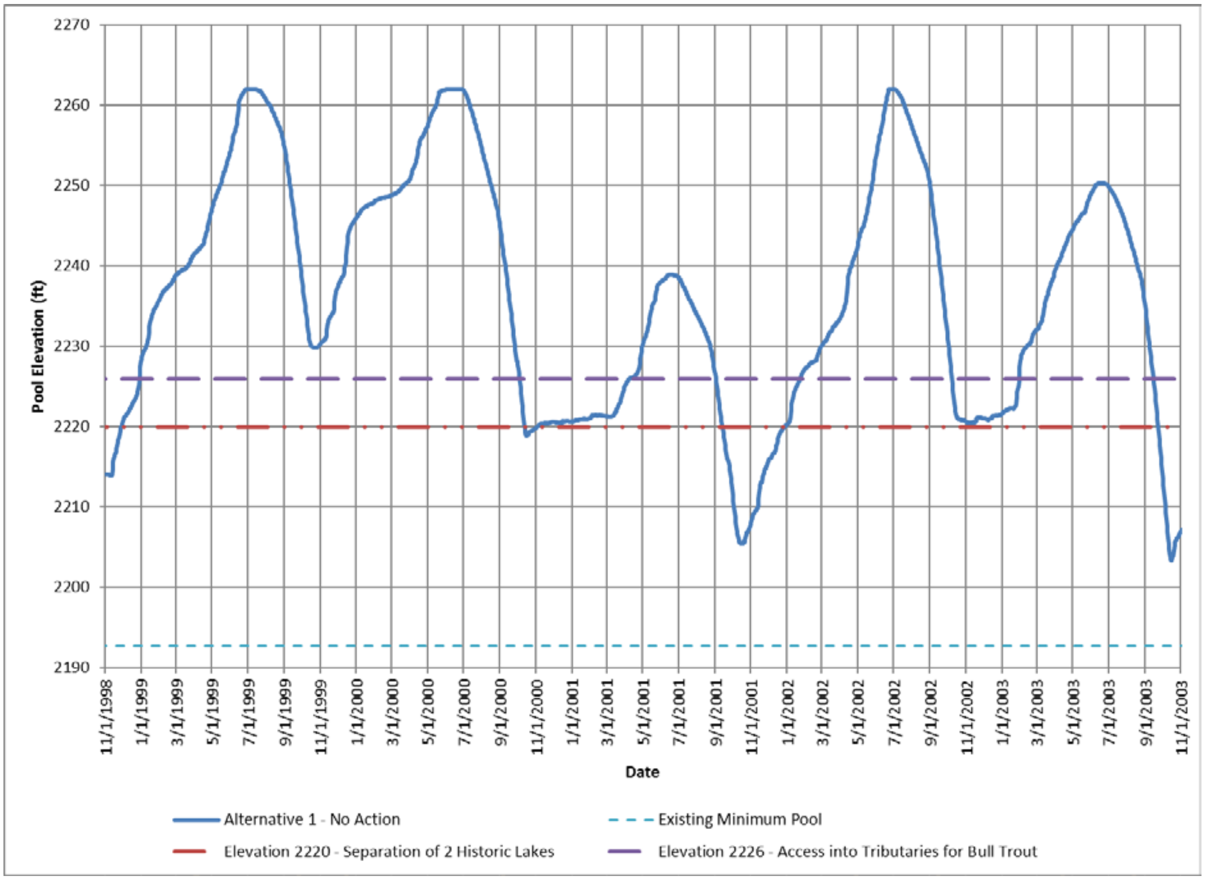



**Figure 3-6. Modeled Kachess Reservoir Operating Elevations, November 1998 to October 2003**

**Table 3-8. Kachess Reservoir Operating Elevations**

| Existing Condition | Elevation (feet) |
|---|---|
| Mean (1926–2015) | 2,236.3 |
| Mean of annual maximum (1926–2015) | 2,254.5 |
| Mean of annual minimum (1926–2015) | 2,212.1 |
| **Drought Years** | |
| Mean (1994) | 2,219.6 |
| Maximum (1994) | 2,236.6 |
| Minimum (1994) | 2,202.9 |
| Mean (2001) | 2,224.9 |
| Maximum (2001) | 2,239.0 |
| Minimum (2001) | 2,205.4 |

### 3.3.5 Kachess River between Kachess Reservoir and Lake Easton

The lower Kachess River is 0.9 mile long and flows from Kachess Dam to Lake Easton, fed from Kachess Reservoir outflow. Figure 3-7 illustrates the existing condition flow in the Kachess River for November 1, 1998, to November 1, 2003. This period includes the drought year of 2001 and years more representative of average and wet runoff conditions, illustrating typical operations over different types of years (drought, average, and wet). Section 3.3.4 describes the operation of Kachess Reservoir, which results in high flows the lower Kachess River in September and October (over 1,200 cfs) and low flows until spring (between 30 to 100 cfs).

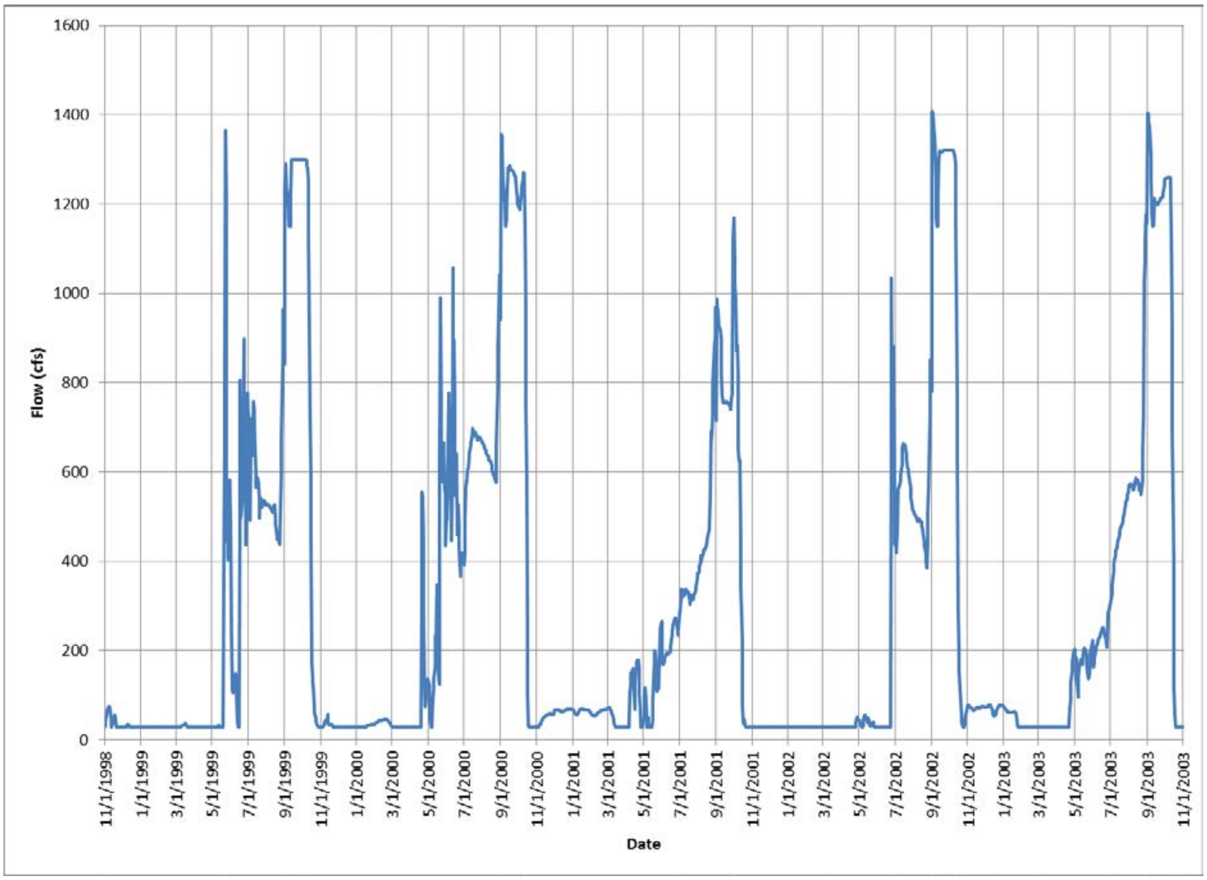



**Figure 3-7. Modeled Kachess River Flow, November 1998 to October 2003**

### 3.3.6 Lake Easton

Lake Easton Diversion Dam, located at RM 202.5 on the Yakima River, is a concrete gravity dam 66 feet high impounding a small lake of about 3,000 acre-feet. The dam provides 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 from Lake Easton

Streamflow conditions in the Easton reach (between Lake Easton Diversion Dam to the Cle Elum River) are affected by releases for irrigation in summer and mini flip-flop operations starting in September. Figure 3-8 illustrates the existing condition flow in the Easton reach for November 1, 1998, to November 1, 2003. This period includes the drought year of 2001 and years more representative of average and wet runoff conditions, illustrating typical operations over different types of years (drought, average, and wet).

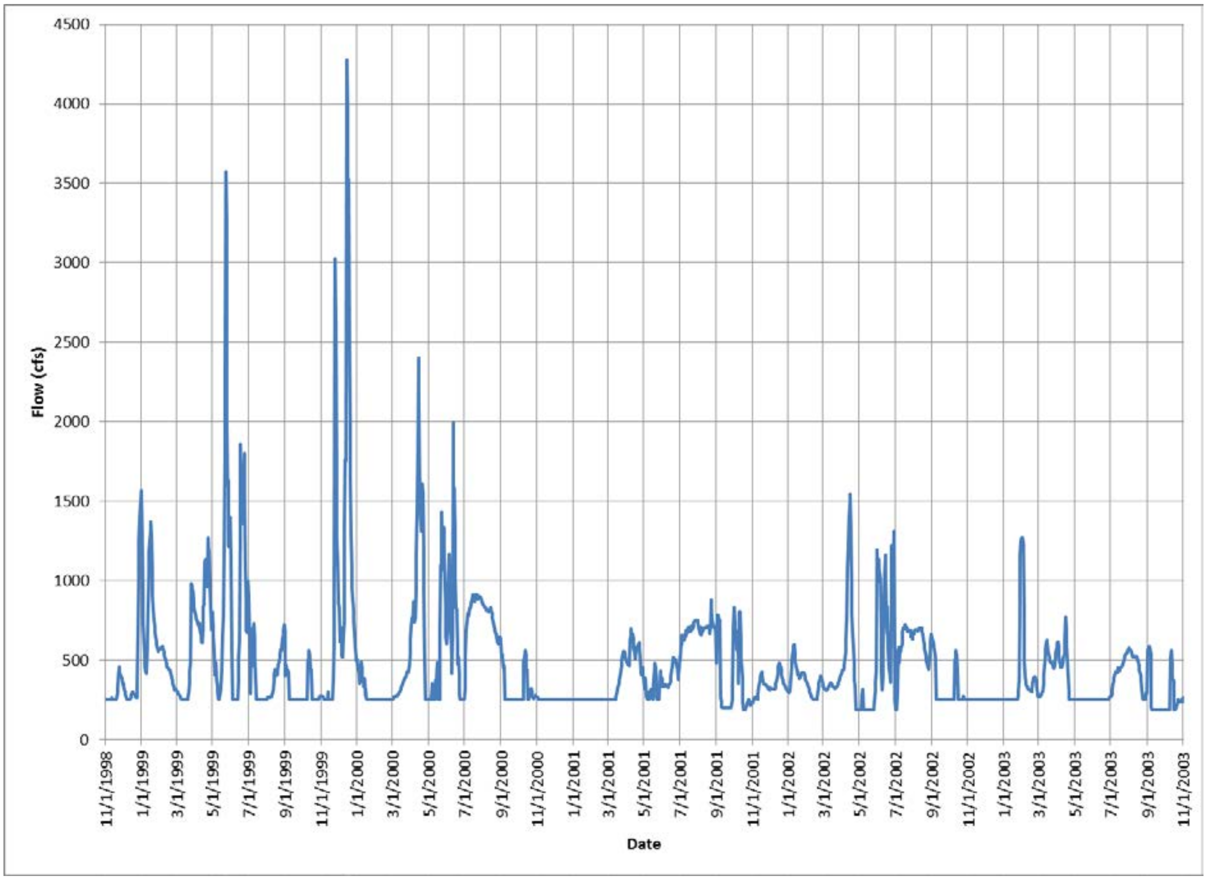



**Figure 3-8. Modeled Yakima River at Lake Easton Dam Flow Conditions, November 1998 to October 2003**

Currently, flows are low (about 180 to 220 cfs), starting during mini flip-flop operations and extending into spring, unless natural flow from tributaries in the reach increases from rain events or snowmelt. 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.

Downstream from the confluence with the Cle Elum River, flows are very high during the summer to supply water to users in the middle Yakima River basin. 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 the 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 500 cfs, except when augmented by natural flows from tributaries or the reservoirs in the upper Yakima River basin or when the Roza powerplant is shut down for operations concerns or maintenance. The low flows reduce the 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 spawning in this reach during the fall and early winter. Low spring flows also limit spring smolt outmigration.

Downstream from 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.

### 3.3.8 Upper Yakima River Tributaries Downstream from Lake Easton

Nine tributaries in the upper Yakima River downstream from Lake Easton may be affected by the alternatives: Manastash, Taneum, Badger, Tucker, Big, Little, Spex Arth, Tillman, and Dry creeks. These tributaries could be affected by spills from KRD. The creeks typically have low flow issues in the summer and fall resulting from little runoff, seepage losses, and/or high water withdrawals.

## 3.4 Surface Water Quality

This section describes the existing water quality of water bodies within and near the project boundaries. The KDRPP and KKC would affect the water level operations of Keechelus and Kachess reservoirs and flows in the mainstem Yakima and Kachess rivers. The primary study area is defined as the Kachess Reservoir area, Kachess River, Keechelus Reservoir area, the Keechelus reach of the Yakima River (between Keechelus Dam and Easton), and Lake Easton. These changes in operations have the potential to influence the water quality of these water bodies. The extended study area is the Yakima River basin (see Figure 3-2) due to Yakima Project operations (see Section 3.3.1 for additional details).

### 3.4.1 Regulatory Setting

The Federal, State, and local regulations discussed in the following sections address water quality and stormwater management. Section 1.10 and Table 1-2 provide additional information.

#### *3.4.1.1 Clean Water Act*

The Federal 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 standards 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 305(b) of the CWA requires all States to prepare a water quality assessment, and Section 303(d) of the CWA requires all States to develop a list of surface waters (marine and freshwater) that are impaired. In Washington State, Ecology prepares this integrated report and submits it to the EPA for review and approval. The Section 303(d)/305(b) integrated report 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 or other water quality improvement project; Category 5 waters are placed on the 303(d) list of waters whose beneficial uses (e.g., aquatic life uses, recreation, or water supply) have been impaired by pollution.

The most recent EPA-approved Section 303(d) Category 5 listing for fresh waters is from 2014 (Table 3-9). Other category designations listed in the 305(b) report are listed in Table 3-10.

**Table 3-9. Water Bodies in the Extended Study Area Included in Category 5 of the 2014 State 303(d) List**

| Water Body | Location | Contaminant |
|---|---|---|
| Keechelus Reservoir | | PCBs in fish tissue |
| Kachess Reservoir | | PCBs in fish tissue |
| Meadow Creek | Tributary to Keechelus | Temperature |
| Gale Creek | Tributary to Kachess Reservoir | Temperature |
| Yakima River | Inlet of Lake Easton | Temperature |
| Yakima River | Upstream of Lake Easton | Temperature |
| Yakima River | Upriver of Cle Elum | Temperature |
| Yakima River | Upriver of Cle Elum | Dissolved oxygen |
| Yakima River | Near Thorp Prairie | PCBs in fish tissue |
| Yakima River | At Umtanum Creek | PCBs in fish tissue |
| Yakima River | At Umtanum Creek | Dioxin in fish tissue |
| Yakima River | At Umtanum Creek | Dieldrin |
| Yakima River | Selah | pH |

Source: Ecology, 2016b

**Table 3-10. Water Bodies in the Extended Study Area Included in Other Designated Categories of the 2014 State 303(d)**

| Water Body | Location | Contaminant | 305(b) Category |
|---|---|---|---|
| Kachess River | • Outflow of Kachess Reservoir | Dissolved oxygen | Category 2 |
| Kachess Reservoir | | 2,3,7,8-TCDD TEQ in fish tissue | Category 2 |
| Yakima River | • Upstream of Lake Easton | Temperature | Category 2 |
| Yakima River | • At Umtanum Creek | Dieldrin | Category 2 |
| Yakima River | • Downstream from Keechelus Reservoir | pH | Category 2 |
| Yakima River | • Downstream from Cle Elum<br>• At Umtanum Creek | 2,3,7,8 – TCDD TEQ in fish tissue | Category 2 |
| Yakima River | • Upriver of Cle Elum<br>• Downstream of Umtanum Creek | Dieldrin in fish tissue | Category 4a |
| Yakima River | • At Umtanum Creek | 4,4′-DDT in fish tissue | Category 4a |

| Water Body | Location | Contaminant | 305(b) Category |
|---|---|---|---|
| Yakima River | • At South Cle Elum Way Bridge<br>• At Umtanum Creek<br>• Downstream from Umtanum Creek | 4,4′-DDE in fish tissue | Category 4a |
| Yakima River | • At South Cle Elum Way Bridge<br>• Downstream from Umtanum Creek | DDT (and metabolites) in fish tissue | Category 4a |

Source: Ecology, 2016b
Notes: DDE = dichlorodiphenyldichloroethylene, DDT = dichlorodiphenyltrichloroethane, TCDD = tetrachlorodibenzodioxin, TEQ = toxic equivalents

### 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 water body 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 (dichlorodiphenyltrichloroethane), suspended sediment, and turbidity.  The mainstem Yakima, lower Kachess, and lower Cle Elum rivers are not included in the forthcoming temperature TMDL because they would 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 the Yakima River and the Okanogan-Wenatchee National Forest TMDLs emphasize maximizing effective shade by the forest canopy to keep temperatures lower in forest streams (Ecology, 2003; 2014b).

In addition, Ecology recently developed a TMDL for the upper Yakima River tributaries for water temperature (Creech and Stuart, 2016).  This TMDL addresses all perennial tributaries to Keechelus and Kachess reservoirs.  Identified actions needed to reduce summer water temperatures include: protecting existing riparian vegetation, restoring or installing riparian vegetation, preventing uncontrolled riparian grazing, restoring the creek's natural shape, upgrading irrigation methods, placing saved irrigation water in trust, and increasing outreach within the TMDL area (Creech and Stuart, 2016).

Ecology published a TMDL for the lower Yakima River for suspended sediment (Ecology, 1998, 2012a).  In the report Ecology establishes targets for amounts of sediment and pesticides in the river that must be met during the irrigation season.  EPA approved this TMDL for the protection of chronic aquatic life criteria in 1998.

### *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, listed below, 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 no measurable degradation of water quality occurs.
- If an action results in a measurable 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 (53.6°F) for Char (bull trout and Dolly Varden) spawning and rearing: Keechelus Reservoir, Little Kachess or 16°C (60.8°F) (core summer salmonid habitat: Kachess Reservoir, Kachess River, Lake Easton) as a result of human activities
  - When natural conditions exceed the maximum temperature, no temperature increases are allowed that would raise water temperature by more than 0.3°C (0.54°F)
- Dissolved oxygen (DO)
  - Not to drop below 9.5 milligrams per liter (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 (TDG)
  - Not to exceed 110 percent of saturation at any point of sample collection
  - The TDG criterion may be adjusted to aid fish passage over hydroelectric dams when consistent with an Ecology-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 unit

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

| | Aquatic Life Use | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Water Body** | **Char Spawning/Rearing[1]** | **Core Summer Salmonid Habitat** | **Salmonid Spawning, Rearing, and Migration** | **Extraordinary Primary Contact** | **Primary Contact Recreation** | **Domestic, Industrial, and Agricultural Water** | **Stock Watering** | **Wildlife Habitat** | **Harvesting Commerce/ Navigation** | **Boating** | **Aesthetic Values** |
| Keechelus Reservoir | X | | X | X | | X | X | X | X | X | X |
| Upper Kachess Reservoir basin (narrowest point dividing lower Kachess Reservoir from upper Kachess Reservoir basin) and all tributaries | X | | X | X | | X | X | X | X | X | X |
| Kachess Reservoir | | X | X | X | | X | X | X | X | X | X |
| Kachess River | | X | | X | | X | X | X | X | X | X |
| Lake Easton | | 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 and tributaries from Cle Elum River to headwaters (except where designated otherwise) | | X | | X | | X | X | X | X | X | X |

| Water Body | Aquatic Life Use | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Char Spawning/Rearing[1] | Core Summer Salmonid Habitat | Salmonid Spawning, Rearing, and Migration | Extraordinary Primary Contact | Primary Contact Recreation | Domestic, Industrial, and Agricultural Water | Stock Watering | Wildlife Habitat | Harvesting Commerce/ Navigation | Boating | Aesthetic Values |
| Yakima River and tributaries above Cedar Creek | X | | | X | | X | X | X | X | X | X |

Source: WAC 173-201A-602
1. WAC 173-201A specifies char in the rules. Char includes bull trout and Dolly Varden.

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

- Bacteria
  - Fecal coliform organism levels must not exceed a geometric mean value of 50 colonies/100 milliliters (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[1]
  - Acute: 2.5 micrograms per liter (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)

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

– 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 on 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 in accordance with WAC 173-201A-602 and the CWA (Table 3-11). These provisions prohibit the degradation of water quality standards within waters that currently meet 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 (µg/L)[1] 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 |

Source: WAC 173-201A-230
[1] Action Value >35; lake-specific study may be initiated

### *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 NOI with Ecology. As described in Section 3.2, 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 SWPPP for all construction activity, water quality monitoring, and record-keeping and reporting protocols. For certain construction projects with a 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 those in 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 Corps. Typically, projects affecting waters of the State (including water bodies and wetlands) 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 affect water quality. In addition, the Section 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 project area is located in northwestern Kittitas County in the upper Yakima River Watershed, designated by the State as Water Resource Inventory Area 39. Water resources in the primary study area include Keechelus Reservoir and tributaries, Kachess Reservoir and tributaries, the 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 has been characterized as 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; Ecology 1995; Reclamation 1999; Hansen et al. 2017). 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).

**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 PCBs in fish tissue (Ecology, 2016b). It is also identified as a water of concern (Category 2) for 2,3,7,8-TCDD (Tetrachlorodibenzodioxin) TEQ (toxic equivalents) in fish tissue (Ecology, 2016b).

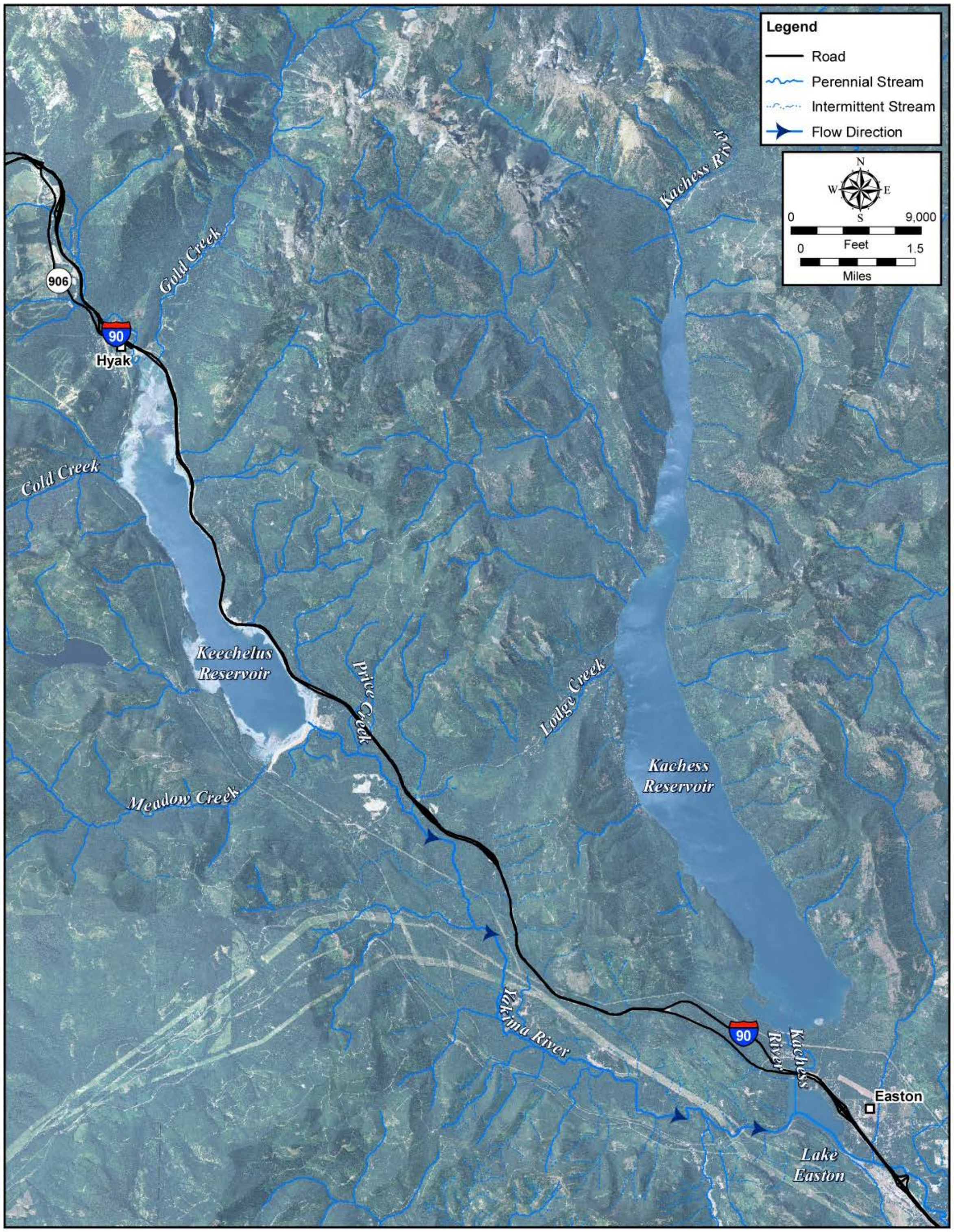



**Figure 3-9. Water Resources in the Primary Study Area**

### Ecology Lake Water Quality Assessment Program

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

Ecology surveyed water chemistry at Keechelus Reservoir in 1993, and 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 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 1 colony/100 mL, or results that were below detection limits during these sampling events.

### Reclamation Water Quality Sampling

Based on STORET database retrieval results (search date August 21, 2014, and subsequent data provided by Reclamation in November 2016), Reclamation collected water quality data in 1999, 2002, 2005, 2008, 2011, 2012, and 2016 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; Reclamation, 2016b). These sampling results indicated that water quality in the reservoir was generally good and met State water quality criteria except for temperature and DO. At the outlet station, one exceedance of a State surface water criterion was recorded for water temperature.

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 [3.3 feet]) of 7.3. Summer peak water temperatures above the State surface water quality criteria of 12°C (53.6°F) for char spawning and rearing were reported at depths of 1, 3, 5, 7, 9, and 11 meters (3.3, 9.8, 16.4, 23.0, 29.5, and 36.1 feet, respectively) (Figure 3-10). During summer 2016, the water temperature at 13 meters (42.7 feet) was 12.5°C (54.5°F), also exceeding the char spawning and rearing criteria (Figure 3-10). A peak water temperature of 21.6°C (70.9°F) 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 of 4.1°C (39.4°F) at the reservoir bottom (81 meters [266 feet]) (Reclamation, 1999). Subsequent water temperature data summarized by Hanson et al. (2015) show a 2014 summer water temperature at the surface of approximately 20°C (68°F) (recorded on August 28, 2014).

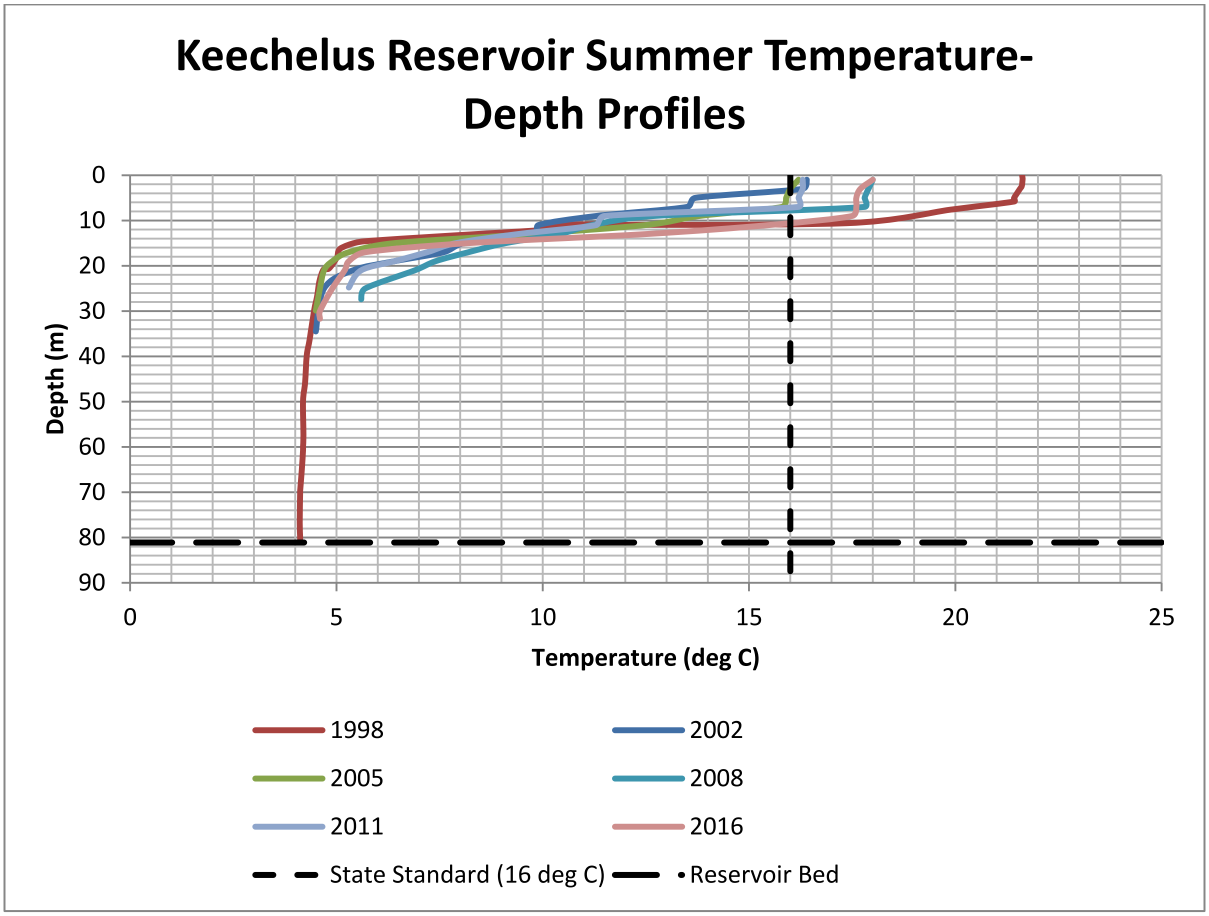



**Figure 3-10. Keechelus Reservoir Summer Temperature-Depth Profiles**

Source: Reclamation, 1999, 2016; EPA, 2014a;
Note: Data collection occurred in July or August of the specified year

DO concentrations increased with depth through the thermocline (Figure 3-11). For example, the average of five measurements at 1 meter (3.3 feet) depth was 9.0 mg/L and increased at depth to an average of over 11.2 mg/L at 21 meters (68.9 feet). DO 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) with the exception of 2016, when DO measurements did not meet the criterion up to a depth of 11 meters (36.1 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 that the reservoir was not anoxic during sampling (Reclamation, 1999).

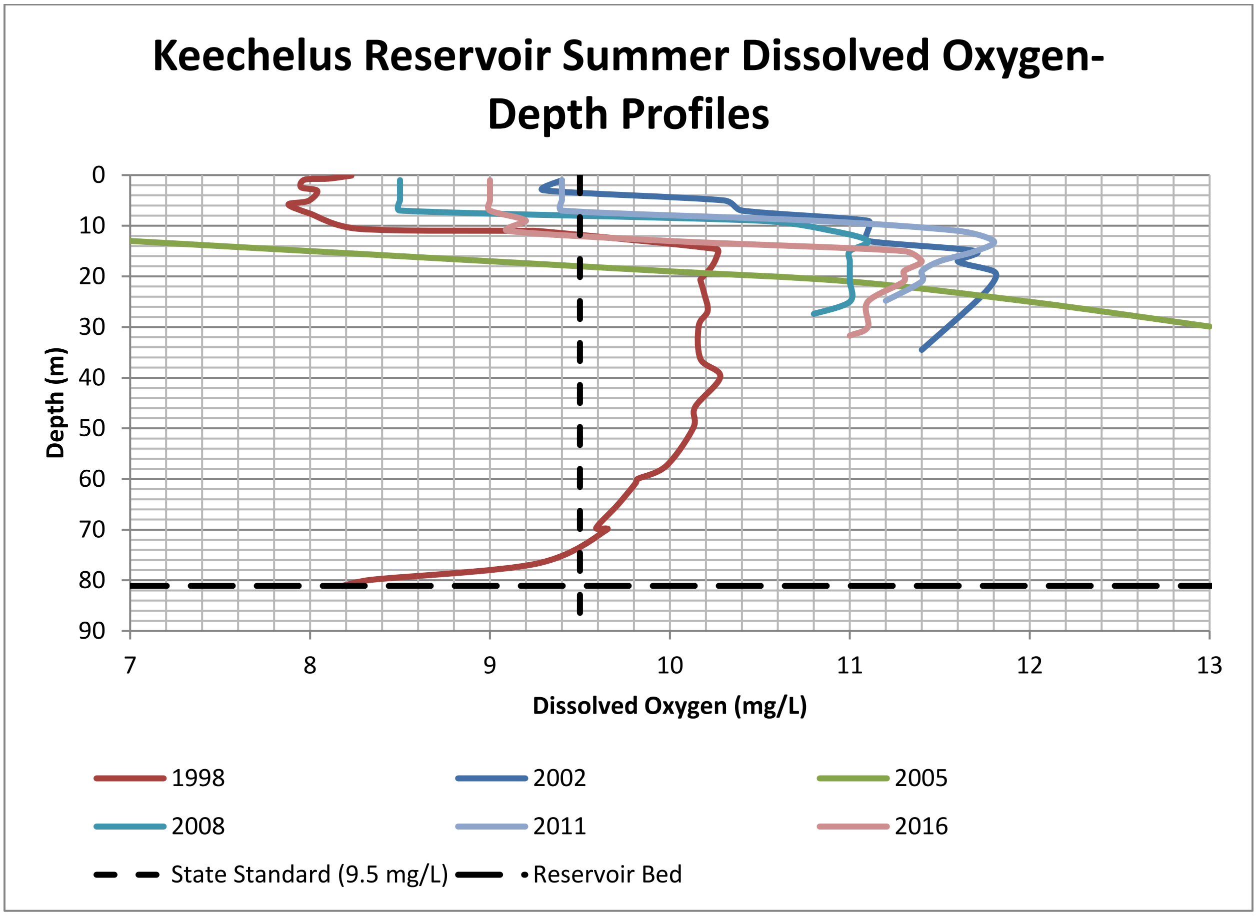



**Figure 3-11. Keechelus Reservoir Summer Dissolved Oxygen-Depth Profile**

Source: Reclamation, 1999, 2016; EPA, 2014a
Note: Data collection occurred in July or August of the specified year

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]).

### Keechelus Reservoir Food Web Study

As part of the Kachess and Keechelus reservoirs food web interactions studies completed for the Washington Department of Ecology, water temperature depth profiles were collected from April through December 2015 (Hansen et al. 2017). The data show that Keechelus Reservoir was well stratified by the month of June and persisted through early November similar to the data collected by Reclamation and shown in Figure 3-10. Peak summer temperature occurred in July with surface water temperatures of approximately 22°C (71.6 °F).

Sampling results indicate water quality at the Keechelus 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 (63.7°F) exceeded the surface water quality temperature criterion of 16°C (60.8°F). During sampling, the average water temperature was 12.6°C (54.7°F), 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 River basin reservoirs in August 1998 and summarized the results in a draft progress report (Reclamation, 1999). Reclamation collected water quality samples at the inflow area, reservoir midpoint, 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 (70.9°F) and the temperature at the bottom was 4.1°C (39.4°F) at 81.1 meters (266 feet).

The results showed that Keechelus Reservoir generally had low nutrient levels. Orthophosphate 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 milligrams per cubic meter ($mg/m^{3)}$ 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 oligotrophic 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 study assessed progress in meeting TMDL targets for DDT and dieldrin and to verify 303(d) listings for other organochlorine compounds (Ecology, 2007). Study results showed that mean sample fish tissue concentrations collected in Keechelus Reservoir exceeded the human health criteria for total PCBs (5.3 micrograms per kilogram [µg/kg]) in sucker, pikeminnow, kokanee, cutthroat, and whitefish. Mean sample concentrations for dieldrin and alpha-exachlorocyclohexane (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 (dichlorodiphenyldichloroethylene**)** detected in the five species sampled ranged from 0.61 to 2.6 µg/kg. The results of this study supported the fish tissue Category 5 303(d) listings in the reservoir.

### 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, although the upper Kachess Reservoir has 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).

**Thermocline**

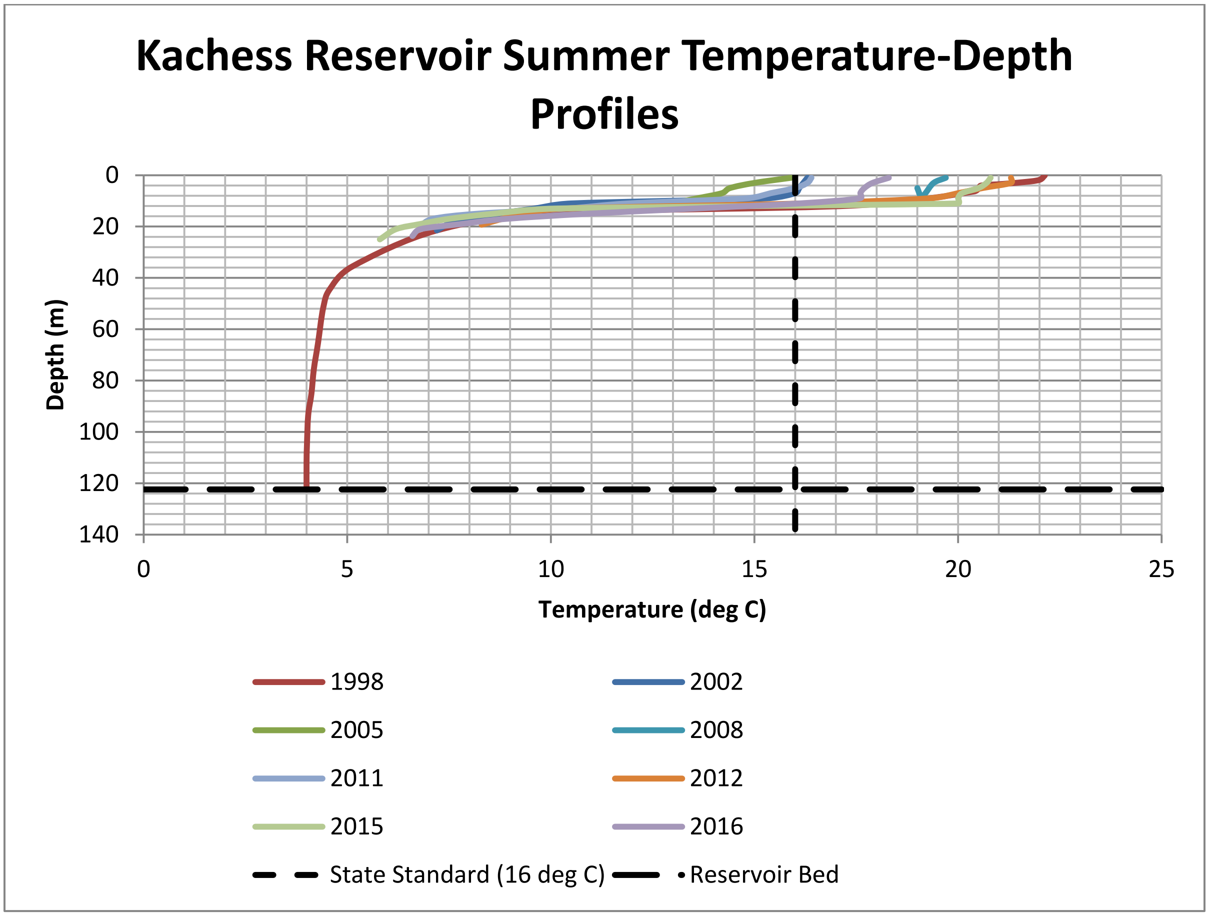
In lakes, a thermocline is a transition layer that exists between the mixed layer at the surface and the deep water layer. In the thermocline, temperature decreases rapidly from the mixed layer to the colder deep water layer.

#### *3.4.4.1 Reclamation Reservoir Water Quality Sampling*

Reclamation collected water quality data in the reservoir (100 meters [328 feet] upstream of the dam) during June, July, and August at various depths throughout the water column. The reservoir outlet is located at elevation 2,192.75. Based on EPA STORET database retrieval results (search date August 21, 2014), these data were collected in 1999, 2002, 2005, 2008, 2011, and 2012 (EPA, 2014a, 2016). These sampling results indicate that 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 (60.8°F) at depths of up to 11.8 meters (38.7 feet) (recorded August 3, 1998). A peak water temperature of 21.3°C (70.3°F) was recorded in August 2012 at depths 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) (Note: Data collection occurred in June, July, or August of the specified year).

Based on one reservoir profile by Reclamation (August 1998), a maximum temperature of 22.1°C (71.8°F) was recorded at the surface and decreased in the hypolimnion of the reservoir, with a temperature of 4.0°C (39.2°F) at the reservoir bottom (122 meters [400 feet]) (Reclamation, 1999). Subsequent water temperature data summarized by Hanson et al. (2015) show a 2014 summer water temperature at the surface of approximately 21°C (69.9°F) (for August 18, 2014).




Note: Data collection occurred in June, July, or August of the specified year

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

DO concentrations increased with depth (Figure 3-13). The average concentration at 1 meter (3.3 feet) depth was 8.9 mg/L (based on seven measurements; 1998 results not available for 1 meter) and increased at depth where an average of 12.1 mg/L was recorded at 19 meters (62.3 feet) (based on five measurements: 2002, 2011, 2012, 2015, and 2016) (Figure 3-13). DO 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 13 meters (42.6 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 at 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]).

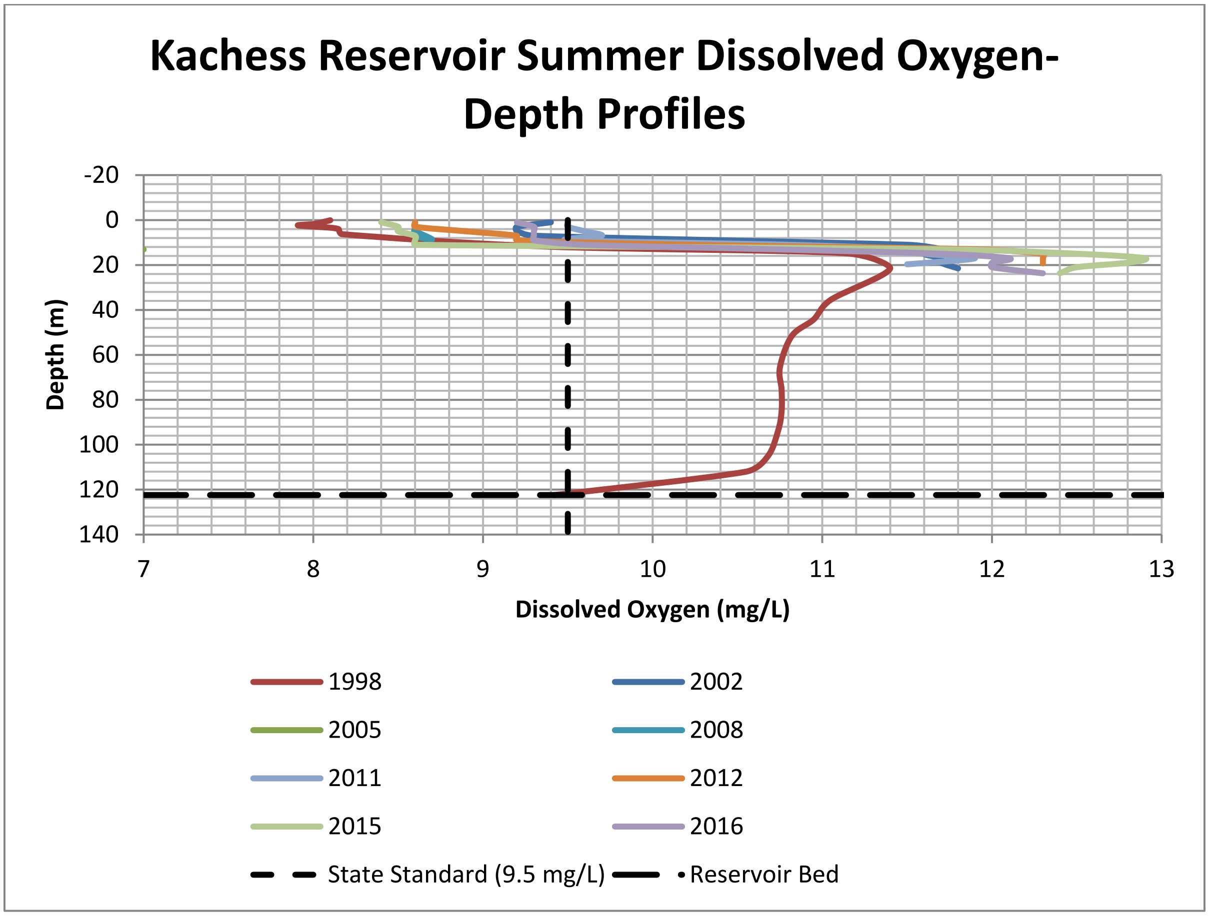



**Figure 3-13. Kachess Reservoir Summer Dissolved Oxygen versus Depth Profile**

Source: Reclamation, 1999; EPA, 2014a
Note: Data collection occurred in June, July, or August of the specified year

Reclamation's 1999 reservoir water quality sampling included Kachess Reservoir (Reclamation, 1999). Reclamation collected water quality samples in August 1998 at the following locations: Kachess Reservoir inflow area, reservoir midpoint, and outlet area. Samples were analyzed for nitrogen, phosphorus, chlorophyll *a*, phytoplankton, and zooplankton. In addition, bathymetry surveys of the reservoirs were conducted. During sampling, the surface temperature was 21.1°C (70°F) and the temperature at the reservoir bottom was 4°C (39.2°F) at 122.4 meters (400 feet) with a Secchi disk reading at a 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). The oligotrophic conditions in the reservoir and low calcium concentrations may limit mussel populations (Ramcharan et al., 1997).

**Reservoir Food Web Studies**

As part of the Kachess and Keechelus reservoirs food web interactions studies completed for the Washington Department of Ecology, water temperature depth profiles were collected from April through December 2015 (Hansen et al. 2017). The 2015 data showed Kachess Reservoir was stratified by May, and this stratification persisted through early November. Peak summer temperature occurred in July with surface water temperatures of approximately 22°C (71.6°F), which is consistent with other data collected by Reclamation shown in Figure 3-12 ( Note: Data collection occurred in June, July, or August of the specified year.) See Section 3.4.3.1 for further discussion of the food web study.

In addition, a CE-QUAL-W2 water quality model of Kachess Reservoir was completed by Portland State University as part of food web structure study (PSU, 2017a). The model simulated flow, water level, temperature, DO, nutrients, algae, organic matter, and zooplankton over an approximately 2-year period from 2014 to 2016. The model was calibrated using water quality samples collected in the reservoir. Data collected to calibrate the model show the presence of a summer thermocline and overall low nutrient (phosphorus and nitrogen) concentrations (PSU 2017a). The model was used to simulate zooplankton concentrations as well. Zooplankton modeled included three groups: daphnia, copepods and other zooplankton (including Basmina and Leptodora). Similar to the water quality parameters, zooplankton were collected in the reservoir to calibrate the model. Background data show the presence of zooplankton throughout the epilimnion at fairly low concentrations. See Section 3.4.3.1 for further discussion of zooplankton populations in Kachess Reservoir.

**Ecology 303(d) Water Quality Listing**

Kachess Reservoir is not listed as water quality limited for water or sediment (Ecology, 2016b). However, the reservoir is 303(d)-listed as Category 5 for PCBs for fish tissues (Ecology, 2016b).

Gale Creek (a tributary to Kachess Reservoir) is 303(d)-listed as Category 5 for temperature (Table 3-9) in Ecology's 2014 Water Quality Assessment, meaning that it is polluted enough to require a TMDL or water quality improvement project (Ecology, 2016b).

#### *3.4.4.2 Ecology Chlorinated Pesticides, PCBs, and Dioxins Fish Tissue Study*

Ecology completed a study in 2006 that analyzed chlorinated pesticides, PCBs, PCDDs, and PCDFs in Yakima River fish tissue (Ecology, 2007). The study assessed progress in meeting TMDL targets for DDT and dieldrin and verified 303(d) listings for other organochlorine compounds (Ecology, 2007). Sucker and pikeminnow tissue was sampled from reservoir fish. Results of this study determined that mean tissue samples collected in Kachess Reservoir pikeminnow (16 µg/kg) exceeded the human health criterion of 5.3 µg/kg for total PCBs. Mean concentrations for dieldrin (0.40 µg/kg), total chlordane (0.40 µg/kg), 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). Based on the lack of eutrophication, Lake Easton was not considered a high-priority lake for restoration (Ecology, 1995).

Ecology surveyed water chemistry at Lake Easton during onsite visits in 1993. This is the most recent data set available from Ecology. On June 1, 1993, Ecology found total phosphorus to be below detection in the epilimnion composite sample. On August 29, 1993, it 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 (Ecology, 2016b).

## 3.4.6 Kachess River

Reclamation collected water quality data in Kachess River 300 meters (approximately 984 feet) downstream from Kachess Dam (station YKA001) during June, July, and August. Based on 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 that 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 (60.8°F) on two occasions. During sampling, the average water temperature was 12.6°C (54.7°F). DO 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. In a 2000 study, the Kachess River upstream of Kachess Reservoir had an average daily water temperature that ranged from a high of 12°C (53.6°F) in early August to a low of 1.3°C (34.3°F) in November (Meyer, 2002). Variation in daily temperature ranged from less than 1°C in November to 4°C (39.2°F) in July. Water temperature data collected by Reclamation in the Kachess River downstream from the reservoir from 2004 to 2012 shows that the 7-day average of the daily maximum temperature (7-DADMax) exceeded the surface water temperature criterion of 16°C (60.8°F) from 2004 through 2007 and met the criterion during 2009 through 2012 monitoring (Figure 3-14).

Reports of a sulfurous smell were listed as concerns in the Scoping Summary Report FEIS (Reclamation and Ecology, 2014d). This observation was presumed to be attributable 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 algal growth.

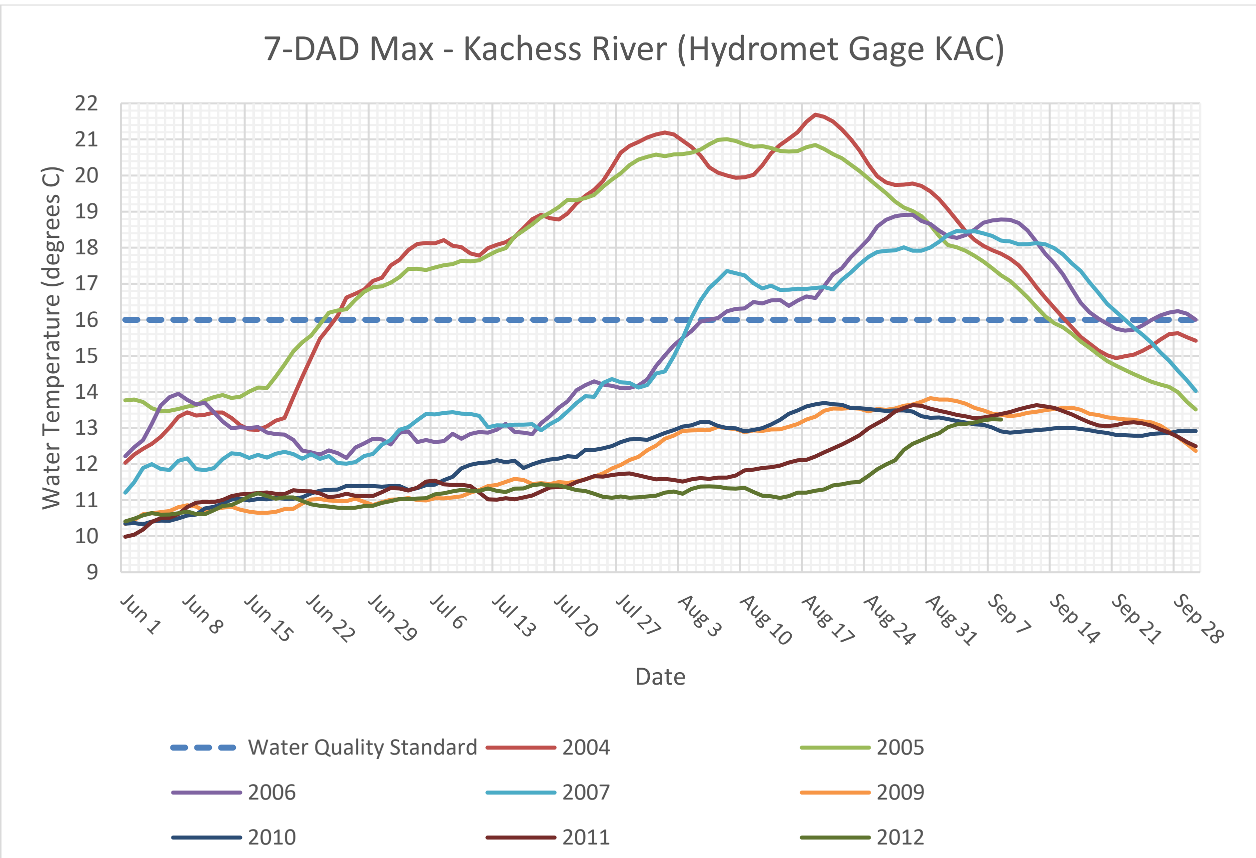



**Figure 3-14. Kachess River 7-Day Average Daily Maximum Temperature**

Note: Data collected at Reclamation gage site KAC located approximately 0.5 mile downstream of the reservoir.

### 3.4.7 Yakima River

Downstream from 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.

#### *3.4.7.1 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 from Lake Easton (Ecology, 2014d). Ecology rates the overall Yakima River water quality as meeting or exceeding expectations and is of lowest concern (based on water year 2015 summary) (Ecology, 2016a). Based on data collected in 2015, DO did not meet the State minimum water quality criteria (9.5 mg/L) at this station (Ecology 2016a). Water temperature data collected by Ecology in the Yakima River from July to September from 2001 to 2010 shows that the 7-day average of the daily maximum temperature (7-DAD Max) exceeded the surface water temperature criterion of 16°C (60.8°F) during each summer of the sampling record (Figure 3-15).

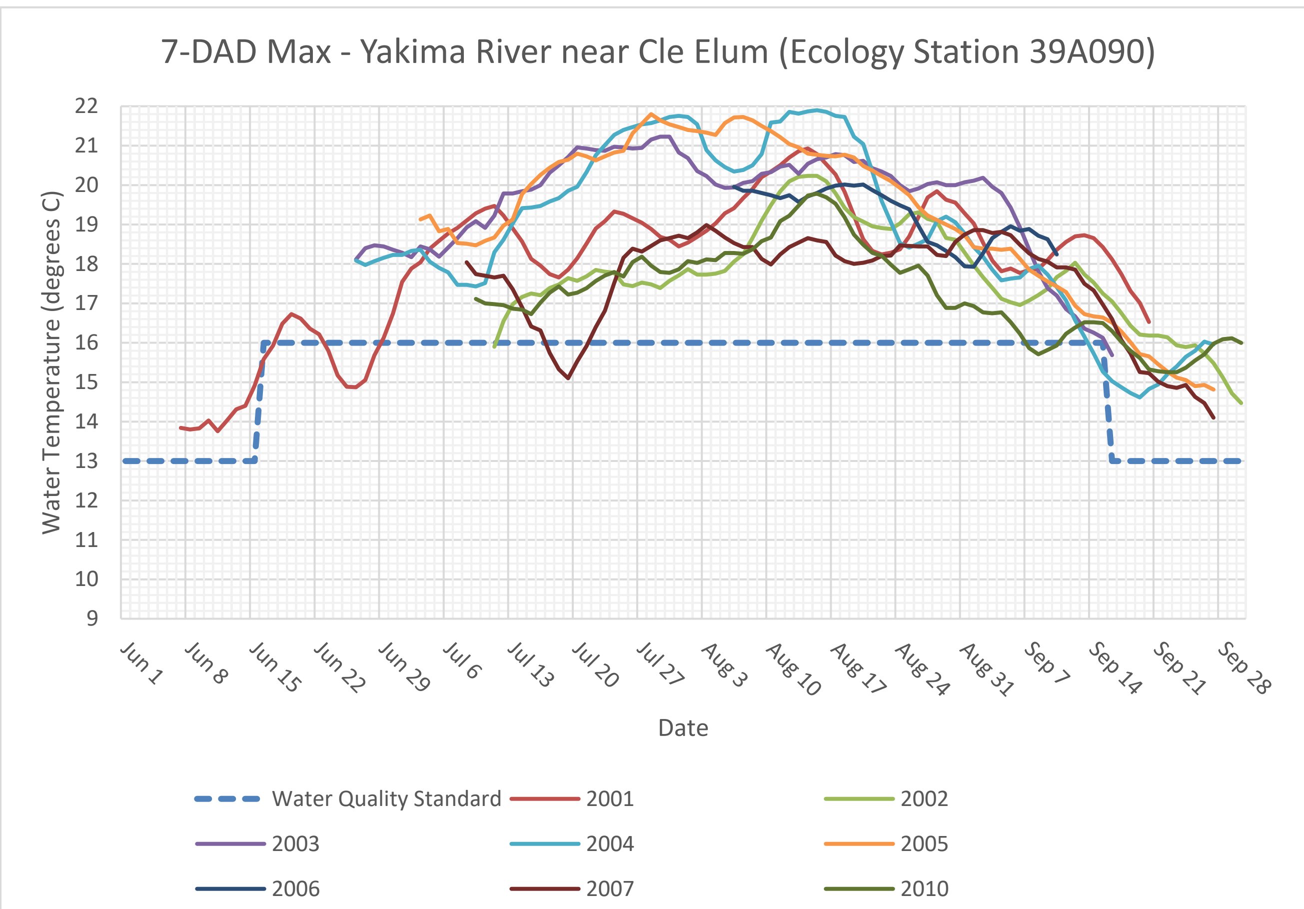



**Figure 3-15. Yakima River 7-Day Average Daily Maximum Temperature**

### 3.4.7.2 Ecology 303(d) Water Quality Listing

The Yakima River is 303(d)-listed as Category 5 for temperature and DO for select segments upstream of Cle Elum (Table 3-9). Downstream from Cle Elum, the Yakima River waters are listed as Category 5 for dieldrin (at Umtanum Creek) and pH (at Selah). For fish tissue, the Yakima River is 303(d) Category 5 for PCBs near Thorp Prairie and dioxin at Umtanum Creek.

The Yakima River is identified as a water of concern (Category 2) for temperature (upstream of Lake Easton and at Umtanum Creek), dieldrin (at Umtanum Creek), and pH (downstream from Keechelus Reservoir and at Umtanum Creek). For fish tissue, the Yakima River is identified as a water of concern for 2,3,7,8-TCDD TEQ downstream from Cle Elum and at Umtanum Creek.

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 downstream near Ellensburg. Turbidity targets were set for tributaries (90th percentile not to exceed 5 NTU) and the mainstem (90th percentile at RM 139.8 and RM 121.7 not to exceed 5 NTU above 90th 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.

### 3.4.7.3 Ecology Chlorinated Pesticides, PCBs, and Dioxins Fish Tissue Study

Ecology’s 2006 study analyzed chlorinated pesticides, PCBs, 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 that 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. The mean concentrations of total PCBs in fish tissue were below detection limits of standard analytical methods in sucker and 16 µg/kg in pikeminnow in Kachess Reservoir. Levels in Keechelus Reservoir ranged from 5.6 µg/kg in cutthroat trout to 17 µg/kg in pikeminnow. These levels are similar to background levels found throughout Washington State, and are most likely the result of aerial deposition (Peterschmidt, 2017).

# 3.5 Groundwater

This section describes the groundwater resources in the primary study areas for KDRPP, KKC, and the Volitional Bull Trout Passage Improvements.

- Kachess Reservoir
  - Locations of proposed KDRPP facilities and other construction-related sites within 2 miles of the Kachess Reservoir shoreline
  - The narrow valley filled with alluvial and glacial deposits south of Kachess Dam
  - The Narrows for construction of the Volitional Bull Trout Passage Improvements
- Keechelus Reservoir
  - Locations of proposed KKC facilities
  - The area in the immediate vicinity of construction
  - The area within 2 miles of the Keechelus Reservoir shoreline
- KKC North Tunnel Alignment
  - Areas overlying the proposed tunnel alignment, as described in Chapter 2

The KKC area is included because of potential influences on groundwater attributable 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 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 3-16 and Figure 3-17 show the primary study areas. The extended study area is the Yakima River basin (Figure 1-1).

The occurrence and quantity of groundwater are 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.

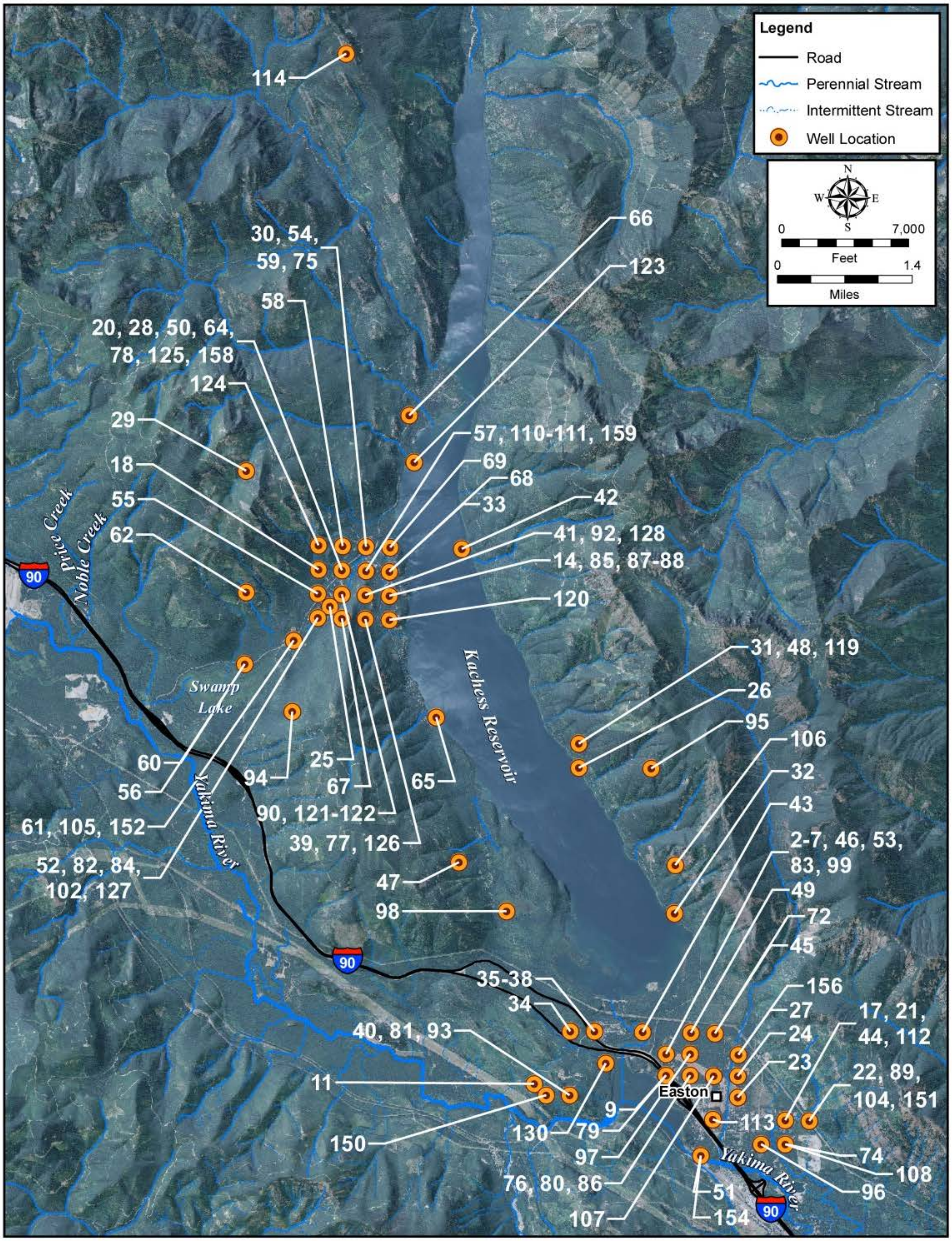



**Figure 3-16. Kachess Reservoir Groundwater Study Area**

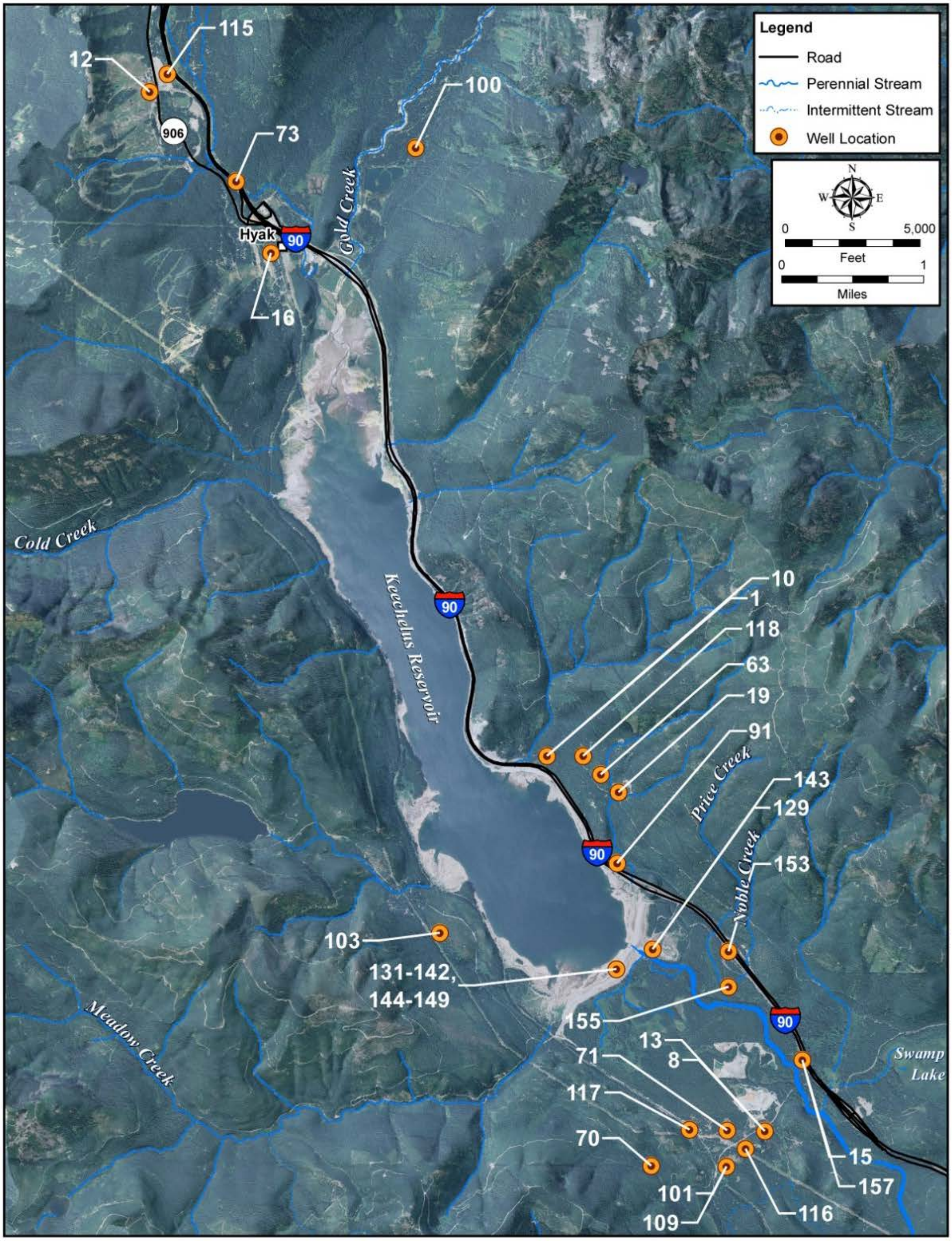



**Figure 3-17. Keechelus Reservoir Groundwater Study Area**

### 3.5.1 Regulatory Setting

Groundwater use is regulated by Ecology in the State of Washington (WAC 173-152). In upper Kittitas County, permitted and permit-exempt 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, groundwater withdrawals must obtain a portion of a senior water right or obtain access 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 amount obtained from a senior water right or from an existing water purveyor or impair existing water rights.

Because of the upper Kittitas Rule many owners of domestic wells have purchased portions of senior surface water rights to mitigate their usage with regard to potential reduction of TWSA at the Parker Gage. These permit-exempt water rights uses are junior to Reclamation’s 1905 water right, they rely on a Reclamation storage and exchange contract in order to be exercisable without interruption, and are subject to local availability. The priority date of the majority of these mitigated rights, is the date that the water was first put to beneficial use.

As part of the water right review process, Ecology would review local hydrogeology, availability of groundwater and the potential for impairment. Exemptions to Upper Kittitas County Groundwater Rule include uses for a structure for which a building permit was vested prior to July 16, 2009, and uses for a parcel that is part of an existing group use that began prior to July 16, 2009. 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 conceptual hydrologic model for the Kachess Reservoir basin is that groundwater, occurring in unconsolidated sediments and fractures in the bedrock, is recharged through precipitation and discharged to springs, streams, and the reservoir. Section 3.2describes the geology around the reservoir. Most of the reservoir is surrounded by igneous and sedimentary bedrock with likely low permeability. 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 substantial quantities of groundwater. Reclamation’s design documents 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 damsite and alluvial valley south of the dam indicate that groundwater is likely 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 3-16). There are 107 wells located within 1 mile of the reservoir and 8 additional wells located between 1 to 2 miles from the reservoir. The well logs show that groundwater in the area is used as a potable water supply for 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 the open area where groundwater flows into the well (or the well screen) for most of these wells is in sedimentary deposits (sand or gravel). The remaining wells are deeper and mostly installed in bedrock.

Operation of KDRPP is estimated to lower the surface water levels in Kachess Reservoir up to an additional 80 feet beyond the current minimum allowable level (i.e., from elevation 2,192.75 to about elevation 2,112.75). Ecology is conducting groundwater level monitoring in two domestic wells and four Reclamation monitoring wells to measure groundwater levels around the reservoir and to determine whether they are hydraulically connected and respond to fluctuations in surface water elevations. Well monitoring locations are shown in Figure 3-18. Monitoring of the Reclamation wells began in December 2013, and monitoring of the domestic wells began in May 2015. Construction details for each of the six wells monitored by Ecology are provided in Table 3-13. The wells are located relatively close to (between 40 and 650 feet from) the reservoir, and well completion depths range from 100 to 300 feet. Geologic information for the well completion intervals is based on well logs and geologic mapping by Tabor et al. (2000).

**Table 3-13. Well Construction Information**

| Well Name | Well Type | Ground Elevation (feet amsl[a]) | Distance to Reservoir (feet) | Well Depth (feet bgs) | Open Interval (feet bgs) | Open Interval Elevation (feet amsl) | Geology of Open Interval |
|---|---|---|---|---|---|---|---|
| Brandt | Domestic | 2,318.17 | 88 | 175 | 135–175 | 2,183.17–2,143.17 | Shale, phyllite, coal, and sandstone bedrock |
| Carlson | Domestic | 2,479.30 | 650 | 300 | 20–300 | 2,459.3–2,179.3 | Gray bedrock (type not indicated on log) |
| At Dam | Monitoring | 2,268.50 | 50 | 230 | 220.15–229.8 | 2,048.35–2,038.7 | Fine to coarse sand and silty sand |
| Below Dam | Monitoring | 2,214.65 | 290 | 190 | 179.6–189.3 | 2,035.05–2,025.35 | Silty sand with gravel |
| East Side Kachess | Monitoring | 2,263.80 | 40 | 273 | 260–270 | 2,003.8–1,993.8 | Sandstone bedrock, fine to medium |

| Well Name | Well Type | Ground Elevation (feet amsl[a]) | Distance to Reservoir (feet) | Well Depth (feet bgs) | Open Interval (feet bgs) | Open Interval Elevation (feet amsl) | Geology of Open Interval |
|---|---|---|---|---|---|---|---|
| West Side Kachess | Monitoring | 2,313.50 | 300 | 100 | 90.7–100.3 | 2,228.8–2,213.2 | Basaltic andesite bedrock, closely to moderately spaced fractures |

[a] above mean sea level


**Figure 3-18. Well Monitoring Locations**

The two residential wells being monitored (Brandt and Carlson) are located near Kachess Reservoir. The Brandt well is located on the east side and the Carlson well is located on the west side of the reservoir. The screened (or open) interval of both wells is completed in bedrock. The Brandt well is completed from elevation 2,143 to 2,183, and the open area of the well is within the maximum and minimum reservoir levels (referred to hereafter as the inundated zone). The Carlson well is completed from elevation 2,179 to 2,459, and most of the open area is far above the inundated zone. Two Reclamation monitoring wells (East Side Kachess and West Side Kachess) were constructed on the east and west sides of the reservoir. Both wells are completed in bedrock, and the open interval of both wells is within the inundated zone. Two Reclamation monitoring wells (At Dam and Below Dam) are completed in unconsolidated deposits. The At Dam monitoring well is located on Kachess Dam and the Below Dam monitoring well is south of the dam. The open area for both wells is within the inundated zone.

Hydrographs for the six monitoring wells are included as Figure 3-19 through Figure 3-24. Hydrographs include Kachess Reservoir elevations, calculated groundwater elevations (from electronic data loggers), and manual static water level measurements. The right side of each figure includes the relative depth of the well with the casing shown in gray and the screen or open interval as a black dashed line. Also shown are the current maximum and minimum reservoir elevations and the potential new minimum reservoir elevations associated with KDRPP. Hydrographs include various scales and time periods that depend on groundwater variations, well access, and functioning data loggers.

The following observations and conclusions are drawn from the groundwater level monitoring performed by Ecology:

- Groundwater flow directions are generally toward the center of the Kachess valley and downstream towards the Yakima River. This direction of flow is evident by groundwater elevations being higher than the reservoir elevation on either side of the reservoir and lower than the reservoir elevation downstream from Kachess Dam (Figure 3-23 and Figure 3-24).
- Average depth to groundwater is approximately 60 feet below the land surface, and groundwater elevations increase with distance from the reservoir. Because of the steep terrain in the valley, groundwater elevations not far from the reservoir are likely to always be higher than the reservoir elevation.
- Shallow groundwater fluctuates relatively rapidly in response to recharge and dry periods, as illustrated in Figure 3-19.
- Deeper groundwater response to recharge and dry periods is more attenuated in magnitude and timing, as illustrated in Figure 3-20.
- During mid- to late summer, when releases from the reservoir occur and precipitation and recharge are very low, the aquifer is "draining" and groundwater levels in shallow wells decline to close to the reservoir elevation. The period of lowest groundwater levels is likely to be limited to a few months during the late summer.

- The reservoir is hydraulically connected to the aquifer, and groundwater levels near the reservoir are influenced by reservoir elevations, especially during the dry time of the year when very little recharge is occurring and groundwater elevations are dropping because of discharge from the aquifer (see Figure 3-19, Figure 3-21, and Figure 3-22).
- At locations where wells are open to the aquifer within the inundated zone and are close enough to the reservoir, groundwater elevations are likely to be close to reservoir elevations and react to changes in pool height (Figure 3-21 and Figure 3-22).
- For areas downstream from the reservoir (Figure 3-23 and Figure 3-24), groundwater levels are also likely to be influenced by reservoir elevations. An impermeable core (or cut-off wall) constructed along the length of the dam impedes the seepage of water from the reservoir through the sedimentary deposits under the dam. This cut-off wall is likely the reason for the small hydraulic response observed in monitoring wells below the dam. Although the groundwater levels show an attenuated response to changes in reservoir level, if the reservoir elevation were to drop below the current minimum elevation, groundwater levels would likely experience additional decline as well.

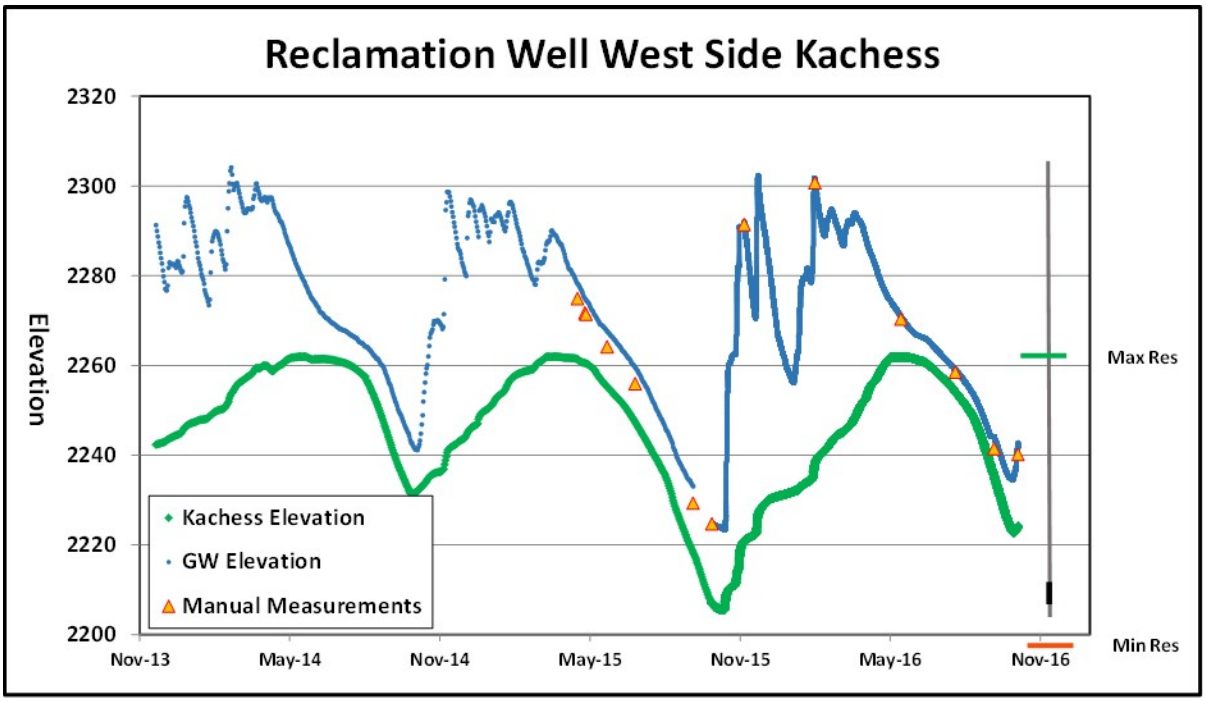



**Figure 3-19. Reclamation Monitoring Well, West Side of Kachess**

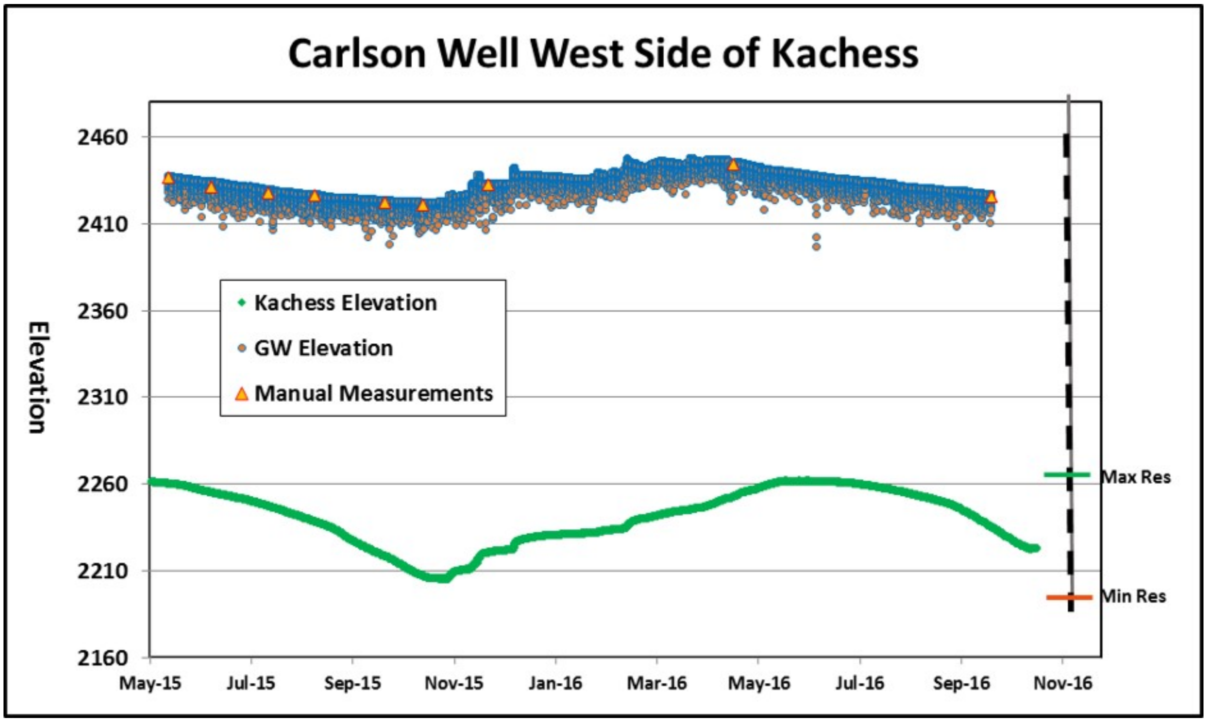



**Figure 3-20. Carlson Domestic Well, West Side of Kachess**

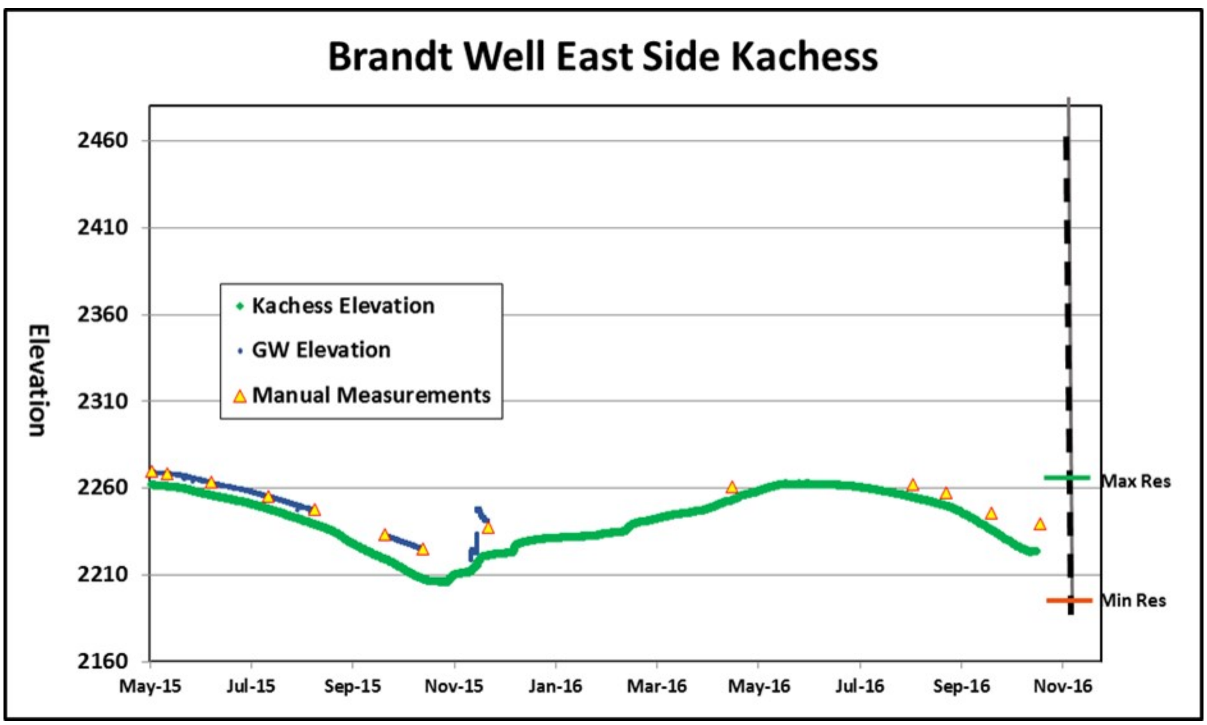



**Figure 3-21. Brandt Domestic Well, East Side of Kachess**

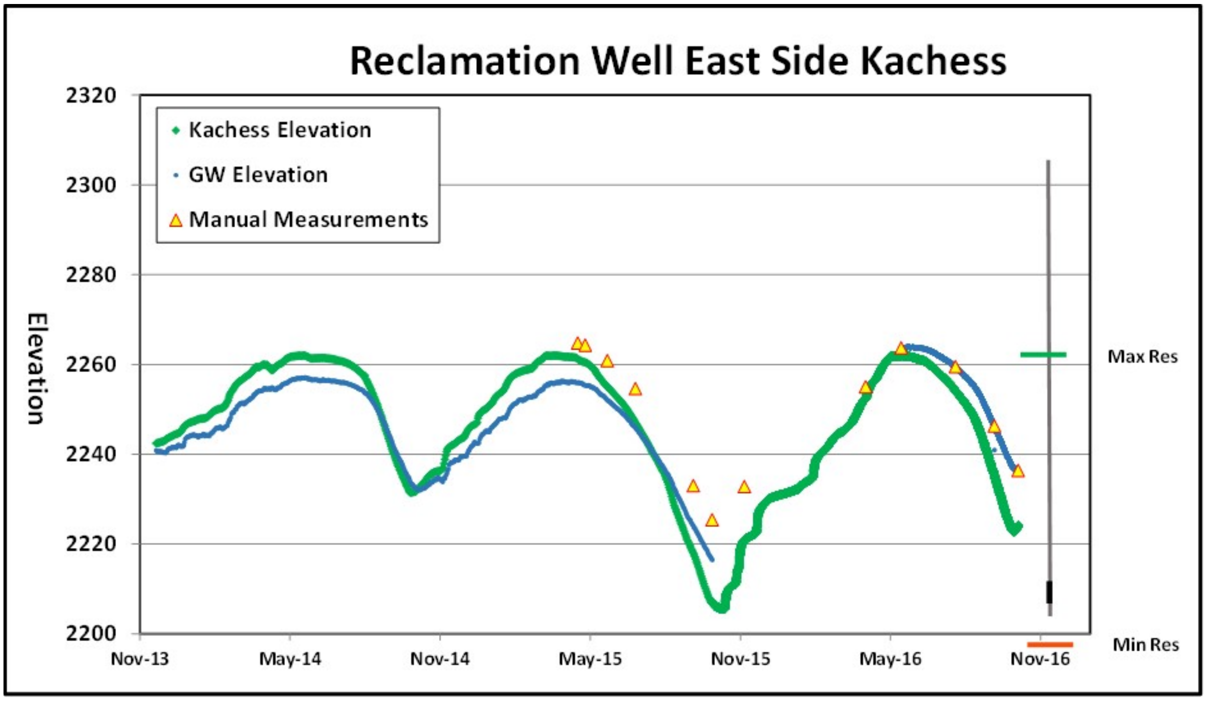



**Figure 3-22. Reclamation Monitoring Well, East Side of Kachess**

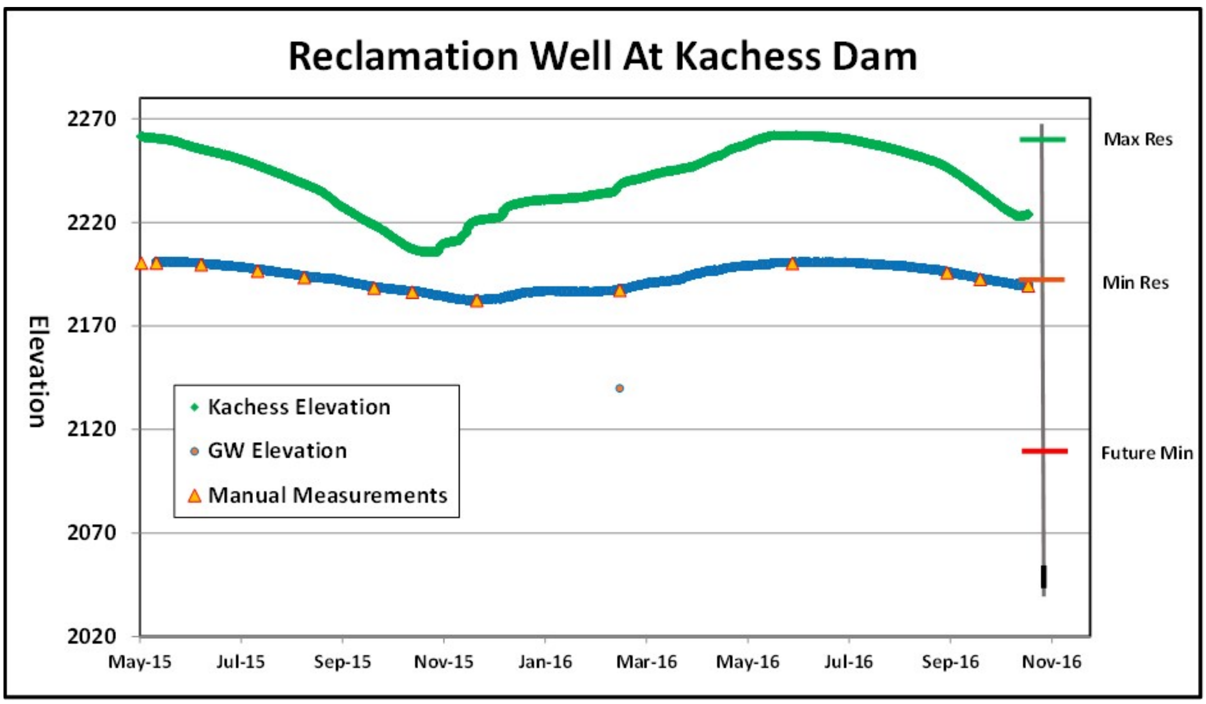



**Figure 3-23. Reclamation Monitoring Well, at Kachess Dam**

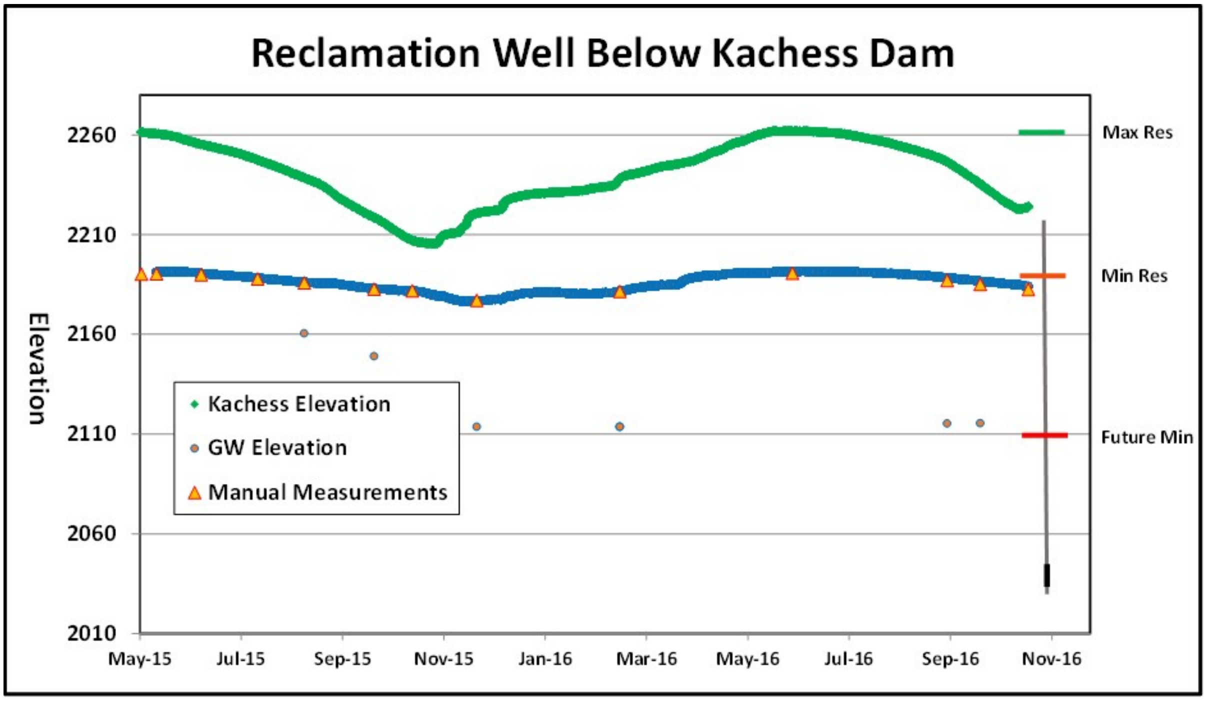



**Figure 3-24. Reclamation Monitoring Well, below Kachess Dam**

During low-pool drawdown conditions, Kachess Reservoir includes a lower reservoir and an upper reservoir that are separated by an earthen high point (the Narrows). During high reservoir levels, the Narrows is inundated and the upper and lower pools join together. The Narrows separates the two reservoirs when the Kachess Reservoir surface water level is below elevation 2,220. The Narrows is about 3,500 feet long and about 1,000 feet wide at its narrowest point (see Figure 3-25). The surface geology at the Narrows is made up of unconsolidated sediments consisting of silt, sand, and gravel at the surface. No soil borings exist to identify the deeper deposits under the surficial sediments in the Narrows; however, it is likely that the deeper geologic deposits in the Narrows are glacial drift or alluvium similar to the geologic deposits at the south end of Kachess Reservoir. The hydraulic conductivity of these materials is assumed to be approximately 10 to 100 feet per day. The vertical thickness of the permeable zones (silt, sand, and gravel) in the subsurface materials is assumed to be 50 feet, and the remainder of the subsurface materials is assumed to be low-permeability deposits that contribute very little to overall groundwater seepage.

### 3.5.2.2 Springs

Kachess Community Association relies on a water supply provided by a spring-fed infiltration gallery near an unnamed tributary, located approximately 300 feet above the Kachess Reservoir high reservoir level. The springs are fed by groundwater originating upslope from the springs. Other springs may exist above the reservoir and are similarly fed by groundwater from higher elevations. It is anticipated that surface water rights may be associated with some springs. A total of 20 surface water rights locations provided by Ecology, which could indicate potential spring locations, are within 2 miles of Kachess Reservoir (see Figure 3-26).

### 3.5.2.3 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 in the primary study area were discovered. However, because wells in the area are used for residential potable supply, because the area is remote, because there is little industrial or commercial land use, and because the aquifer receives a large amount of recharge from precipitation, it is anticipated that groundwater quality in the uppermost aquifers is very good.

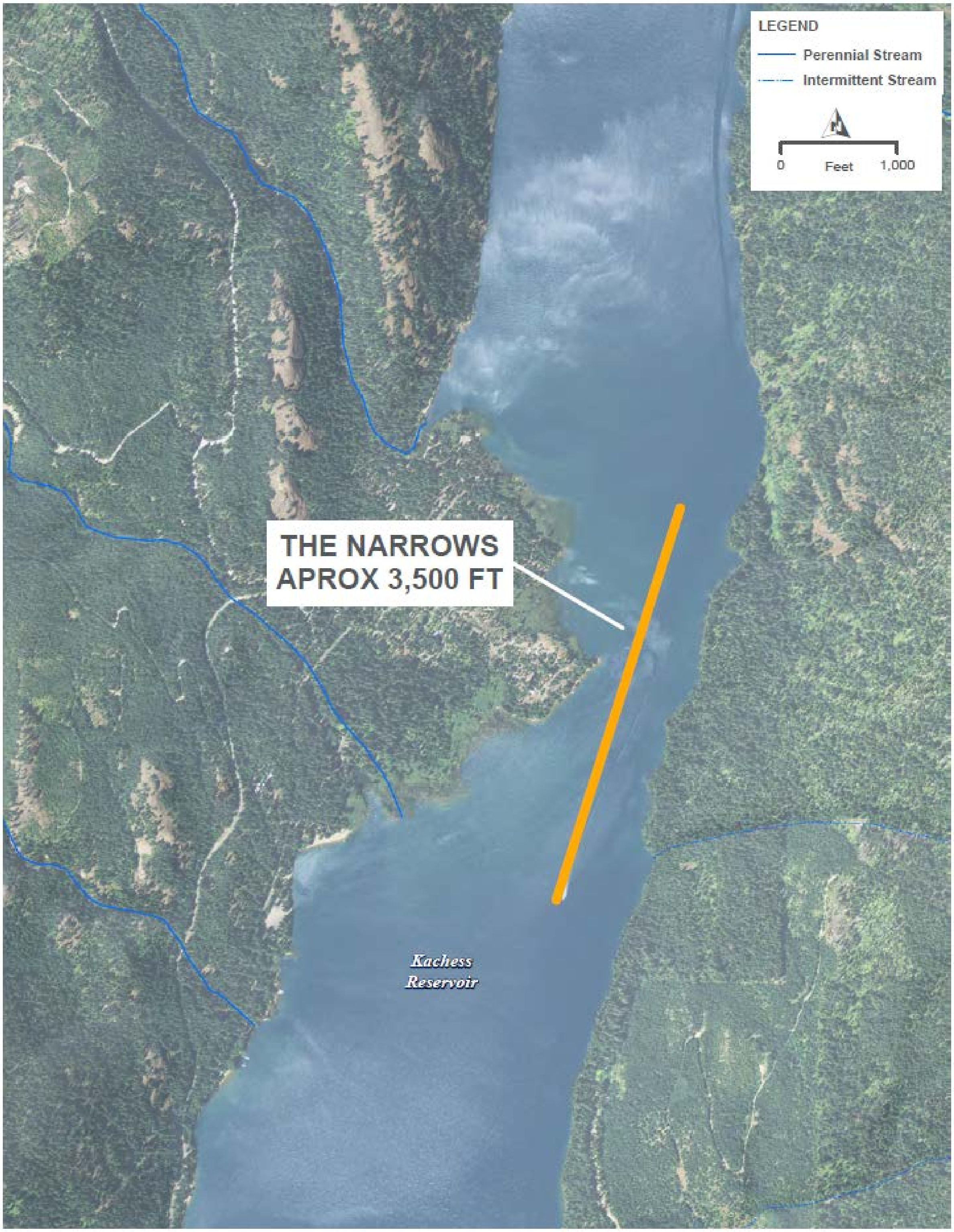



**Figure 3-25. Kachess Reservoir and the Narrows**

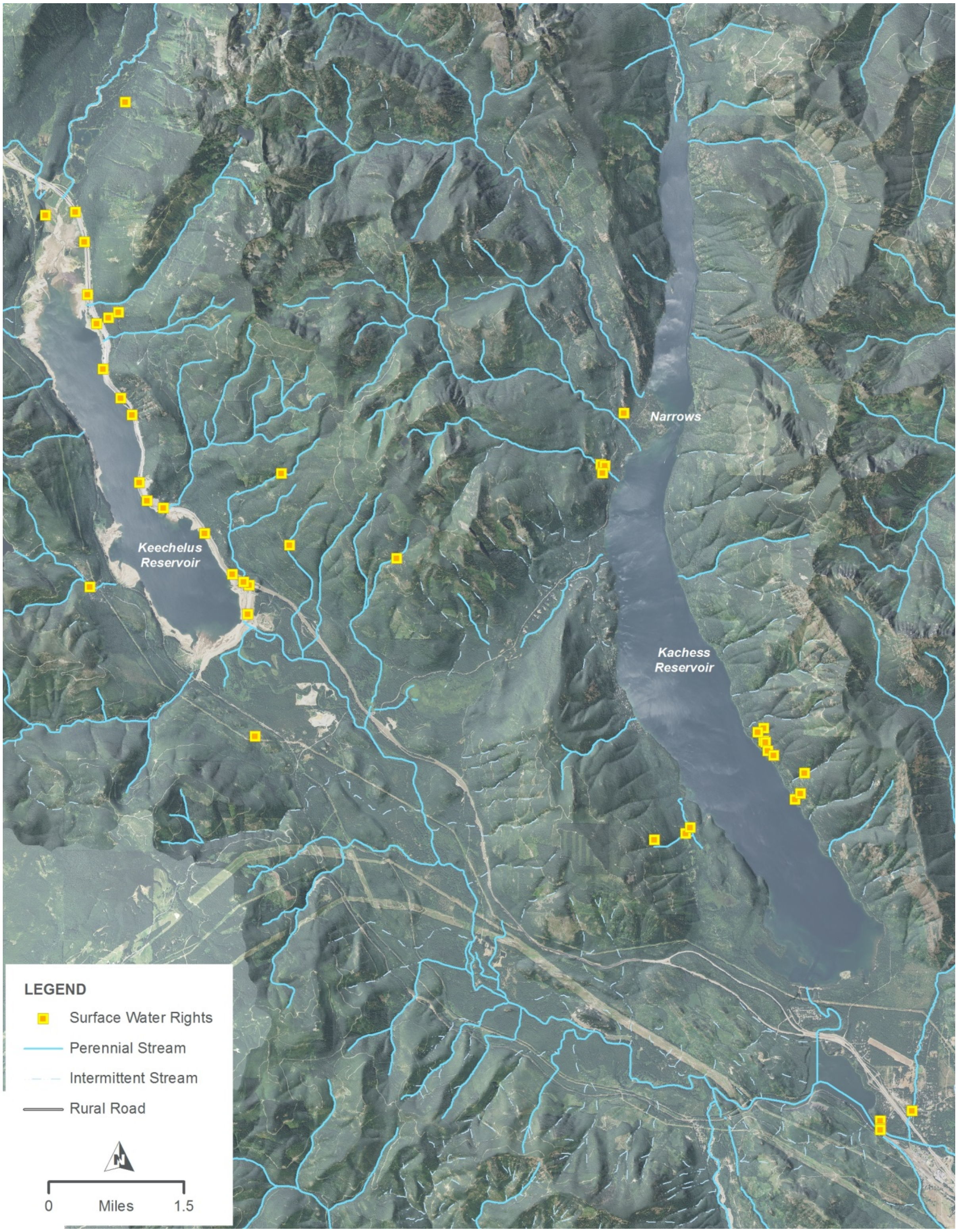



**Figure 3-26. Approximate Locations of Surface Water Rights**

## 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 substantial 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 3-17). Forty-four wells are within 1 mile of the reservoir, approximately 20 of which are dewatering wells that 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 6 wells are less than 100 feet deep and 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 Springs*

Springs may exist above Keechelus Reservoir, and would be fed by groundwater from higher elevations. It is anticipated that surface water rights may be associated with some springs. A total of 24 surface water rights provided by Ecology, which could indicate potential spring locations, are within 2 miles of Keechelus Reservoir (see Figure 3-26).

### *3.5.3.3 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 in the primary study area were discovered. However, because wells in the area are used for residential potable supply, because the area is remote, because 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 North Tunnel Alignment

### *3.5.4.1 Hydrogeology*

The following hydrogeology description focuses on the west end of the tunnel within the Yakima River alluvial valley where groundwater control (dewatering) during construction may affect groundwater levels. The river alluvium and glacial outwash deposits in this area 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 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 3-17). There are 38 wells located within 2 miles of the proposed 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 shores of the reservoir. Only two water supply wells at the permanently closed Crystal Springs campground located southwest of the proposed tunnel alignment are completed within the shallow alluvial deposits and are in hydraulic connection with the shallow alluvial aquifer. These are well numbers 15 and 157 in Figure 3-17.

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 Keechelus Reservoir southeast down the Yakima River valley. Groundwater either flows southeast down the river valley or is discharged into the Yakima River. An impermeable cut-off wall is 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 alignment, 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, 2014d). These data indicate that seasonal groundwater levels fluctuate by 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 that the glacial and alluvial sediments in the study area would likely yield substantial quantities of water during dewatering or other groundwater control efforts for project construction.

#### *3.5.4.2 Springs*

Springs may exist near the proposed KKC alignment, and would be fed by groundwater from higher elevations. It is anticipated that surface water rights may be associated with some springs. Surface water rights, which could indicate potential spring locations, are shown in Figure 3-26.

#### *3.5.4.3 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 study area were discovered. However, it is anticipated that groundwater quality is very good because wells in the area are used for residential potable supply, because the area is remote, because there is little industrial or commercial land use, and because the aquifer receives a large amount of recharge from precipitation and through-flow from the Yakima River.

## 3.6 Fish

The historical lakes and tributaries of the upper Yakima River basin formerly supported anadromous spring Chinook (*Oncorhynchus tshawytscha*), summer steelhead *(Oncorhynchus mykiss)*, coho (*Oncorhynchus kisutch)*, sockeye salmon (*Oncorhynchus nerka)*, and resident bull trout (*Salvelinus confluentus*). However, the construction of dams and irrigation storage reservoirs has precluded anadromous fish access to over 70 miles of productive, historically available habitat in the basin. Kachess and Keechelus dams are 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).

Within Kachess and Keechelus reservoirs, annual operational reductions in reservoir elevations and historic land use actions such as road building and mining have restricted fish access to tributary habitats. Reservoir operations may eliminate or greatly reduce surface water connections between the reservoirs and tributary habitats, thereby creating barriers to fish passage. In addition, perched culverts and tributary channel modifications contribute to degraded fish passage conditions. Reiss et al. (2012) identified passage barriers and dewatering as significant threats to bull trout residing in both reservoirs. Major passage barriers have been identified in Gold and Cold creeks feeding Keechelus Reservoir and in the Kachess River and Box Canyon Creek feeding the Kachess Reservoir (Reiss et al., 2012). Tributary passage conditions are described in more detail in Sections 3.6.2.2 and 3.6.3.2.

Resident fish species currently occupy habitats in the reservoirs and tributaries upstream of Kachess and Keechelus dams. Downstream from 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 and in the Kachess and Yakima rivers downstream from the dams. Bull trout and steelhead, which are Federally listed species, are discussed in Section 3.9.

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

- Kachess Reservoir from the current maximum pool elevation 2,262 to the proposed operational minimum pool elevation 2,112.75
- All tributaries currently accessible to resident fish species that discharge into Kachess Reservoir (e.g., the Kachess River, Box Canyon Creek, Mineral Creek, Thetis Creek, Lodge Creek, and Gale Creek)

- Keechelus Reservoir and all tributaries currently accessible to resident fish species that discharge into Keechelus Reservoir (e.g., Gold, Cold, Meadow, Mill, Coal, and Townsend creeks)
- The Kachess and Yakima rivers within 300 feet of diversion and intake and discharge outlet work construction areas downstream from 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 reservoir outlet works downstream to the Wapato Irrigation Diversion just upstream of Sunnyside Dam in Parker, Washington, which is the lowermost point in the Yakima River basin where water regime influences would be experienced (Figure 1-1).

### 3.6.1 Regulatory Setting

For State water quality standards as they pertains to the maintenance of habitat for fish, including temperature criteria for salmon and trout, refer to Section 3.4.1.3 of Surface Water Quality. The regulatory setting for the recovery of ESA-listed bull trout and Middle Columbia River (MCR) Steelhead is described in Section 3.9, Federal Threatened and Endangered Species.

The Magnuson-Stevens Fishery Conservation and Management Act is the primary law governing marine fisheries management in the U.S. identifies Essential Fish Habitat as, "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Federally managed species with Essential Fish Habitat in the Kachess River and upper Yakima River are Chinook and coho salmon. Other anadromous salmonids, such as steelhead, are rarely captured in the Pacific Fishery Management Council's ocean fisheries and, therefore, are not addressed with regard to Essential Fish Habitat.

Pygmy whitefish are a Washington State sensitive species, which is a native species vulnerable to becoming endangered or threatened in a significant portion of its range within the State without cooperative management or removal of threats (WAC 232-12-297.

### 3.6.2 Kachess Reservoir Area

Kachess Reservoir and contributing tributaries upstream of Kachess Dam support both resident and nonnative fish species. The fish assemblage in Kachess Reservoir and tributaries is expected to be representative of that observed in the upper Yakima River basin. Eastern brook trout are the only expected nonnative fish species in Kachess Reservoir (Anderson, 2014). The occurrence of resident species in the upper Yakima River basin including the reservoirs (Table 3-14) is based on summary data (Mongillo and Faulconer, 1982; Pearsons et al., 1998; Reclamation and Ecology, 2011b; Wydoski and Whitney, 2003), 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 3-14. Potential Habitat Use by Resident (Nonanadromous) Fish Species Inhabiting the Upper Yakima 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 10°C (50°F) | Prefers temperatures close to 10°C (50°F) | Diel vertical migrations between limnetic and deep water habitats | Not expected |
| Mountain whitefish | September to December | September to December | Yes | Not expected | Yes | Typically in temperatures from 8.9°C (48°F) to 11.1°C (52°F) |
| Pygmy whitefish | From late summer to early winter, when temperature is from 0°C (32°F) to 3.9°C (39°F) | From late summer to early winter, when temperature is from 0°C (32°F) to 39°F | Typically in temperatures less than 10°C (50°F) (Hallock and Mongillo, 1998) | Not expected | Typically in temperatures less than 10°C (50°F) (Hallock and Mongillo, 1998) | Typically in temperatures less than 10°C (50°F) (Hallock and Mongillo, 1998) |
| Cutthroat trout | Not expected | March to July, typically in water temperatures around 10°C (50°F) | Prefers waters between 12.2°C (54°F) and 15°C (59°F) and less than 22.2°C (72°F) (Hickman and Raleigh, 1982) | Prefers waters between 12.2°C (54°F) and 15°C (59°F) and less than 22.2°C (72°F) (Hickman and Raleigh, 1982) | Prefers waters between 12.2°C (54°F) and 15°C (59°F) and less than 22.2°C (72°F) (Hickman and Raleigh, 1982) | Prefers waters between 12.2°C (54°F) and 15°C (59°F) and less than 22.2°C (72°F) (Hickman and Raleigh, 1982) |

| Resident Species | Shoreline Spawning | Tributary Spawning | Shallow Littoral Rearing | Open Limnetic Rearing | Deep Water or Benthic Rearing | Tributary Rearing |
|---|---|---|---|---|---|---|
| Rainbow trout | Not expected | February to June | Typically in waters where temperatures are less than 21.1°C (70°F) | Typically in waters where temperatures are less than 21.1°C (70°F) | Move into deep water when surface temperatures exceed 21.1°C (70°F) | Typically in waters where temperatures are less than 21.1°C (70°F) |
| Eastern brook trout (I)* | August to December when water temperatures are between 4.4°C (40°F) to 10°C (50°F) at depths less than 5 feet deep | August to December when temperatures are between 4.4°C (40°F) to 10°C (50°F) and declining | Typically in water temperatures less than 20°C (68°F) | Typically in water temperatures less than 20°C (68°F) | Yes | Typically in water temperatures less than 20°C (68°F) |
| Longnose dace | May to late August at temperatures of 11.7°C (53°F) to 18.9°C (66°F) (Edwards et al., 1983) | May to July | Typically found in shallow waters (Edwards et al., 1983) | Pelagic fry (Edwards et al., 1983) | Not expected | Yes |
| Leopard dace | Not expected | May to July | Observed in temperatures of 15°C (59°F) to 17.8°C (64°F) | Not expected | Not expected | Observed in temperatures of 15°C (59°F) to 17°C (64°F) |
| Speckled dace | Not expected | June to August | Typically from 0°C (32°F) to 20°C (68°F) | Not expected | Not expected | Typically from 0°C (32°F) to 20°C (68°F) |
| Chiselmouth | Not expected | Late May to early July | Typically from 8.9°C (48°F) to 27.2°C (81°F) | Not expected | Not expected | Typically 8.9°C (48°F) to 27.2°C (81°F) |

| Resident Species | Shoreline Spawning | Tributary Spawning | Shallow Littoral Rearing | Open Limnetic Rearing | Deep Water or Benthic Rearing | Tributary Rearing |
|---|---|---|---|---|---|---|
| Redside shiner | April to July | April to July | Typically 12.8°C (55°F) to20°C (68°F) | Not expected | Typically 12.8°C (55°F) to 20°C (68°F) but moves to deep water habitats when temperatures increase | Typically12.8C° (55°F) to 20C (68°F) |
| Peamouth | Late May to June when temperatures range from 10°C (50°F) to 15°C (59°F); hatch in 7 to 8 days at 12.2°C (54°F) | Late May to June when temperatures range from 10°C (50°F) to 15°C (59°F); hatch in 7 to 8 days at 12.2°C (54°F) | Yes | Not expected | Yes | Yes |
| Northern pikeminnow | Late May to early August when temperatures range from 13.9°C (57°F) to 18.3°C (65°F); hatch in 7 days at 64°F | Late May to early August when temperatures range from 13.9°C (57°F) to 18.3°C (65°F); hatch in 7 days at 64°F | Yes | Distributed throughout water column in summer | Typically benthic in winter | Yes |
| Largescale sucker | Not expected | 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 | Not expected | June to July at temperatures of 8.9°C (48°F) to 18.9°C (66°F | Typically 12.8°C (55°F) to 21°C (70°F | Not expected | Not expected | Typically 12.8°C (55°F) to 21°C (70°F) |
| Bridgelip sucker | Not expected | Mid April to mid-June at temperatures 7.8°C (46°F) to 15°C (59°F) | Not expected | Not expected | Not expected | Yes |

| Resident Species | Shoreline Spawning | Tributary Spawning | Shallow Littoral Rearing | Open Limnetic Rearing | Deep Water or Benthic Rearing | Tributary Rearing |
|---|---|---|---|---|---|---|
| Burbot | Late winter through early spring when temperatures are about 1.7°C (35°F) | Late winter through early spring when temperatures are about 1.7°C (35°F) | Moves to shallow water during winter (Bonar et al., 2000) | Pelagic larvae | Summer distribution in deeper waters | Not expected |
| Threespine stickleback | May to August; hatch in 7 days at 17.8°C (64°F) | May to August; hatch in 7 days at 17.8°C (64°F) | Yes | Yes | Yes | Yes |
| Paiute sculpin | May to June | May to June | Observed in warmer waters ranging from 15°C (59°F) to 25°C (77°F) | Not expected | Observed in warmer waters ranging from 15°C (59°F) to 25°C (77°F) | Observed in warmer waters ranging from 15°C (59°F) to 25°C (77°F) |
| Torrent sculpin | April to June | April to June | Yes | Not expected | Not expected | Observed in temperatures ranging from 15°C (59°F) to 22.°C (72°F) |
| Mottled sculpin | Not expected | February to June in waters ranging from 3.9°C (39°F) to 15°C (59°F); eggs hatch in 20 to 30 days at temperatures between 10°C (50°F) and 15.6°C (60°F) | Not expected | Not expected | Not expected | Yes |

Notes: Data presented in table were obtained from Wydoski and Whitney (2003), except where other sources are noted parenthetically in the table.
*Nonnative, introduced species are identified by a parenthetic “I” following species name.

### *3.6.2.1 Kachess Reservoir*

Kachess Reservoir provides lake-type habitat for resident fish species within two connected subbasins: lower Kachess Reservoir and upper Kachess Reservoir. 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 659 days, based on data from 1926 to 2015, as discussed in Section 4.6.4.

Zooplankton is an important food source for fish in Keechelus and Kachess reservoirs (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 the Kachess subbasin was similar to that of Cle Elum Reservoir and higher than that of Little Kachess basin and Bumping Lake, but lower than that of Keechelus Reservoir (Table 3-15; Mongillo and Faulconer, 1982). In terms of numerical zooplankton abundance, Kachess and Little Kachess subbasins ranked highest among the Yakima River basin reservoirs (Table 3-15). 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. A recent comparison of zooplankton densities across the growth season and across reservoirs suggests that during spring and early summer, peak zooplankton production in the top 10 meters (32.8 feet) of the water column could be up to 3 times higher in Cle Elum Reservoir than in Kachess or Keechelus reservoirs (Hansen et al., 2017).

**Table 3-15. Zooplankton Weight and Abundance in Yakima Basin Reservoirs**

| Reservoir | Zooplankton Weight per Volume of Water ($mg/m^3$) | Zooplankton Number per Volume of Water ($number/m^3$) |
|---|---|---|
| Cle Elum | 19.98 | 2,522 |
| Lower Kachess | 19.28 | 5,872 |
| Upper Kachess | 12.47 | 3,319 |
| Keechelus | 28.70 | 1,052 |
| Bumping Lake | 1.75 | 1,499 |

Source: Mongillo and Faulconer, 1982

Generally, zooplankton densities are highest in the warm upper 10 meters of the water column; however in Kachess Reservoir, zooplankton are still a readily available prey item in deeper water (Hansen et al., 2017).

Goodwin and Westley (1967) concluded that the standing crop of zooplankton in 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). Hanson et al. (2015) suggested that the available habitat in Kachess Reservoir could support 10 times more sockeye than kokanee if sockeye replaced kokanee.

Invertebrate prey items other than zooplankton are scarce in Little and Big 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 the total number of individuals, number of species, and size of benthic invertebrates in Yakima River basin reservoirs.

Freshwater shellfish are known to exist in Lake Kachess however no surveys have been done to identify species, distribution, or abundance that exist in the lake. The California floater (*Anodonta californiensis*) is a freshwater mussel that was recently listed as a State of Washington candidate priority species, however Reclamation and Ecology have no specific knowledge of this species existing in Lake Kachess.

Based on gillnet surveys and estimates of angler catches during the 1970s and early 1980s, the overall abundance of resident fish in Big 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 because recent entrainment studies had higher catch rates of resident fish at Kachess Reservoir versus Keechelus Reservoir (Thomas, 2014). A recent gillnet and electroshocking study in the nearshore environment found that kokanee and bull trout are rare; burbot, northern pikeminnow, mountain whitefish, and largescale sucker are present and are evenly distributed across depths; and redside shiner are abundant, primarily occurring in the top 10 meters (33 feet) of the water column. Adult bull trout were observed only in nearshore areas in May prior to development of thermal stratification in the reservoir, and only prespawn kokanee in nearshore areas were observed in the fall while staging for spawning. Midwater trawling showed fish densities are low and comprised mainly of kokanee, with two pygmy whitefish observed (Hansen et al., 2017). Similar to kokanee in other lakes, kokanee in Kachess Reservoir undertake diel vertical migrations, diving deeper, and potentially condensing into schools during the day to avoid predation and to thermoregulate. During the thermally stratified period in summer, optimal temperatures for growth occur below the thermocline and kokanee remain within or below the thermocline (10- to 20-meter depths) (33 to 66 feet) even at dusk and at night, suggesting that their diet may be limited by reduced zooplankton abundance at these depths. Kokanee in Kachess Reservoir exhibit slow growth and small size at age compared to other lake populations and the population is at risk of a feed and growth bottleneck in summer (Hansen et al., 2017).

Top fish predators in Kachess Reservoir are bull trout, northern pikeminnow, and burbot that become increasingly piscivorous with increasing body size over 400 mm (16 inches) (Hansen et al., 2017). Top fish predators in Kachess Reservoir are supported by prey fish that feed on diverse sources of forage in both the reservoir bottom of shallow shoreline areas and in open water areas, in contrast to Keechelus Reservoir which has a food web supported mainly by open water zooplankton (Hansen et al., 2017). Kokanee are a major prey item for predatory fish in Kachess Reservoir. Bull trout are rare compared to other predators; bioenergetic modeling indicates that burbot and pikeminnow could consume approximately 3 times and 8 times, respectively, more kokanee than bull trout in Kachess Reservoir (Hansen et al., 2017).

#### *3.6.2.2 Kachess Tributaries*

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 adequate channel depth to allow permanent or seasonal fish 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).

**Table 3-16. Kachess Tributary Habitats Considered Suitable for Anadromous Salmonids**

| Tributary | Stream Habitat | |
|---|---|---|
| | Potentially Accessible (miles) | Potentially Available above Human-made Barriers |
| Kachess River | 0.90 | 0 |
| Box Canyon Creek | 1.60 | 0 |
| Mineral Creek | 0.25 | 0 |
| Gale Creek | 1.50 | 0 |

Note: 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. USFS (1997) has identified five fish-passage-barrier culverts in miscellaneous tributaries to the Kachess River (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 another waterfall is present 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 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 have ranged as high as 20°C (68°F) (Reclamation, 2005b).

### Mineral Creek

Mineral Creek is 19 miles long, with a natural blockage at RM 0.25. 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 compared to historic conditions for existing resident species and to anadromous species that may be introduced in the future. Persistence of bull trout in similarly impacted tributaries such as Gold Creek and the upper Kachess River suggests these tributaries can provide suitable habitat when accessible.

**Gale Creek.** Gale Creek is 4 miles long with a barrier waterfall above RM 1.5. Fish access is potentially limited because flows may be subsurface in the lowermost stream reach (the first 165 linear feet) when the reservoir is drawn down. Riparian conditions vary among reaches, with Reach 1 having the lowest percentage of 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).

### 3.6.3 Keechelus Reservoir Area

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 3-14). Similarly, Keechelus Reservoir and tributaries provide habitat for Federally listed bull trout (endangered species; described in Section 3.9 and for State listed pygmy whitefish (sensitive species).

#### *3.6.3.1 Keechelus Reservoir*

Similar to the other Yakima River basin reservoirs, Keechelus Reservoir 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 123 days based on data from 1926 to 2016 as discussed in Section 4.6.4. 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 with the baseline estimate obtained for the active pool only.

Of the Yakima Project reservoirs, Keechelus Reservoir ranks highest in the weight of zooplankton per volume of water (Table 3-15). Similar to Kachess Reservoir, zooplankton drives Keechelus Reservoir fish production (Mongillo and Faulconer, 1982); however, the Keechelus Reservoir food web is supported more by open water (i.e., pelagic) production of invertebrate prey compared with Kachess Reservoir (Hansen et al., 2017). The peak bloom of *Daphnia*, the preferred prey source of kokanee, occurs in July in Keechelus Reservoir approximately 1 month later than in Kachess Reservoir, potentially coinciding with thermal stratification that limits access to this prey item for kokanee that prefer to reside below the thermocline.

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 indicates 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).

Freshwater shellfish likely exist in Lake Keechelus however no surveys have been done to identify species, distribution, or abundance that exist in the lake. The California floater (*Anodonta californiensis*) is a freshwater mussel that was recently listed as a State of Washington candidate priority species, however Reclamation and Ecology have no specific knowledge of this species existing in Lake Keechelus.

Keechelus Reservoir had a higher abundance of fish than any other Yakima Project reservoir, based on gillnet surveys and estimates of angler catches during the 1960s through the early 1980s. Kokanee, pygmy whitefish, and northern pikeminnow were captured most frequently (Mongillo and Faulconer, 1982).

### *3.6.3.2 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 adequate channel depth to allow permanent or seasonal fish 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 3-17; Ackerman et al., 2002; Reclamation, 2005b).

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 3-17. Keechelus Tributary Habitats Considered Suitable for Anadromous Salmonids**

| Tributary Stream | Stream Habitat | |
|---|---|---|
| | Potentially Accessible (miles) | Potentially Accessible if human-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 | 1.0 |
| Coal Creek | 2.5 | 2.5 |
| Townsend Creek | 0.2 | 0.5 |

Note: 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 large woody debris presence or pool frequency (Reclamation, 2005b). The standards are 100 pieces of large wood, 36 inches in diameter and 50 feet long; and 100 pieces of small wood, 24 inches in diameter and 50 feet long. The NMFS large-wood standard is 20 pieces of large wood.

### Gold Creek

Gold Creek has a natural falls at approximately RM 7.0 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 large woody debrispresence, 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 large woody debrispresence 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 a maximum water temperature of about 17°C (62.6°F) 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 (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 because of 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 (59°F) around the end of July, and the maximum water temperature can reach 21°C (70°F) during this time period (Reclamation, 2005b).

Anadromous salmonids may have historically used the smaller tributaries of Keechelus Reservoir (e.g., Mill, Resort, and 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 their downstream reaches now inundated by the reservoir (Reclamation, 2005b).

### 3.6.4 Yakima River and Kachess River Downstream from 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 (Table 3-18), 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 from Sunnyside Dam (which is in the middle reach at 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 (see Section 3.3.1.1) 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 River and the Cle Elum River are low, potentially affecting the 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 impacts in the Yakima River around the confluence with the Teanaway River and the Yakima River above the Yakima Canyon.

### Kachess River

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, 2011f).

**Table 3-18. Comparison of Current Seasonal Streamflow Regime to Natural Streamflow Regime for Selected Yakima River Mainstem Reaches**

| Season | Reach | | | | |
|---|---|---|---|---|---|
| | Keechelus | Easton | Ellensburg | Roza | Wapato |
| Winter (Oct–March) | Flow is reduced and is less variable | Flow is reduced | Flow is reduced | Flow is reduced | Flow is reduced |
| Spring (April–June) | Flow is reduced | Flow is reduced | Flow is reduced | Flow is reduced | Flow is reduced |
| Summer (July–Sept) | Flow is greatly increased until early Sept flip-flop | Flow is increased until early Sept flip-flop | Flow is greatly increased until early Sept flip-flop | Flow is greatly increased | Flow is reduced to target flow at Parker |

Note: Adapted from Table 3-11 in Reclamation and Ecology, 2012

### Keechelus Reach

Habitat conditions in the Keechelus reach (RM 214.5 to 202.5) of the Yakima River are heavily influenced by seasonal flow fluctuations that reduce the quality and quantity of available habitat (Table 3-18) 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 affected life stages (NPCC, 2001). The most significant environmental impacts, in descending order, were habitat complexity, flow, and key habitat (NPCC, 2001).

Improving flow conditions in the Yakima River in the Keechelus reach was deemed a high priority in the Integrated Plan. Desired flow objectives for fish and modeled outcomes of the 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

**Easton Reach**

Flow conditions in the Easton reach (RM 202.5 to 185.6) of the Yakima River differ from the natural flow regime (Table 3-18), with low flows in the winter and spring and higher flows in the summer. The primary instream flow objectives for the Easton reach are to increase spawning and rearing habitat and improve outmigration conditions for spring Chinook, sockeye, and coho salmon (Reclamation and Ecology, 2011c).

Specific high-priority flow objectives for the Easton reach include (Reclamation and Ecology, 2011c):

- Increase September and October flows to 220 cfs for spring Chinook and reestablish coho spawners
- Increase minimum flows to 250 cfs all other times for rearing spring Chinook and coho

Instream flows of approximately 150 cfs provide the maximum amount of spring Chinook fry habitat and flows of 750 cfs provide the minimum amount of fry habitat. For juvenile spring Chinook, flows of 300 cfs provide the maximum amount of rearing habitat, whereas higher flows decrease the quantity of available habitat, with a minimum quantity of habitat occurring at flows of approximately 1,100 to 1,200 cfs (Reclamation, 2008a).

For resident rainbow trout, the maximum amount of rearing habitat occurs at 3,500 cfs and the minimum amount of habitat occurs at 700 to 900 cfs. The maximum quantity of subyearling juvenile rearing habitat occurs at 300 cfs and the minimum amount of habitat occurs at 1,300 cfs (Reclamation, 2008a).

**Ellensburg (Umtanum) Reach**

To address differences between the operational and natural flow regime in the Ellensburg reach (RM 176.1 to 127.9; Table 3-18) of the Yakima River, the primary flow objective is to improve fish-rearing conditions. During July through early September, flows are too high for anadromous salmonids (Reclamation and Ecology, 2011c).

Specific high-priority flow objectives for the Ellensburg reach include (Reclamation and Ecology, 2011c):

- Reduce flow by 1,000 cfs beginning July 1 to improve rearing conditions for juvenile Chinook and coho

- Reach a flow of 1,000 cfs by August 31

Maximum fry habitat for spring Chinook occurs around 2,400 cfs. The quantity of side channel habitat for spring Chinook fry begins to level off at flows greater than approximately 2,300 cfs. The best condition for juvenile rearing habitat for spring Chinook is between 400 and 80 cfs, but decreases as flows increase to 2,400 cfs (Reclamation, 2008a).

For resident rainbow trout, minimum and maximum fry habitat occurs at 1,288 and 4,000 cfs, respectively. The amount of subyearling rainbow trout habitat is maximized between 400 and 800 cfs, and decreases at higher flows (Reclamation, 2008a).

**Roza Reach**

To address differences between the operational and natural flow regime in the Roza Reach (RM 127.9 to 103.8; Table 3-18) of the Yakima River, the primary flow objectives are to improve conditions for fall and winter spawning and rearing and spring smolt outmigration (Reclamation and Ecology, 2011c).

Specific high-priority flow objectives for the Roza reach include (Reclamation and Ecology, 2011c):

- Increase flows in the spring to a minimum of 1,400 cfs to benefit all salmonid species in the Yakima River basin, including spring Chinook, steelhead, coho, and sockeye
- Increase flows in the fall and winter to between 1,000 and 1,400 cfs to improve habitat quality and quantity for spring Chinook, steelhead, and coho that rear in this reach

**Wapato Reach**

To address differences between the operational and natural flow regime in the Wapato Reach (RM 103.8 to 80.4; Table 3-18) of the Yakima River, the primary instream flow objectives are improving spring smolt outmigration in dry years and summer rearing conditions (Reclamation and Ecology, 2011c).

The specific high-priority flow objective for the Wapato reach includes (Reclamation and Ecology, 2011c):

- Provide a spring pulse of 15,000 to 20,000 acre-feet in early May in dry years to improve smolt migration conditions for spring and fall Chinook, steelhead, coho, and sockeye

Coho salmon are the primary salmonid species residing in this reach during the summer. The maximum quantity of coho rearing habitat occurs at approximately 5,000 cfs (Reclamation, 2008a).

#### *3.6.4.1 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). Migration timing is summarized in Table 3-19 for adults, and in Table 3-20 for juvenile migration.

**Table 3-19. 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 | | | | | | | | | | | | |

Note: Adapted from Reclamation, 2005b; steelhead is discussed in Section 3.9.
= General Migration Period
= Peak Migration Period

**Table 3-20. 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 | | | | | | | | | | | | |

Note: Adapted from Reclamation, 2005b; steelhead is discussed in Section 3.9.
= General Migration Period
= Peak Migration Period

#### *3.6.4.2 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 (Berg and Fast, 2001; Pearsons et al., 1996). 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 number of spring Chinook adults passing Roza Dam and entering the upper Yakima River has been stable, centered around a 10-year average (2007 through 2016) of 5,421 (Columbia River DART, 2017) and the average number of redds observed between Keechelus and Easton dams is 86 (Hubble, 2014a).

#### *3.6.4.3 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. A recently-funded expanded hatchery program will rear and release up to 700,000 juvenile coho salmon in the upper Yakima and Naches River watersheds each year (BPA-DOE 2018).

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 (2007 through 2016) of coho adults passing Roza Dam and entering the upper Yakima River is 692 (Columbia River DART, 2017). Since coho salmon began migrating upstream of Roza Dam again (in 1997), the numbers of individuals have varied year to year, with a peak run of 3,915 fish in 2014.

#### 3.6.4.4 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 depend on lakes for juvenile rearing, and the 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 through 2016, attributable 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). Since the reintroduction period began (2009), the number of sockeye that have passed Roza Dam has varied annually, ranging from 13 to 3,949 fish with an average of 942. (Columbia River DART, 2017).

#### 3.6.4.5 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 affect 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 Reservoir shoreline
  - Kachess Reservoir banks between elevations 2,262 (maximum pool) and 2,112.75 (proposed operational minimum)
  - Downstream locations along the Kachess River that could be affected by construction and project operations
  - Transmission line route
  - Proposed location for the Kachess Reservoir portal (KKC)
- Keechelus Reservoir
  - Location of the proposed KKC facilities area
  - Area along the Keechelus Reservoir shoreline
  - Keechelus reach of the Yakima River
- KKC North Tunnel Alignment
  - Areas overlying the proposed tunnel alignment, as described in Chapter 2

The Kachess Reservoir area is discussed in Section 3.7.2, the Keechelus Reservoir area is discussed in Section 3.7.3, and the KKC area is discussed in Section 3.7.4.

The extended study area is the Yakima River basin (Figure 1-1). For vegetation and wetlands, potential downstream effects of the action alternatives would most likely occur on the Kachess River and the 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, narrow-crested ridges, and high-relief peaks approaching an elevation of 8,000 feet (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, Kachess Lake Campground on Kachess Reservoir, Kachess portals and discharge structure sites, and KKC facility site 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 EIS.

## 3.7.1 Regulatory Setting

Vegetation and wetlands that may be affected by project activities are subject to the multiple regulations, programs, plans, and policies. Federal regulations and policies include the CWA, which regulates the discharge of fill material in "waters of the U.S.", which includes wetlands. WAC Chapter 220-110 (Hydraulic Code) requires an environmental permit for construction activities in or near Washington State waters.

## 3.7.2 Kachess Reservoir Area

### *3.7.2.1 KDRPP East Shore Pumping Plant Site*

**Vegetation**

Vegetation at the proposed East Shore Pumping Plant site on the east side of Kachess Reservoir is gently sloped and consists of two distinct communities: a deciduous tree community and a 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 consists 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 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-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 3-27). The NWI provides a landscape-scale inventory of wetlands and does not replace the accuracy of onsite wetland delineations. The NWI's mapping resolution 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 onsite wetland delineations would be conducted as part of project-level evaluations.

The NWI classifies all of Kachess Reservoir as a lacustrine (freshwater lake) wetland—defined as deep water habitat that exceeds 20 acres and lacks trees, shrubs, or emergent vegetation (Cowardin et al., 1979). One palustrine emergent wetland (approximately 0.4 acre) is mapped on the NWI south of the left (north) abutment of Kachess Dam near the proposed pipeline discharge spillway (Figure 3-27). 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 Pumping Plant facility (Figure 3-27). 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 3-27). 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 inventory and none were observed near the proposed causeway access road or transmission line alignment.

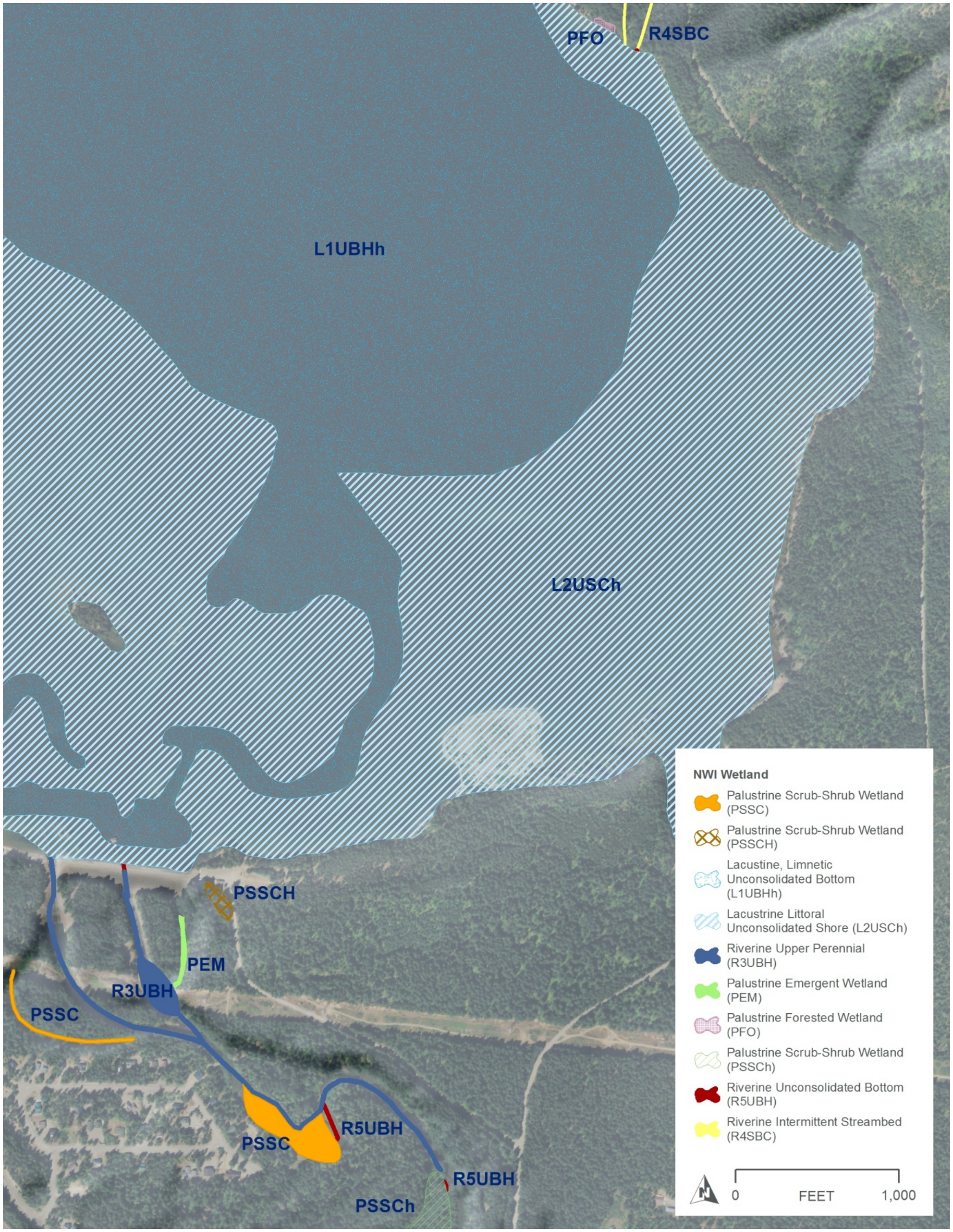



**Figure 3-27. Wetlands in the Kachess Reservoir Study Area**

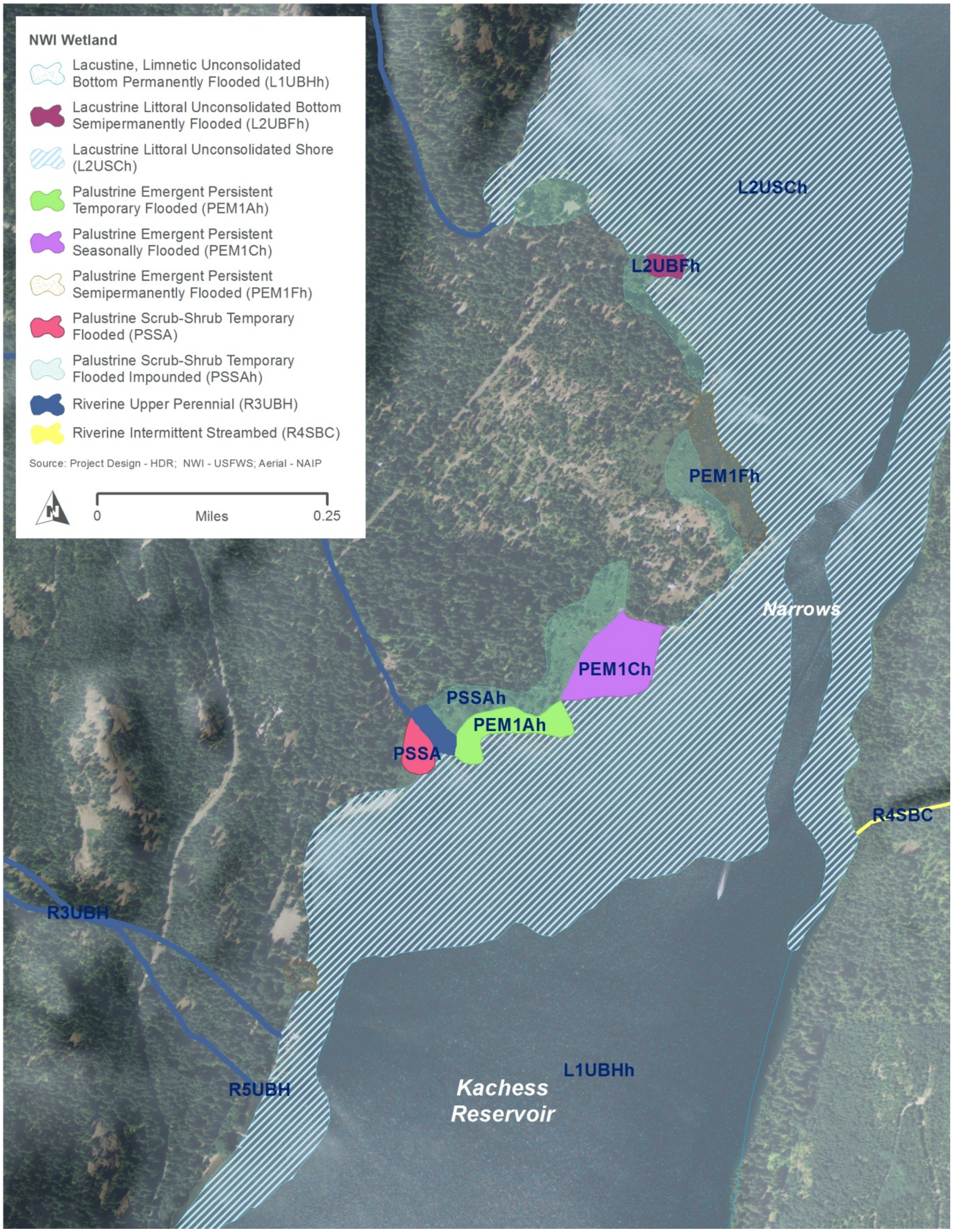



**Figure 3-28. Wetlands in the Narrows Study Area of Kachess Reservoir**

### *3.7.2.2 KDRPP South Pumping Plant Site*

**Vegetation**

The proposed south pumping plant facility would be sited in a mature coniferous and deciduous forest stand south of Kachess Dam (Figure 3-27). The proposed intake and tunnel would be located along the unvegetated floor of Kachess Reservoir. Vegetation along the proposed transmission line alignment consists of second-growth coniferous forest.

**Wetlands**

NWI mapped wetlands near 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 south of Kachess Dam (Service, 2013) (Figure 3-27). 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.

### *3.7.2.3 KDRPP Floating Pumping Plant Site*

**Vegetation**

The proposed floating pumping plant site would be located along the unvegetated floor of the Kachess Reservoir. The proposed east shore boat ramp and parking area would be sited in a second-growth coniferous forest dominated by Douglas-fir and the floor of the Kachess Reservoir.

**Wetlands**

The proposed floating pumping plant and east shore boat ramp would be located in Kachess Reservoir, which is mapped in the NWI as a lacustrine wetland feature. No wetland features are mapped along the east shore parking area.

### *3.7.2.4 Kachess Reservoir from Elevation 2,262 to the Minimum Pool Elevation 2,112.75*

As discussed previously, 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 along the west side of the reservoir and near the mouth of the Kachess River at the north end of the reservoir (Figure 3-28) (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.

#### *3.7.2.5 Kachess River Downstream from 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 downstream from 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 from the Kachess River, the NWI maps two freshwater scrub-shrub wetlands whose sizes range from 2.5 to 3.4 acres. Lake Easton is mapped as a 224-acre lacustrine feature.

#### *3.7.2.6 Kachess Portals and Discharge Structures for KKC*

**Vegetation**

*Alternative 3 – KDRPP South Pumping Plant* includes a portal and discharge structure on the west shore of Kachess Reservoir. Vegetation at the portal and discharge structure consists of second-growth and sub-mature 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.

**Wetlands**

The portion of Kachess Reservoir shoreline at the proposed discharge location 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 (Service, 2013).

### 3.7.3 Keechelus Reservoir Area

#### *3.7.3.1 KKC Facility Sites*

**Vegetation**

Vegetation near Keechelus Dam is a mix of upland forest, wetland habitats, and disturbed areas associated with an old borrow pit and existing operations at Keechelus Dam (Dubendorfer, 2002). The Yakima River diversion and intake would be 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.

*Alternative 5A, 5B, and 5C* include two conveyance options for the conveyance 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 Keechelus Dam as a riverine feature (Service, 2013).

The 9-acre wetland mitigation site downstream from Keechelus Dam consists of a series of excavated pools constructed in the early 2000s to compensate for wetland impacts attributable to repairs to Keechelus Dam (Dubendorfer, 2002) (Figure 3-29). 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, species such as field pennyroyal, common cattail, and burr-reed. Scrub-shrub wetland vegetation—mainly willows and red alders—is established upslope of the excavated pools (Figure 3-29).

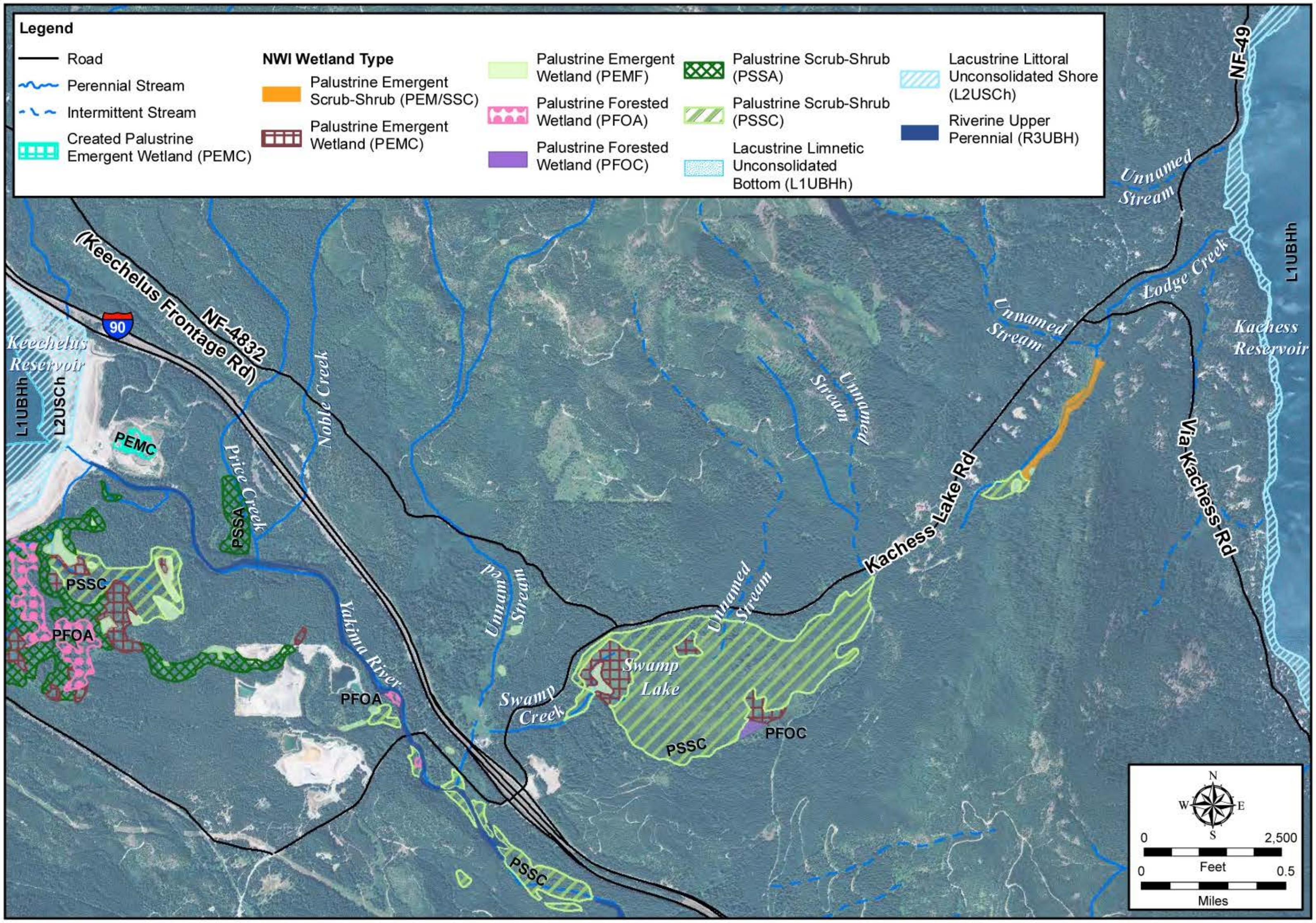



**Figure 3-29. Wetlands in the KKC Study Area**

### 3.7.3.2 Keechelus Reservoir

**Vegetation**

Vegetation along the Keechelus Reservoir shoreline is predominantly wetland vegetation (discussed in the next subsection). 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 are mainly scattered palustrine wetlands, occurring generally in areas with gently sloping shorelines that allow for the establishment of rooted vegetation (Figure 3-29). 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.

### 3.7.3.3 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 consists 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 3-29) (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 shrubs, 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 of forage opportunities, refugia opportunities, and intact movement corridors for terrestrial animals (Hruby, 2004).

## 3.7.4 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 3-29).

### 3.7.5 USFS Survey and Manage Standards and Guidelines for Vascular Plant Species

As part of the *Northwest Forest Plan* (USFS, 2011), 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 (BLM, 2011). Some species require preproject surveys and prescribed management actions, if found.

Appendix D provides the USFS Survey and Manage standards and guidelines list of vascular plant species that have been documented in the Cle Elum Ranger District (Garvy-Darda, 2014; Lau, 2012; USFS, 2001).

### 3.7.6 State Sensitive Species

Two State sensitive vascular plant species—western ladies tresses and water alwort—have been recorded near 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 near 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).

### 3.7.7 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 in Appendix D 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 and include construction activities, changes in reservoir pool elevations, and downstream changes, as described in Chapter 4. Based on these types of impacts, the primary study areas for wildlife and wildlife habitat include the following areas:

- Kachess Reservoir

- The portion of Kachess Reservoir shoreline that would be exposed during drawdown (between elevations 2,262 and 2,112.75) for KDRPP
- Wildlife habitats within 1 mile of proposed facility construction sites along the Kachess Reservoir shoreline for KDRPP
- The Narrows at Kachess Reservoir for construction of the Volitional Bull Trout Passage Improvements
- Wildlife habitat within 0.25 mile of the proposed new transmission line

- Keechelus Reservoir
  - 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
  - The Kachess River within 300 feet of proposed diversion, intake, and discharge outlet structures

- KKC North Tunnel Alignment
  - Wildlife habitat within 0.25 mile of the proposed KKC North Tunnel alignment
  - The Yakima River within 300 feet of the proposed diversion, intake, and discharge outlet structures

The extended study area is the Yakima River basin, which encompasses the Kachess and Keechelus Reservoir 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 Regulatory Setting

Laws, regulations, and guidance applicable to vegetation and terrestrial wildlife associated with the proposed project are at the Federal, State, and local levels. In addition to Federal regulations pertaining to listed threatened and endangered species under the ESA as described in Section 3.9.1, and the CWA described in Section 3.4, the USFWS has statutory authority and responsibility for enforcing the Migratory Bird Treaty Act (MBTA). The MBTA (16 USC 703–713) makes it illegal for anyone to “take,” possess, import, export, transport, sell, or purchase, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations. The MBTA implements conventions between the U.S. and four countries (Canada, Mexico, Japan, and Russia) for the protection of migratory birds. Additionally, the Bald and Golden Eagle Protection Act (16 USC 668–668c) prohibits anyone without a permit issued by the Secretary of the Interior from "taking" bald eagles, including their parts, nests, or eggs.

State and local regulations are in place to protect critical areas and natural resource lands for fish and wildlife species. Washington Natural Area Preserves Act (RCW 79.70) established the Washington Natural Heritage Program within the DNR to identify which species and ecosystems are priorities for conservation. Washington State Forest Practices Rules (WAC 222) establishes standards for forest practices such as timber harvest, precommercial thinning, road construction, fertilization, and forest chemical application. At the local level, the Kittitas County critical areas ordinance, developed under the Growth Management Act, requires the county to designate and protect critical areas. Critical areas are defined as wetlands, aquifer recharge areas, frequently flooded areas, geologically hazardous areas, and fish and wildlife habitat conservation areas.

### 3.8.2 Kachess and Keechelus Watersheds

The project area occurs 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 large mammals including elk and deer, carnivores such as cougar and bear, 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 harvesting. Coniferous forests are the most prevalent habitat type and range from relatively recent clearcuts to single-species, even-aged stands to mature or old growth forest. Fire suppression has created overly dense stands, while logging practices have removed the largest, oldest trees.

The project area 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 disrupts 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 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 site near Keechelus Dam. More recently, as part of WDFW's impact assessment for these projects, wildlife and habitat surveys were conducted in 2014 and 2015, and spotted owl surveys in 2015 and 2016 (WDFW, 2016). Forested habitats in vegetation disturbance areas on the western shore of Kachess Reservoir for the two alternatives under KKC were assessed in October 2014 and April 2015. Habitats were also assessed between the Yakima River diversion and the Keechelus portal near I-90. Assessments were also conducted around potentially impacted areas as a result of the proposed KDRPP including the east shore and south shore pumping plants, transmission lines, permanent and temporary access roads, power substations and temporary construction facilities (WDFW, 2016).

### 3.8.3 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, such as 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, an 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 in Section 3.8.6.

Steep topography and fluctuating water levels in the reservoir limit emergent wetland or riparian habitats along the shoreline. 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. For the floating pumping plant alternative, the proposed boat ramp parking area on the east shore would be in similar habitat, but the pumping plant itself would be on the reservoir. 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 3-30).

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 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.

**Figure 3-30. Conifer Habitat at KDRPP Kachess River Discharge**

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.

### 3.8.4 Keechelus Reservoir Area

The Keechelus Reservoir area is similar to the Kachess Reservoir area in its 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 3.8.2, 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, 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 constructed in the early 2000s for the Keechelus Dam repair project (Dubendorfer, 2002). 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).

### 3.8.5 KKC North Tunnel Alignment

Wildlife habitats for the KKC portal location are described in Sections 3.8.3 and 3.8.4. Currently, little to no wildlife habitat is present at portal locations, an expected condition given past clearing and current levels of human activity and noise. Wildlife habitats including coniferous forest and portions of the Swamp Lake wetland complex are located adjacent to the portal area.

Wildlife habitats along the KKC tunnel route 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, and grizzly bear (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.

### 3.8.6 State Species of Concern

In 2014 and 2015, WDFW biologists conducted surveys for wildlife and habitat in the expected area of impact for the various project alternatives and recorded Priority Habitats and Species. WDFW 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, present habitat. The WDFW priority habitats in the primary study area include cliffs, bluffs, riparian areas, and wetlands, and elk, white-tailed deer, and mountain goat habitat (WDFW, 2014a).

New priority habitat and species observations were discovered during general wildlife surveys and included pileated woodpecker observations at the Kachess portal and in the area immediately west of the Yakima River proposed diversion for KKC. A talus area just north of the KKC North Tunnel Alignment portal to Kachess has the potential for presence of Larch Mountain salamander, a state sensitive and USFS survey and manage species. WDFW in coordination with USFS is currently conducting presence/absence surveys for this species.

Sooty grouse were also observed in the Kachess Portal area. Evidence of both deer and elk was regularly encountered, and a variety of birds and nongame mammals were also encountered during the surveys (WDFW, 2015).

Areas surveyed for the KDRPP options, particularly the pumping plant at the East Shore location, would be adjacent to Kachess Ridge which is known habitat for mountain goats and also mapped within Priority Habitat and Species as goat winter and summer range. Mountain goats were observed on Kachess Ridge during the surveys and mule deer were frequently encountered, either through animal presence or their sign in all of the forested habitats impacted by the KDRPP options (WDFW, 2015). Deer were frequently observed below Kachess Dam in the area. When reservoir levels were low in fall 2014, grebes, common loon and various waterfowl species such as common goldeneye and common merganser were observed foraging in this area. A variety of birds and nongame mammals were also encountered during the surveys (WDFW, 2015). 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 affect threatened and endangered species: construction activities, changes in reservoir pool elevations, and downstream changes, as described in Section 4.9.

Based on these types of impacts, the primary study areas for threatened and endangered species include the following areas (see Chapter 2 figures for additional detail):

- Kachess Reservoir
  - Kachess Reservoir banks between elevations 2,262 (maximum pool) and 2,112.75 (proposed operational minimum)
  - Terrestrial habitat within 1 mile of proposed facility construction along the Kachess Reservoir shoreline
  - All tributaries that discharge into Kachess Reservoir (Kachess, Mineral, and Box Canyon creeks) and that are currently accessible to listed fish species
- Keechelus Reservoir
  - Keechelus Reservoir and all tributaries currently accessible to listed fish species that discharge into Keechelus Reservoir (Cold and Gold creeks) and that are currently accessible to listed fish species
  - 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
  - The Kachess and Yakima rivers within 300 feet of proposed diversion, intake, and discharge outlet structures
- KKC North Tunnel Alignment

– Terrestrial habitat within 0.25 mile of the KKC North Tunnel alignment

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 primarily affect listed fish species that occur in the mainstem Yakima River from the existing Kachess and Keechelus reservoir outlet works downstream to the Wapato Irrigation Diversion just upstream of Sunnyside Dam in Parker, Washington, which is the lowermost point in the Yakima River basin where water regime influences would be experienced (Figure 1-1).

### 3.9.1 Regulatory Setting

The 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.

### 3.9.2 Listed Species and Critical Habitat

Federally listed species with the potential to occur within the primary and extended study areas, along with designated or proposed critical habitat are included in Table 3-21. The Federal species lists were obtained from the Service and NMFS in May 2014.

**Table 3-21. Species Federally Listed or Proposed for Listing that Potentially Occur in the Primary Study Area and Extended Study Area**

| Species | Federal Status[a] | Anticipated Occurrence in Primary Study Area[b] | Anticipated Occurrence in Extended Study Area[b] | Critical Habitat in Primary Study Area/Extended Study Area? |
|---|---|---|---|---|
| Bull trout – Columbia River DPS[c] | T | Yes | Yes | Yes/Yes |
| Steelhead – Middle Columbia River DPS | T | Yes | Yes | Yes/Yes |
| Northern spotted owl | T | Yes | No | Yes/Yes |
| 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 |
| North American wolverine | PT | No | No | None |

[a]E = endangered, T = threatened, PT = proposed threatened
[b]Primary study area and extended study area as identified in Section 3.9.
[c]DPS = distinct population segment

All species listed in Table 3-21 could be affected by KDRPP and KKC, 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 (i.e., the populations are genetically isolated). Steelhead numbers in the Yakima River 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 is larger and more aggressive and can displace northern spotted owls. Barred owls they adapt more readily to human disturbance and have 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 and key tributaries to the upper Yakima River basin reservoirs are included in the designation. Reservoir tributaries designated as critical habitat include Cold and Gold creeks (Keechelus Reservoir) and Box Canyon and Mineral creeks and the Kachess River (Kachess Reservoir).

As part of the Integrated Plan, Reclamation and Ecology identified several Bull Trout Enhancement (BTE) projects to address the need to improve the resiliency of bull trout populations in the Yakima River Basin (Reclamation and Ecology 2011). The BTE framework identifies BTE projects and the rationale used to prioritize, develop, and implement them (Appendix C), informed by population information and proposed next steps provided in the Yakima Bull Trout Action Plan (BTAP; Reiss et al. 2012).

Bull trout occurred historically throughout most of the Yakima River basin. Today, however, they are fragmented into relatively isolated populations (Table 3-22). Although bull trout were probably never as abundant as other salmonids in the basin—attributable 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 3-22. Yakima Basin Bull Trout Stocks Recognized by WDFW (Definitions for status classifications appear below table)**

| Stock | Life History Form | Status | Comments |
|---|---|---|---|
| Keechelus Reservoir | Adfluvial | Critical | Chronically low redd counts |
| Kachess Reservoir | 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[b] | Fluvial | Critical | Chronically low redd counts |
| Ahtanum Creek | Resident | Critical | Chronically low redd counts |

Source: WDFW, 1998
[a]Status rating are defined following the table.
[b]*Stock not recognized by the Service as a subpopulation in the final listing rule.

The WDFW status ratings shown on Table 3-22 include the following:

- 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 at which 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

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

**Stock**

Fish spawning in a particular lake or stream(s) (or portion of it) at a particular season that, to a substantial degree, do not interbreed with any group spawning in a different place, or in the same place at a different season.

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 make up 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 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 River basin. These local populations are listed in Table 3-23.

Bull trout have been observed in each of the 16 tributaries listed in Table 3-23, 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 3-23 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 3-23): 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 3-23. Bull Trout Local Populations and Primary Life History Types in 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 | Migratory adfluvial |
| 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 bull trout was listed on the ESA. 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, Reclamation and Ecology determined that this approach was the most accurate and reliable method. The *Yakima Core Area Status Assessment Template* (Service, 2005a) rated redd data quality and quantity in the Yakima River 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 Keechelus Reservoir, Kachess Reservoir Yakima River, Cle Elum River, and Teanaway River subpopulations (Service, 2002). The Keechelus Reservoir, Kachess Reservoir, and Yakima River subpopulations are known to occur in the project area; however, individual fish from other subpopulations may migrate into the affected reaches of the upper Yakima River to rear or forage. Figure 3-31 shows the current bull trout distribution and confirmed spawning areas in the upper Yakima River basin (WDFW, 2017). This map provides the most up-to-date information on bull trout use of the upper Yakima River system. In addition to known spawning in Gold Creek, Mineral Creek, and Box Canyon Creek, bull trout have been observed in other tributaries to Lake Kachess including Gale Creek, and tributaries to Lake Keechelus including Rocky Run Creek, Resort Creek, and Coal Creek.

Bull trout spawn in late summer and early fall, and most spawning activity in the Yakima River 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.

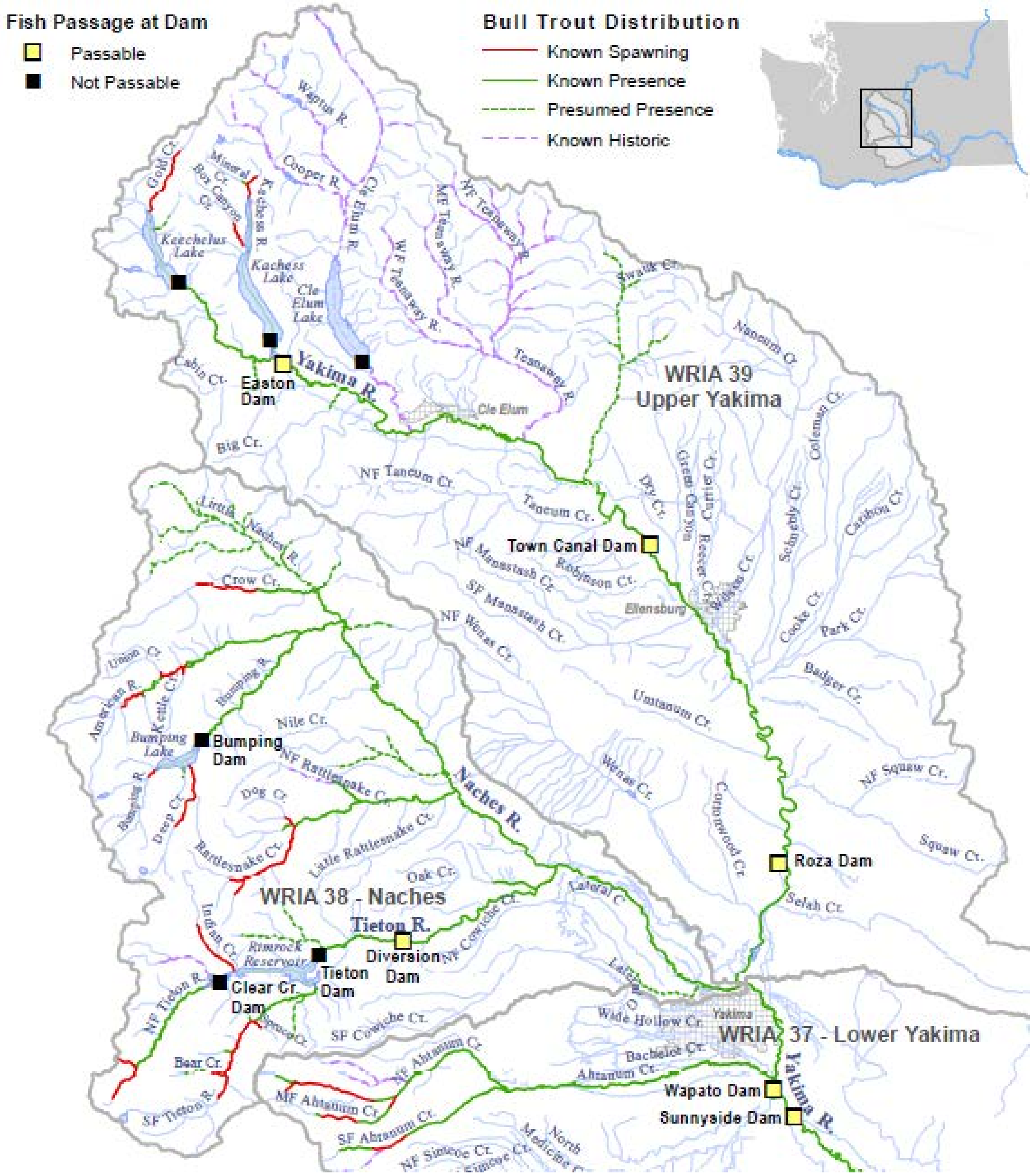



**Figure 3-31. Upper Yakima River Drainage Bull Trout Distribution and Spawning Areas**

### 3.9.3.1 Kachess Reservoir Subpopulation

An adfluvial subpopulation of bull trout occur in Kachess Reservoir in low numbers. Adult bull trout prey primarily on kokanee and prefer to prey on fish that forage in open water (pelagic zone) as opposed to those that live near the shoreline or lake bottom (Hansen et al. 2017). Due to their low numbers and abundant prey sources, adult bull trout population sizes are not currently limited by foraging opportunities or competition by other piscivorous fish (e.g. northern pikeminnow and burbot; Hansen et al. 2017). The abundance of bull trout may currently be limited by other factors, such as resource limitations during juvenile life stages or poor suitability and access to spawning and rearing habitat.

Bull trout enter their spawning streams from July to early October and spawn from mid-September through mid-October in this subpopulation (USFS, 2004; WDFW, 1998). 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 major tributaries (Kachess River and Mineral Creek and Box Canyon Creek) because of impassible barriers and the predominance of large substrate material. Bull trout may use any accessible tributaries, including Gale Creek, for rearing and overwintering habitat. Bull trout have been observed in Lake Easton, which is downstream of Kachess Dam, suggesting some Kachess Reservoir bull trout may occasionally become entrained in the outlet works through Kachess Dam.

During surveys conducted between 1984 and 2012, an average of 10 redds were observed in Box Canyon Creek and in the Kachess River. The maximum number of redds observed during this period was 31 in Box Canyon Creek and 33 in the Kachess River, and the minimum was 0 in each tributary, which occurred in several different years (Reiss et al., 2012). It is estimated that the bull trout adult spawning population size in Kachess Reservoir is less than 50 individuals (Reiss et al., 2012).

### 3.9.3.2 Keechelus Reservoir Subpopulation

An adfluvial bull trout population exists in Keechelus Reservoir in low numbers (Hansen et al. 2017, WDFW, 1998). Adult bull trout in Keechelus Reservoir prey primarily on kokanee and other fish in open water (pelagic zone) as opposed to those that live near the shoreline or lake bottom (Hansen et al. 2017). This subpopulation consists of one local population that spawns and rears in Gold Creek. Currently, these bull trout have an adfluvial life history because access has been cut off to the upper Yakima River 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 River basin, and they may develop into fluvial fish. This population is geographically close 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, an average of 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. WDFW (1998), however, did recognize a mainstem Yakima River stock. Until recently, the justification for such recognition was weak. Old catch records and anecdotal accounts indicated that 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, 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 ranged in size from 200 to 300 millimeters (8 to 12 inches).

Bull trout spawning activity was observed in the upper Yakima River during a redd survey of the reach between the Keechelus and the Easton Diversion dams in mid-September 2000. The Service and WDFW biologists found two bull trout redds and four live adults; another redd and a dead adult were found the following year (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 because they exist in the Naches River subbasin and because local movement between the Naches River and Yakima River is known to occur. During a telemetry study conducted by WDFW, a few bull trout tagged in the Naches River were tracked into the mainstem Yakima River. These individuals used the mainstem Yakima River between Ahtanum and Wenas creeks for brief periods before migrating back to the Naches River.

Within the Yakima River, bull trout juvenile habitat has been characterized in relation to flow conditions in the Easton and Ellensburg reaches (Reclamation, 2008c). In the Easton reach, during April and May, the maximum quantity of bull trout fry habitat occurs at flows of 150 cfs and decreases as flow increase, reaching a minimum quantity of habitat at a flow of 700 cfs. For the period of June through September, when subyearling bull trout are rearing, the maximum quantity of habitat is available at flows of 300 cfs, and increasing flows result in a decrease in available habitat, with the minimum occurring at about 1,300 cfs (Reclamation, 2008c).

In the Ellensburg reach, during April and May, the maximum quantity of bull trout fry habitat occurs at a flow range of 400 to 6,500 cfs, with the minimum amount of habitat occurring at flows of 1,000 to 1,200 cfs. For the period of June through September, when subyearling bull trout are rearing, the maximum quantity of habitat is available at flows of 500 to 800 cfs, and increasing flows result in a decrease in available habitat, with the minimum occurring at about 2,300 cfs (Reclamation, 2008c).

### 3.9.4 Middle Columbia River Steelhead

The steelhead population in the Yakima River basin is a component of the MCR DPS steelhead that was listed as threatened in 1999 (64 FR 14517). The Yakima Steelhead Recovery Plan identifies the causes for the decline of steelhead in the Yakima Basin, sets specific goals for recovery, and identifies the actions that will be needed to achieve those goals (Conley et al. 2009). In 2005, and updated in 2011, NMFS completed a 5-year status review of MCR Steelhead, concluding that the greatest opportunity to advance recovery is to increase flows in the Yakima Basin and other large tributaries to the Middle Columbia River, among other improvements to fish passage, hatchery fish management, and water temperature reductions.

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 from Keechelus Dam and the Kachess River downstream from 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 River basin reported a robust and widespread steelhead population (Bryant and Parkhurst, 1950; Davidson, 1953; Fulton, 1970; McIntosh et al., 1990; NPCC, 1986).

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 Sections 3.6.2 and 3.6.3 for reservoir tributary information).

Generally, adult steelhead migration into the Yakima River basin begins in late summer, peaks in late October, and occurs again in late February or early March following a relatively inactive period during the coldest winter water temperatures. The run is dominated by wild fish because 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 use 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 River 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 3-32). During the most recent 10-year period (2004 to 2013), an average of 233 wild steelhead passed over Roza Dam (Columbia River DART, 2017). More recent data on steelhead abundance and distribution in the Yakima basin indicate that only between 3.8 and 9.2 percent of all steelhead entering the Yakima River basin migrated into the upper Yakima River above Roza Dam between 2001 and 2014 (Table 3-24).

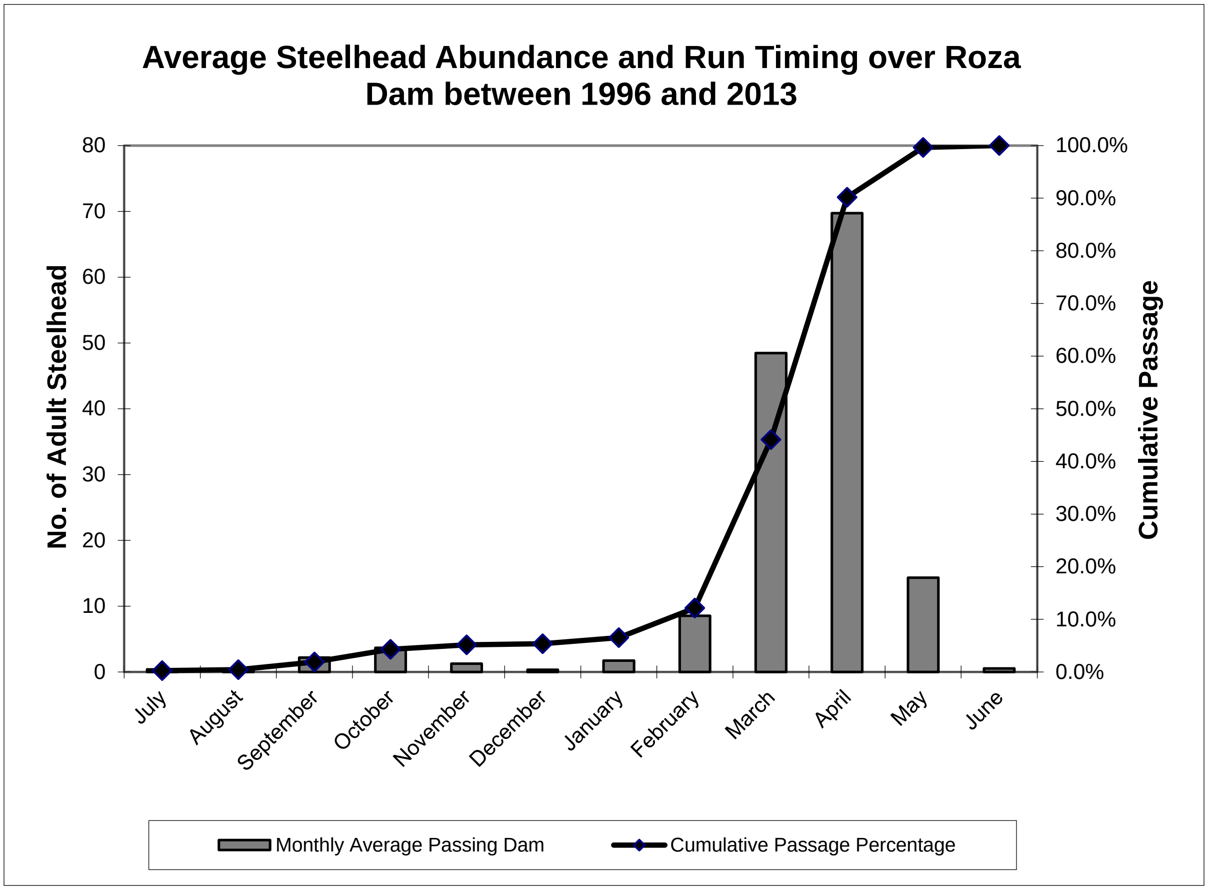



**Figure 3-32. Average Steelhead Abundance by Month and Cumulative Passage Timing of Steelhead Passing Roza Dam between 1996 and 2013**

Source: YKFP, 2011

**Table 3-24. Passage of Steelhead at Prosser Dam (RM 47.1) and Roza Dam (RM 127.9) for Brood Years 2000 to 2014**

| Brood Year | Number of Steelhead Passing Prosser Dam | Number of Steelhead Passing Roza Dam | Percentage 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 and 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 River basin (Reclamation, 2009). Of these, most (98.3 percent) moved upstream following release, and 62.0 percent of those fish moved into tributaries to spawn. Upper Yakima River steelhead migrated primarily 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.

Within the Yakima River, juvenile steelhead habitat has been characterized in relation to flow conditions in the Easton and Ellensburg reaches (Reclamation, 2008c).

In the Easton reach, instream flows of 150 cfs provide the maximum amount of steelhead fry habitat. As flows increase, the quantity of fry habitat decreases and reaches a minimum at 750 cfs. For subyearling steelhead, flows of approximately 300 cfs provide the maximum amount of habitat. Similar to fry, available subyearling habitat decreases with increasing flows, and the minimum quantity of habitat occurs at 1,100 to 1,200 cfs (Reclamation, 2008c).

In the Ellensburg reach, the maximum quantity of steelhead fry habitat occurs around 2,400 cfs and decreases somewhat up to 2,700 cfs. For subyearling steelhead, the highest quantity of rearing habitat is provided at flows between 400 and 900 cfs. At higher flows, the quantity of habitat decreases, with the minimum amount of habitat occurring at flows between 2,700 and 6,500 cfs (Reclamation, 2008c).

### 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 (upright dead trees); 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 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 to 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 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 managed owl conservation area 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* and 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 were published on December 4, 2012 (Service, 2012). Critical habitat designation includes most forested habitats on the west and north sides of 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 may be too fragmented to support nesting. While much of the area is not likely to support nesting habitat for northern spotted owls, most of the area is designated as critical habitat for the species by USFWS and there have been historical territories of northern spotted owls in the area. Under the revised critical habitat rule in 2012 (USFWS, 2012), most non-Federal land was excluded from the critical habitat designation. Thus, despite the East Shore Pumping Plant area not being listed as critical habitat under the USFWS rule, the habitat demonstrates qualities similar to habitat that is listed on adjacent land and was surveyed to determine potential impacts on the species. Habitat around the proposed KCC and KDRPP projects has habitat characteristics suggesting that it is largely dispersal habitat because of its multispecies composition, overstory trees with an average diameter at breast height of 16 inches, and downed wood of small size (WDFW, 2016).

Spotted owl surveys for the KCC and KDRPP alternatives were conducted by WDFW biologists in 2015 and 2016, and northern spotted owls were not detected in either year (WDFW, 2016). Northern spotted owls have never been detected in the vicinity of the Keechelus portal or discharge portals along Kachess Reservoir. Previous data from USFWS (2014) indicated that the closest historic nest site to proposed activities at Kachess Reservoir was approximately 500 feet east of the proposed KDRPP East Shore Pumping Plant.

The East Shore Pumping Plant location is within a historical northern spotted owl site known as Kachess Ridge. Northern spotted owls have not been detected within 0.3 mile from the East Shore Pumping Plant location since 1999 (Kachess Ridge owl center). Northern spotted owls have never been detected in the vicinity of the South Shore Pumping Plant alternative (WDFW, 2016). The nearest owl center to the Keechelus portal is Mosquito Creek, over 1.5 miles away and owls have not been detected there since 1991. The nearest owl center to the discharge portal alternatives is Box Ridge, over 4.7 miles away, and northern spotted owls have not been detected there since 2009 (WDFW, 2016).

### 3.9.6 Other Listed Species

The following subsections briefly describe other Federally listed and proposed 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, wolverine, 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, in part because of 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 River basin (WDFW, 2011a). The other four packs are 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 implementing 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 would occur, 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 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 habitat in the area. Grizzly bear observations have been recorded near 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 areas (WDFW, 2014a). If present in these areas, lynx are likely uncommon or rare.

#### *3.9.6.4 North American Wolverine*

On October 18, 2016, the Service issued a notice that it was reopening the February 4, 2013, proposed rule to list the DPS of wolverine occurring in the contiguous United States as threatened (81 FR 71670). The wolverine is a carnivore that occupies arctic, alpine, and subalpine habitats in the northern portions of the northern hemisphere (Copeland et al., 2010). The southern portion of the species’ range extends into the contiguous United States, including high-elevation alpine portions of Washington, Idaho, Montana, Wyoming, California, and Colorado (78 FR 7863).

Wolverines inhabit mountainous forest regions, particularly in the North Cascades in Washington. Wolverines do not appear to specialize on specific vegetation or geological habitat aspects, but instead select areas that are cold and receive enough winter precipitation to reliably maintain deep persistent snow late into the warm season (Copeland et al., 2010). The requirement of cold, snowy conditions means that, in the southern portion of the species' range where ambient temperatures are warmest, wolverine distribution is restricted to high elevations. In 2010, the Service concluded that listing the wolverine as a threatened or endangered species was warranted, based largely on the threat to the species' continued existence in much of the southern portion of its range because of climate change (75 FR 78030).

The wolverine is among the most elusive of North America's carnivores because it avoids people and developed areas, preferring cold and remote mountainous areas. Wolverines traverse large areas and occupy large home ranges. 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.

#### *3.9.6.5 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 its 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 (Carter and Erickson, 1992; Marshall, 1988; Nelson et al., 1992; Ralph, 1994; Sealy and Carter, 1984).

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 makes nests near forest edges 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).

Keechelus and Kachess reservoirs and their tributary streams are 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 farthest inland nest documented in Washington was approximately 55 miles from the ocean (WDFW, 2013). Keechelus Reservoir is the most western of the reservoirs and is 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 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 at the north end of Keechelus Reservoir (WSDOT, 2008).

#### *3.9.6.6 Yellow-billed Cuckoo*

The Service listed the western DPS of yellow-billed cuckoo as a threatened species on October 3, 2014 (79 FR 192). Critical habitat for the cuckoo was proposed on August 15, 2014; however, habitat in Washington State was excluded from the proposed designation (79 FR 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 FR 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 (Gabrielson and Jewett, 1970; Jewett et al., 1953; Marshall, 1996; Marshall, 2003; Roberson, 1980). In Washington State, the last confirmed breeding records were from the 1930s, and it was likely 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 1 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 FR 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 (Flotlin, 2011; Salzer, 2010). If breeding is occurring in Washington State, it is likely limited to less than 10 breeding pairs.

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 (including vegetation, landform modification, and soil manipulation), changes in reservoir pool elevations, new or modified facilities, and downstream changes that may affect landscape character and sense of place for local residents and recreational users, as described in Section 4.10. 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
- 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 facilities along the Kachess Reservoir shoreline would be constructed and viewed, including the route of the KDRPP power transmission line. These areas are described in Section 3.10.1, Kachess Reservoir, and shown in Figures 2-1, 2-6, and 2-9.

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; and the Keechelus Reach of the Yakima River. These areas are described in Section 3.10.2.

The dominant features of the primary study area are Keechelus and Kachess reservoirs. Before the Keechelus and Kachess dams were constructed, 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 the 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 areas.

### 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 to 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 elevations occur at the end of the irrigation season when it is drawn down. During drawdown, much of the exposed shoreline is devoid of vegetation. Figure 3-33 illustrates the exposed shoreline at the Narrows between the upper and lower Kachess Reservoirs. The gradual slope to the reservoir bottom results in a large area of exposed reservoir bed when water levels are low. In dry years, the reservoir does not completely fill and the upper portion of the reservoir is exposed year-round. The change in seasonal drawdown contributes to an altered landscape character of Kachess Reservoir.

**Figure 3-33. Kachess Narrows**

Kachess Reservoir is located between the north-south trending Keechelus Ridge to the west and Kachess Ridge to the east (Figure 3-34). 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 3-34. 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.

### 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 Palouse to Cascades State Park Trail (previously known as 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 3-35).  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 3-35.  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 Palouse to Cascades State Park 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. Overall, the views from the trail are natural appearing and slightly altered. The trail is fairly enclosed on both sides by existing highly textured conifer stands. Landscape variety in landscape views is provided by riparian meadows, wetlands, stream crossings and distant mountain ridges. 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. In a few areas, the foreground view appears heavily altered where the trail crosses through the massive powerline corridors that dominate the landscape. Additional background views are of distant peaks. Development is limited to the narrow band of the highway, which is mostly obscured by trees. Figure 3-36 shows a view of the Palouse to Cascades State Park Trail as it passes over the existing culvert at Cold Creek.

**Figure 3-36. View of Palouse to Cascades State Park Trail and Cold Creek Culvert**

I-90 is the major east-west travel corridor in the State, providing commercial access and easy access for people seeking outdoor recreational activities in the area. 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 Mountains to Sound Greenway was organized in 1991 to preserve and create a greenway along the I-90 travel corridor. The goals are to accommodate a network of recreational trails, rest areas and wildlife corridors; a location for truck stops and high-tech businesses; and a landscape of working farms, forests, and communities. Enhancing scenic beauty along the highway is a priority. 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 North Tunnel Alignment

The area along the KKC North Tunnel Alignment is 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 KKC North Tunnel Kachess Lake Road portal located on the west side of the NF-4828 would be visible in the short term.

### 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), 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). USFS applies zoning designations to its land as part of its forest planning process, termed land allocation. USFS's land allocation for Keechelus and Kachess reservoirs is Developed Recreation (RE-1) Retention VQO, Scenic Travel 1 and 2 Retention VQO, and Partial Retention VQO, depending on the middleground and foreground view context of management activities (Reclamation, 2008a). In areas designated for Retention VQO, all foreground landscapes shall have a perception of natural appearing with a "high" scenic integrity. High scenic integrity refers to a valued landscape character that "appears" intact. Deviations may be present but must repeat the form, line, color, texture, and pattern common to the landscape character completely and at such scale that they are not evident. (USDA and USFS, 1995).

Implicit in the Developed Recreation (RE-1) allocation is the essential role of constructed recreation facilities and the resulting environmental modification. Structures and other modifications must meet identified design, placement, and appearance standards; however, by definition, their presence does not necessarily reduce the visual quality level to the degree they would in other land allocations or settings. A greater tolerance for environmental modifications and their effects on visual quality standards is incorporated into the Developed Recreation (RE-1) allocation. The goal of landscape management on all National Forest System Lands is to manage for the highest possible visual quality, commensurate with other appropriate public uses, costs, and benefits. USFS (1990) considers visual quality to be one of the most important resources to be protected under this land allocation.

Foreground is based on landscape visibility and is defined as views up to a half mile distance zone, middleground is a half mile to 4 miles distance zone, and background is 4 miles to the horizon from the travelway and use areas. The immediate foreground distance zone is 300 feet. Additional information and descriptions regarding VQOs may be found in the

Forest Service Scenery Management System (USDA and USFS, 1995) and the Visual Management System National Forest Landscape Management Handbooks (USFS, 1974).

In 1995, 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 transmission lines are located south of both reservoirs and north of I-90. USFS considers the landscape appearance around Bonneville Power Administration transmission lines as very low, meaning it appears heavily altered. The visual quality analysis in this FEIS references both the VQO and the SIL of the study area. Table 3-25 describes the relationship between VQOs and SIL as contained in the Scenery Management System (USDA, 1995).

**Table 3-25. 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 would result largely from temporary, construction-related fugitive dust and emissions, as described in Section 4.11. Based on these mechanisms, the primary study area for air quality includes the areas around Keechelus and Kachess reservoirs where construction is proposed. 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 project area. The affected environment for air quality impacts does not include the extended study area (the downstream Yakima River basin) because the project would not result in any impacts on air quality outside the primary study area. The environmental setting is described in terms of air pollutant sources and existing concentrations in the primary and extended study areas.

## 3.11.1 Regulatory Setting

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 north of the Keechelus and Kachess Reservoirs, 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 primary study area. Even in these more developed areas, air quality is generally "good," according to Ecology's Washington Air Quality Advisory rating system, which indicates that air pollution is minimal and ambient conditions pose little health risk. The sparse population and rural nature of most of Kittitas County, including the primary study area, 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, such as construction-related clearing, excavation, and transport of soil.

Applicable State and Federal ambient air quality standards are listed in Table 3-26. 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 is less than or equal to 2.5 micrometers in diameter, can also be inhaled deeply and has been found to be the most dangerous size of particulates in terms of human health.

Projects that require earthwork or otherwise have the potential to create fugitive dust and 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 3-26. Ambient Air Quality Standards**

| Pollutant[a] | National | | Washington State |
|---|---|---|---|
| | Primary | Secondary | |
| Carbon monoxide<br>8-hour average<br>1-hour average | 9 ppm<br>35 ppm | NS<br>NS | 9 ppm<br>35 ppm |
| Ozone<br>1-hour average[b]<br>8-hour average[c] | 0.12 ppm<br>0.08 ppm | 0.12 ppm<br>0.08 ppm | 0.12 ppm<br>0.08 ppm |
| Lead<br>Maximum arithmetic mean<br>(averaged over calendar quarter) | 1.5μg/m$^3$ | 1.5μg/m$^3$ | NS |
| Nitrogen dioxide<br>Annual average | 0.05 ppm | 0.05 ppm | 0.05 ppm |

| Pollutant[a] | National | | Washington State |
|---|---|---|---|
| | Primary | Secondary | |
| Particulate matter ($PM_{10}$)<br>Annual arithmetic average<br>24-hour average[d] | 50 µg/m$^3$<br>150 µg/m$^3$ | 50 µg/m$^3$<br>150 µg/m$^3$ | 50 µg/m$^3$<br>150 µg/m$^3$ |
| Particulate matter ($PM_{2.5}$)<br>Annual arithmetic average<br>24-hour average | 15 µg/m$^3$<br>65 µg/m$^3$ | 15 µg/m$^3$<br>65 µg/m$^3$ | 15 µg/m$^3$<br>65 µg/m$^3$ |
| Particulate matter (TSP)<br>Annual geometric average<br>24-hour average | NS<br>NS | NS<br>NS | 60 µg/m$^3$<br>150 µg/m$^3$ |
| Sulfur dioxide ($SO_x$)<br>24-hour<br>3-hour | 0.14 ppm<br>NS | NS<br>0.5 ppm | 0.10 ppm<br>NS |

Notes: NS = no standard established, µg/m$^3$ = micrograms per cubic meter, ppm = parts per million

[a] Annual standards are never to be exceeded; short-term standards are not be exceeded more than once a year unless noted.

[b] Standard is attained when the expected number of days with a 24-hour concentration above 150 µg/m$^3$ is 1 or less.

[c] Standard is attained when the expected number of days with an hourly average above 0.12 ppm is equal to 1 or less.

[d] This would replace the 1-hour ozone standard when EPA approves a State or local agency's State Implementation Plan for ozone.

### 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 project area. 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 in the project vicinity are rural and have relatively low levels of traffic compared to I-90 or more urban roads.

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 soil, and by the use of 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 information presented in this report was developed in collaboration with basin stakeholders and was peer reviewed in accordance with the Bureau of Reclamation and Department of the Interior polices. This report is intended to inform and support planning for the future by identifying potential future scenarios. The analyses provided in this report reflect the use of best available datasets and methodologies at the time of the study.

Water resources studies are developed in collaboration with basin stakeholders to evaluate potential future scenarios to assess risks and potential actions that can be taken to minimize impacts, including supply and demand imbalances. These types of studies support a proactive approach to water resources management, using the best available science and information to develop scenarios of future conditions within the watershed. This positions communities to take steps now to mitigate the impacts of future water supply management issues, including water shortages, impacts of droughts and floods, variations in water supply, and changing water demands for water for new or different uses.

Because every water resources planning study requires the study partners to make assumptions about future conditions, addressing the uncertainties in those assumptions is an essential component of the planning process. For example, there are uncertainties associated with the characterization of future water supply and demand, demographics, environmental and other policies, economic projections, climate conditions, and land use, to name a few. Moreover, projections are often developed using modeling techniques that themselves are only potential representations of a particular process or variable, and therefore, introduce additional uncertainties into characterizations of the future. The cumulative, interacting uncertainties are not well known in the scientific community and, therefore, are not presented within this study. By recognizing this at each process step, uncertainties are adjusted for and reduced when possible, to allow Reclamation and its stakeholders to use the best available science to create a range of possible future risks that can be used to help identify appropriate adaptation strategies, which is fundamental to the planning process. Importantly, scenarios of future conditions should not be interpreted as a prediction of the future, nor is the goal of any water resources planning study to focus on a singular future. Rather the goal is to plan for a range of possible conditions, thereby providing decision support tools for water managers.

Of significant interest are projections of future climate, which ultimately drive many assumptions of water supplies and demands through their influence on the water cycle. Projections of future climate are developed using the scientific communities' best assessment of potential future conditions as characterized by global climate models (GCMs). GCM projections are based upon initial model states, assumptions of future greenhouse gases in the atmosphere, and internal as well as external forcings, such as solar radiation and volcanic activity to name just a few. Changes in land surface, atmosphere, and ocean dynamics, as well as how such changes are best modeled in GCMs continue to be areas of active research. Depending on these and other uncertainties, projected future conditions, such as the magnitude of temperature and precipitation changes, may vary. Observed climatic data and GCM simulations show warming trends over recent decades. However, the degree to which the magnitude of GCM simulated warming agrees with historic observations, where some studies find more GCM warming (Santer, et al, 2017) while others show warming rates more in line with observations (Lin and Huyber, 2016 and Richardson, et al 2016), varies based on the data, methods, and time periods used for making such comparisons. The evaluation and refinement of GCM performance is an ongoing area of research and includes methods to characterize model outputs and observations, and how measurement errors, internal variability, and model forcings can be improved to enhance future performance (Lin and Huyber, 2016).

Further, it is important to recognize that these models perform better at global rather than regional or watershed level scales. Accordingly, techniques must be employed to localize or "downscale" GCM output for applications such as basin-specific water resources planning studies. These downscaled projections of climate are used as inputs to hydrologic models to produce projected streamflows, which are then used to assess impacts to the water resource system in question. Uncertainties at each of the steps necessary to translate GCM output to water resources impacts can be characterized and adjusted for, yet uncertainties remain in the downscaling process that can result in variations depending on the modeling technique used.

Ultimately, future conditions at any particular time or place cannot be known exactly, given the current scientific understanding of potential future conditions. Likewise, it is important to recognize that the risks and impacts are the result of collective changes at a given location. Warming and increased carbon dioxide may increase plant water use efficiency, lengthen the agricultural growing season, but may also have adverse effects on snowpack and water availability. These complex interactions underscore the importance of using a planning approach that identifies future risks to water resources systems based on a range of plausible future conditions, and working with stakeholders to evaluate options that minimize potential impacts in ways most suitable for all stakeholders involved.

Based on the results of public scoping (Reclamation and Ecology, 2014d) and at the request of Ecology, climate change is included in this FEIS to address challenges described in the Integrated Plan and in State legislation RCW 90.38. The affected environment for climate change is described according to potential trends and patterns that could affect the alternatives, especially surface water resources. Global climate change has the potential to affect water resources in the Kachess and Keechelus watersheds and the Yakima River basin; therefore, all 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 runoff volume and timing, stream flows, 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 the previous analysis, project-level hydrologic modeling studies of potential changes associated with climate change were conducted for this FEIS.

The Yakima River basin was both the primary and extended study area for climate change for the SDEIS and this FEIS. 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 in the study area, are related to streamflows, stream temperature, water supplies, and reservoir levels, described in Section 3.3. The modeling conducted to estimate the potential range of effects for the SDEIS is described in Section 3.12.1.

In 2017, the UW Hydro/Computational Hydrology group at the University of Washington and the Oregon Climate Change Research Institute at Oregon State University developed updated hydrology and meteorology datasets for the Columbia River Basin, which are called "RMJOC-II" (BPA et al., 2018). RMJOC-II results from the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC, 2014), and is an update to the previous Columbia River climate change hydrologic data developed for the RMJOC that was used in evaluating climate change impacts in the SDEIS.

Reclamation and Ecology compared the new RMJOC-II datasets with the previous RMJOC datasets used for the SDEIS assessment, and assessed how the new datasets would affect the evaluation of water resource impacts presented in this FEIS for the No Action and action alternatives. Methods used in the analysis with the RMJOC-II data are identical to those used previously, except the hydrological data were changed to incorporate the new climate change datasets. As in the previous climate change analysis, three scenarios of potential climate change were evaluated, and the scenario representing changes in the middle of the range of the three (termed "adverse") was selected for focused review.

The characteristics and differences between the historical streamflows and projected future streamflows in the selected scenario were evaluated by Reclamation and Ecology and used for an assessment of change since the SDEIS. Compared with the previously used RMJOC adverse flows, the RMJOC-II adverse flows are higher, including average annual flow, winter flow and summer flow. Simulations using the RiverWare model for the No Action and action alternatives under the "adverse" RMJOC-II scenario are documented in a technical memorandum (HDR, July 2018).

Overall, the RMJOC-II climate change results are within the range of conditions that were presented in the SDEIS. The water supply results under the "adverse" RMJOC-II scenario are generally better compared with the previously documented adverse climate change results analyzed in the SDEIS. Under RMJOC-II conditions, more water supply would be available, and instream flows would be higher. Since RMJOC-II is considered less impactful than the RMJOC conditions, a full, updated analysis using RMJOC-II is not included in the FEIS.

Therefore Section 3.12 of the FEIS retains the climate change analysis for water resources that was presented in the SDEIS.

## 3.12.1 Assessment of Climate Change in the Yakima River Basin

### *3.12.1.1 Existing Climate Research*

Streamflow in the Yakima River basin is influenced primarily by a mix of direct runoff from fall, winter, and spring rains and by spring snowmelt. Wetter and colder winters tend to generate greater snowpack in the highest-elevation portions of the watersheds above the five existing Yakima River 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 natural 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 River basin would be most affected by climate change. The results of the simulation indicate that because the watershed areas above the Yakima River 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. This shift in precipitation is expected to result in increased runoff during the cool season (October to March) and reduced runoff during the warm season (April to September).

In 2016, Reclamation and its partners assessed the risks and impacts of climate change to western U.S. water resources (Reclamation, 2016a). This assessment supports the findings of previous climate change analyses projecting warmer temperatures in the Columbia River Basin, including the Yakima River subbasin, moving through the 21$^{st}$ century. Additionally, it supports findings that, while the mean amount of annual precipitation is not anticipated to change considerably, its timing is projected to change, with increased precipitation during the cool season and decreased precipitation during the warm season. It also supports findings that the form of precipitation would shift from snow to rain. Such changes are projected to increase flows during the winter and decrease flows during the summer (Reclamation, 2016a).

### *3.12.1.2 Climate Modeling of the Yakima River Basin*

To develop an understanding of the potential effects of climate change on the water resources in the study area for the FEIS, Reclamation and Ecology used climate change data from the University of Washington to model climate change effects. Two climate change scenarios for the Columbia River Basin, which includes the Yakima River basin, are described briefly below: historically based hydrology (the historic scenario) and climate-influenced hydrology (the adverse scenario) (RMJOC, 2010). As described in Section 3.3, Surface Water

Resources, hydrologic modeling was used to evaluate flows under the historic and adverse climate scenarios. The following describes the modeled results of *Alternative 1 – No Action* under the historic scenario and adverse climate scenarios. The results from *Alternative 1* under the historic scenario form the No Action baseline condition as described in Section 3.3. The historic and adverse climate scenario results described in this section are used for comparison with the action alternatives described in Section 4.12.

The historic scenario uses hydrologic conditions developed from historical stream gage data collected in the study area. The adverse scenario uses University of Washington data that approximate the median predicted climate variations associated with the 30-year period from 2030 to 2059. The adverse scenario incorporates a 1.7°C (3.06°F) average increase in temperature and a 3.7 percent average increase in precipitation. These changes are less than the changes predicted under other sets of emission assumptions and global climate models, but are larger than others. Thus the assumptions used for the action alternatives are near the middle of the range of climate changes predicted using global climate models considered and their assumptions.

Table 3-27 summarizes the historic and adverse climate change scenarios used in analyses for the SDEIS.

**Table 3-27. Summary of Climate Change Scenarios**

| Scenario | Climate Model Used | Descriptive Label | Average Temperature Change | Average Precipitation Change | Average Annual Inflow to Five Reservoirs (kaf*) | Average Unregulated Flow at the Parker Gage (kaf) |
|---|---|---|---|---|---|---|
| Historic | None | Baseline | 0 | 0 | 1,699 | 3,534 |
| Adverse | HadCM** (B1 emissions pathway) | 2040s Central Change | 1.7°C (3.06°F) increase | 3.7% increase | 1,561 (8.1% decrease) | 3,265 (7.6% decrease) |

Source: Reclamation and Ecology, 2011d, 42
*kaf = thousand acre-feet
** HadCM = Hadley Centre Coupled Model 3.

## 3.12.2 Climate Change Effects in the Yakima River Basin

The following subsections present potential changes in the Yakima River basin water supply as predicted by the adverse climate scenario compared with the historic scenario.

### *3.12.2.1 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, 2011g). Because of this lack of storage, the water supply of the Yakima River basin is susceptible to changes in snowpack caused by climate change. As shown in Table 3-27, average annual unregulated flows measured at the Parker stream gage would decrease under the adverse scenario. This reduction in streamflow would require Reclamation to release larger amounts of water from the five reservoirs to meet irrigation demands and instream flow targets.

Compared with the historic scenario, increased air temperatures under the adverse climate change scenario would cause more precipitation to fall as rain rather than snow in the Cascade Mountain 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). As presented in Table 3-27, average annual inflow to the five reservoirs would decrease under the adverse scenario. This decrease would occur despite an increase in precipitation because watershed runoff decreases as evapotranspiration loss increases with the higher temperatures.

Previous studies have shown that the snowmelt volume in the Yakima River basin is likely to decrease by 12 percent given a 1°C (33.8°F) rise in air temperature, and by 27 percent given a 2°C (35.6°F) rise (Vano et al., 2010). The results prepared for the SDEIS and summarized below are comparable because they show an approximately 11 percent decrease in inflow to Kachess and Keechelus reservoirs.

#### *3.12.2.2 Changes in Quantity and Timing of Runoff*

Total modeled inflow into Keechelus and Kachess reservoirs under the historic and adverse climate scenarios is shown in Figure 3-37 and tabulated in Table 3-28.

The model results indicate substantial changes in runoff into Keechelus and Kachess reservoirs attributable to climate change. Under the adverse scenario, the annual reservoir inflow would decrease an average of 11 percent compared with the historic scenario (Reclamation and Ecology, 2016a). Spring runoff is expected to decrease by an average of 24 percent, and summer runoff is expected to decrease by 52 or 63 percent for Keechelus and Kachess, respectively. Fall and winter runoff is expected to increase by an average of 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 Keechelus and Kachess reservoirs to be depleted at a faster rate to meet demand.

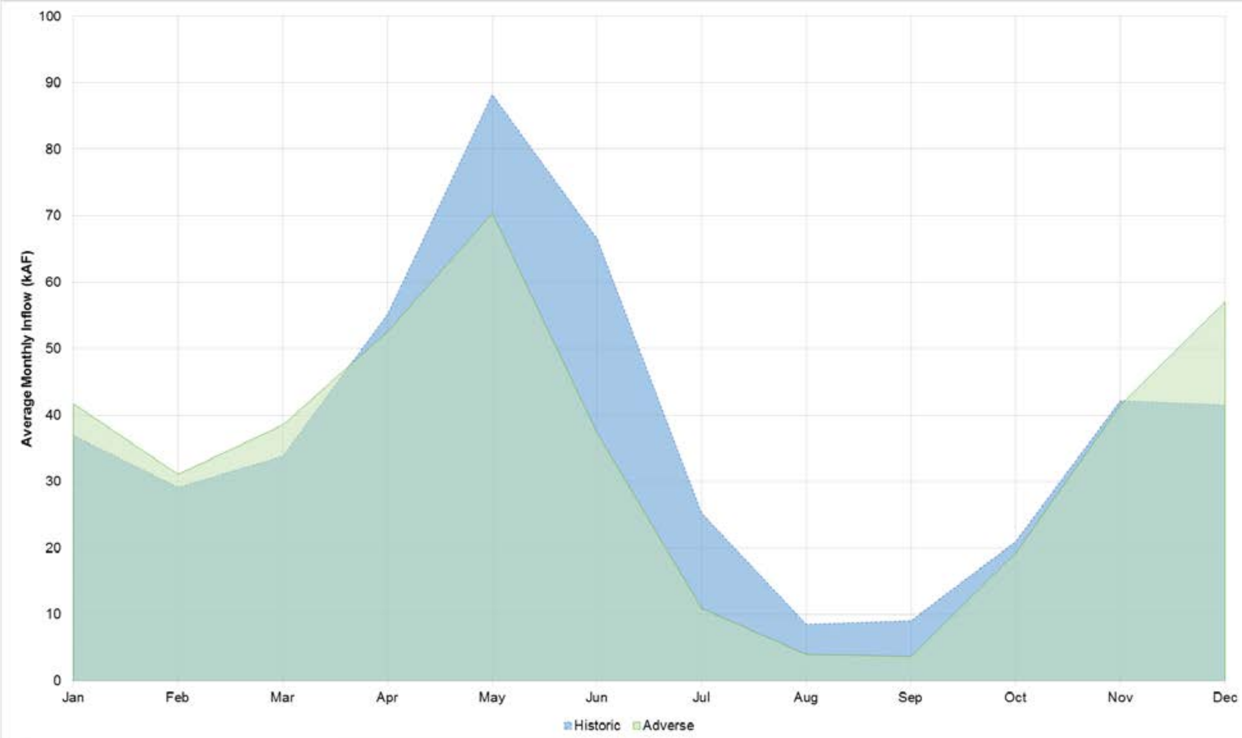



**Figure 3-37. Comparison of Average Monthly Combined Reservoir Inflow to Keechelus and Kachess Reservoirs between Historic and Adverse Scenarios**

Source: Reclamation and Ecology, 2016a
*kaf = thousand acre-feet

**Table 3-28. Comparison of Average Seasonal Inflows into Keechelus and Kachess Reservoirs for the Historic and Adverse Climate Change Scenarios**

| Scenario | Fall (Oct–Dec) | Winter (Jan–March) | Spring (April–June) | Summer (July–Sept) | Total |
|---|---|---|---|---|---|
| **Keechelus Reservoir Inflow** | | | | | |
| Historic (kaf*) | 58.8 | 52.3 | 110.8 | 24.9 | 244.3 |
| Adverse (HadCM B1) (kaf) | 66.3 | 58.1 | 84.1 | 12.0 | 218.3 |
| Difference (%) | 13 | 11 | –24 | –52 | –11 |
| **Kachess Reservoir Inflow** | | | | | |
| Historic | 46.8 | 48.6 | 101.6 | 18.2 | 212.9 |
| Adverse (HadCM B1) (kaf) | 52.7 | 54.7 | 77.6 | 6.7 | 189.7 |
| Difference (%) | 13 | 13 | –24 | –63 | –11 |

Source: Reclamation and Ecology, 2016a
*kaf = thousand acre-feet

A comparison between simulated existing reservoir water surface elevation under the historic and adverse climate scenarios is shown in Figure 3-38 for Keechelus Reservoir and in Figure 3-39 for Kachess Reservoir. On average, Keechelus Reservoir is predicted to be 11 feet lower, with a monthly average difference ranging from 0 to 20 feet lower under the adverse climate change scenario. The model predicts the existing Kachess Reservoir to be 9 feet lower, on average, with a monthly average difference ranging from 5 to 14 feet lower under the adverse climate change scenario.

As shown in Figure 3-38 and Figure 3-39, water surface elevations would be lower under the adverse climate scenario. This lowered elevation would result in the reservoirs filling less frequently. Under the adverse scenario, full pool in Kachess and Keechelus reservoirs would be achieved in 23 and 21 fewer years (out of a total of 90 modeled), respectively, than under the historic scenario.

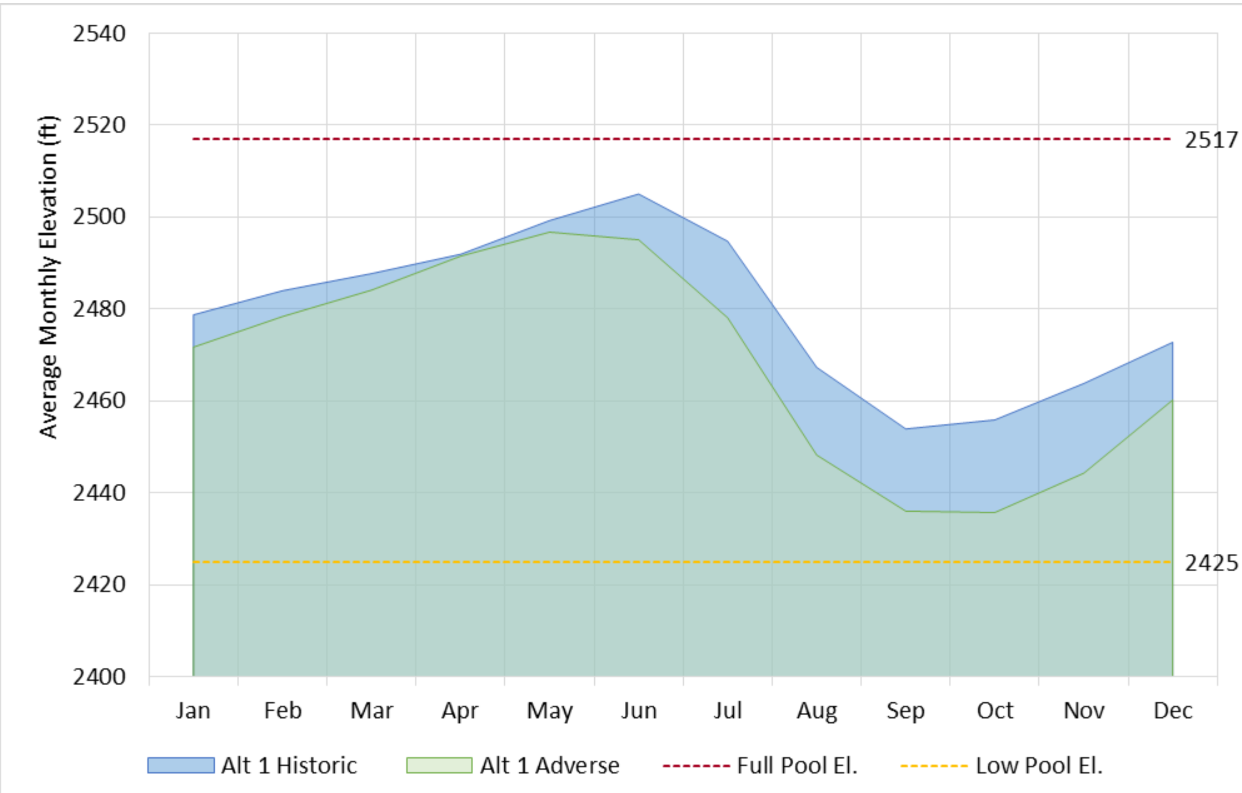



**Figure 3-38. Comparison of Average Monthly Keechelus Reservoir Water Surface Elevation between Historic and Adverse Scenarios for the Alternative 1 – No Action Alternative**

Source: Reclamation and Ecology, 2016a

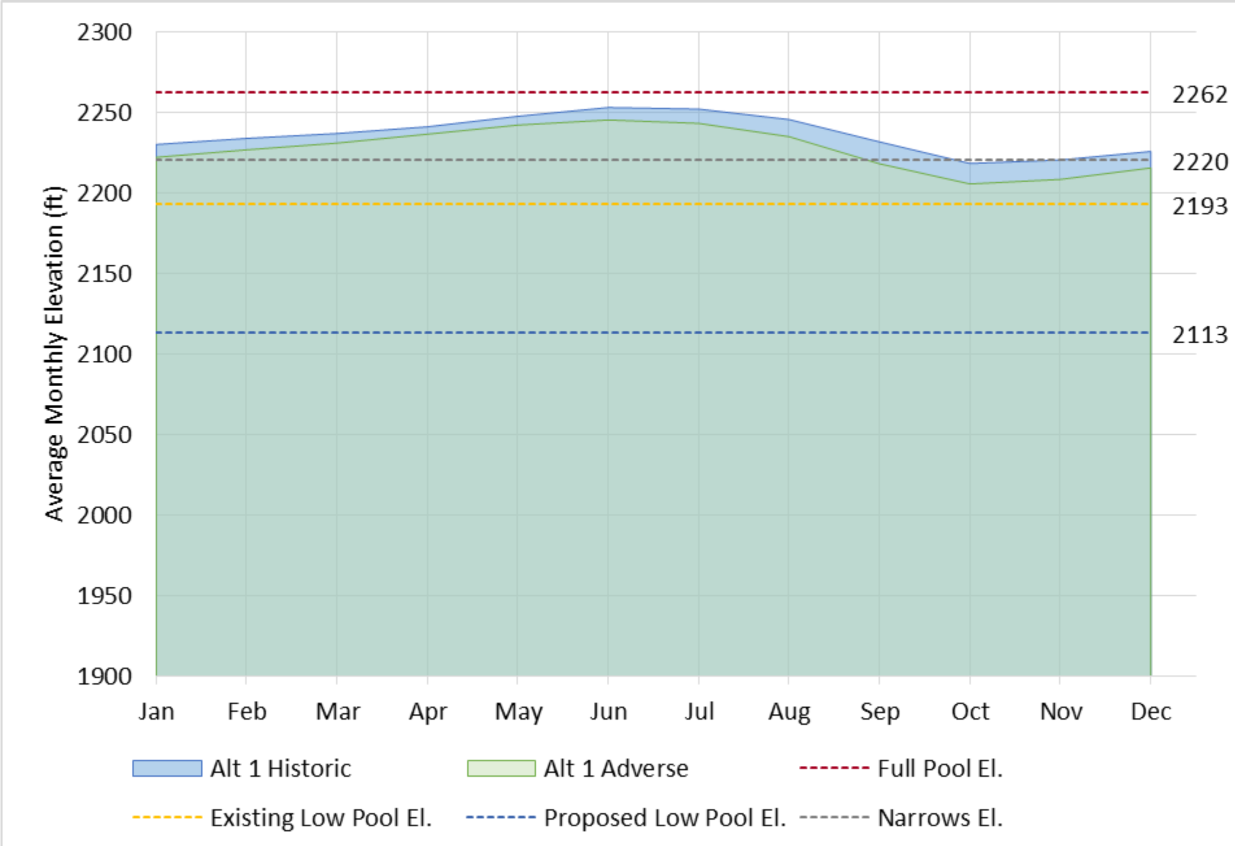



**Figure 3-39. Comparison of Average Monthly Kachess Reservoir Water Surface Elevation between Historic and Adverse Scenarios for the Alternative 1 – No Action Alternative**

Source: Reclamation and Ecology, 2016a

### *3.12.2.3 Changes in Water Supply*

Under the adverse scenario, a large reduction in summer runoff would put a much larger demand on water stored in the reservoirs in the Yakima River system. Natural runoff and streamflow in the system would decrease by 50 percent or more in some months compared with the historic scenario; therefore, irrigation demands and instream flow targets would have to be met by releasing larger amounts of water from the existing reservoirs. Currently, during many years, 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 the Yakima River basin water supply are most clearly quantified by examining the prorationing level, the TWSA, and the April through September irrigation deliveries. Under the adverse scenario, average September 30 prorationing is reduced by 21 percent compared with the historic scenario, and minimum year prorationing is reduced by 19 percent. This decrease in available irrigation water supply under the adverse scenario would result in more frequent prorationing and lower prorationing levels (Table 3-29). Average July 1 TWSA would be reduced by 318,000 acre-feet, and average delivery to the major irrigation districts would be reduced by 124,000 acre-feet.

**Table 3-29. Comparison between Simulated Water Supply Conditions under Historic and Adverse Climate Change Scenarios**

| Range | | Sept 30 Prorationing (Percent) | July 1 TWSA (kaf)* | April–Sep Deliveries (kaf) |
|---|---|---|---|---|
| Historic scenario | Min | 19 | 857 | 997 |
| | Average | 89 | 1,523 | 1,642 |
| | Max | 100 | 2,225 | 1,742 |
| Adverse scenario | Min | 0 | 696 | 653 |
| | Average | 68 | 1,205 | 1,518 |
| | Max | 100 | 1,844 | 1,890 |
| Change attributable to adverse scenario | Min | –19 | –161 | –344 |
| | Average | –21 | –318 | –124 |
| | Max | 0 | –381 | 148 |

Source: Reclamation and Ecology, 2016a
* kaf = thousand acre feet

### *3.12.2.4 Changes in Instream Flow*

The adverse climate change scenario effects on instream flow would also be substantial. For the purposes of the SDEIS, the most important Yakima River reaches are Keechelus and Easton, since these reaches are directly downstream of the locations of the action alternatives and , therefore, would be the most directly affected by the action alternatives.

Climate change would generally reduce streamflows in the Yakima River basin, especially during the summer months. In the Keechelus reach, average annual flows would be reduced approximately 11 percent under the adverse scenario compared with the historic scenario. Average summer (July to August) flows would be greatly reduced while average winter flows would be greatly increased. -Drought year flows would be reduced by approximately 20 percent. This reduction in flows would contribute to the goal of reducing the artificially high summer Keechelus reach streamflows. These changes are summarized in Table 3-30.

**Table 3-30. Mean Keechelus Reach Flow under *Alternative 1 – No Action***

| Modeled Year | Mean Flow (cfs) | | Percentage Change |
|---|---|---|---|
| | *Alternative 1* Historic | *Alternative 1* Adverse | |
| **1926–2015** | | | |
| Annual | 337 | 301 | –11% |
| July–August | 866 | 131 | –85% |
| January | 154 | 741 | 381% |
| **1994 (Drought Year)** | | | |
| Annual | 230 | 183 | –20% |
| July–August | 614 | 370 | –40% |
| January | 81 | 90 | 11% |
| **2001 (Drought Year)** | | | |
| Annual | 261 | 203 | –22% |
| July–August | 673 | 497 | –26% |
| January | 132 | 114 | –13% |

Predicted seasonal flow exceedances in the Keechelus reach are shown in Table 3-31. Under the adverse scenario, median spring and summer flow exceedances for the Keechelus reach would be lower compared with the historic scenario. Winter median flows would be unchanged.

**Table 3-31. Seasonal Change in Keechelus Reach Flow under Historic and Adverse Climate Scenarios**

| Season | Flow (cfs) | | Percentage Change |
|---|---|---|---|
| | No Action Historic | No Action Adverse | |
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 100 | 100 | 0% |
| High (10% exceedance) | 153 | 127 | –17% |
| Low (90% exceedance) | 80 | 80 | 0% |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 350 | 308 | –12% |
| High (10% exceedance) | 675 | 700 | 4% |
| Low (90% exceedance) | 100 | 80 | –20% |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 527 | 311 | –41% |
| High (10% exceedance) | 1,070 | 1,016 | –5% |
| Low (90% exceedance) | 80 | 80 | 0% |

Changes in Easton reach streamflow are summarized in Table 3-32. In the Easton reach, average annual flows would be reduced by approximately 7 percent under the adverse scenario compared with the historic scenario. Average summer flows would also decrease, while average winter flows would increase. The decrease in summer flow during drought years would be 2 to 143 cfs.

**Table 3-32. Mean Easton Reach Flows under *Alternative 1 – No Action***

| Modeled Year | Mean Flow (cfs) | | Percentage Change |
|---|---|---|---|
| | *Alternative 1* Historic | *Alternative 1* Adverse | |
| **1926–2015** | | | |
| Annual | 458 | 425 | –7% |
| July–August | 530 | 477 | –10% |
| January | 450 | 557 | 24% |
| **1994 (Drought Year)** | | | |
| Annual | 366 | 387 | 6% |
| July–August | 534 | 532 | –1% |
| January | 306 | 238 | –22% |
| **2001 (Drought Year)** | | | |
| Annual | 398 | 321 | –19% |
| July–August | 694 | 551 | –21% |
| January | 250 | 190 | –24% |

The effects of the adverse scenario on instream flow in the Easton reach are shown in Table 3-33. Spring and summer flow exceedances for the Easton reach would be lower under the adverse scenario compared with the historic scenario. Median and low winter flow exceedances would decrease, while high winter flow exceedances would increase under the adverse scenario.

**Table 3-33. Seasonal Change in Easton Reach Flow under Historic and Adverse Climate Scenarios**

| Season | Flow (cfs) | | Percentage Change |
|---|---|---|---|
| | No Action Historic | No Action Adverse | |
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 305 | 252 | –17% |
| High (10% exceedance) | 712 | 821 | 15% |
| Low (90% exceedance) | 222 | 190 | –15% |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 393 | 305 | –22% |
| High (10% exceedance) | 1100 | 786 | –29% |
| Low (90% exceedance) | 193 | 190 | –2% |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 310 | 344 | 11% |
| High (10% exceedance) | 735 | 821 | 12% |
| Low (90% exceedance) | 196 | 190 | –3% |

The changes in runoff timing and volume 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 KDRPP and KKC operate and how effective they would be 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 compared with the historic scenario. These issues are discussed further in Section 4.12.

### 3.12.3 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 substantially 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 a variety of aquatic and terrestrial species in the Yakima River basin, including the Federally listed threatened MCR steelhead and bull trout.

Water quality conditions depend on several variables including water temperature, flow, runoff rate and timing, and the watershed's physical characteristics (Reclamation, 2016a). Climate change has the potential to alter all of these variables (Reclamation, 2016a). Hydrologic modeling suggests that climate change would reduce spring and summer inflows and reservoir levels. These circumstances, coupled with higher temperatures, could increase water temperatures and result in water quality impacts in the study area. Potential water quality impacts are discussed further in Section 4.4.

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 (69.8°F) may rise from less than 5 weeks under 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 because of climate change (Karl et al., 2009).

Climate change is also likely to affect forest health; the frequency and extent of wildfires; visual characteristics of the landscape as influenced by vegetation, and winter recreational activities such as downhill skiing, cross-county skiing, snowshoeing, and snowmobiling.

## 3.13 Noise

Construction and operation of the completed facilities would cause impacts on noise-sensitive receptors. These impacts are described in Section 4.13, Noise. Accordingly, the primary study area for noise and vibration includes the following locations:

- Kachess Reservoir
  - Areas that would be affected by construction and operation of proposed facilities along the Kachess Reservoir shoreline
  - The Narrows for construction of the Volitional Bull Trout Passage Improvements
- Keechelus Reservoir
  - Areas that would be affected by construction and operation of proposed facilities along the Keechelus Reservoir shoreline
- KKC North Tunnel Alignment
  - Areas overlying the proposed tunnel alignment as described in Chapter 2

Construction activities and facilities in each 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 River basin) because the project would not result in any impacts from noise or vibration outside the primary study area. Disturbance to wildlife species from noise impacts generated from construction activities is discussed in Sections 4.8 and 4.9.

### 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 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 contributes to 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, the maximum velocity experienced by any point in a structure during a vibration event. An indication of the magnitude of energy transmitted through vibration, peak particle velocity is often used in determining potential damage to buildings because of 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.

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 3-34 summarizes the maximum permissible levels applicable to noise received at the three EDNAs.

**Table 3-34. 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 the following 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 and 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 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 (a feature of the KKC North Tunnel Alignment on the west side of Kachess Reservoir, see Figure 2-10). 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 characteristic 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. The airport, which is managed by WSDOT and located less than 1 mile from the dam, 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

Similar to Kachess Reservoir, 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 along 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 KKC North Tunnel Alignment

The proposed KKC North Tunnel Alignment runs generally east-west between Kachess and Keechelus reservoirs. The conveyance areas are sparsely populated, with existing residential structures focused along Kachess Lake Road and Via Kachess Road areas within approximately 1.5 miles of the west shoreline of Kachess Reservoir. Conveyance construction would occur below ground with a tunnel boring machine.

## 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 Section 4.14. 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
- 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
- KKC North Tunnel Alignment (Section 3.14.3)
  - Areas overlying the KKC tunnel alignment

The extended study area is the Yakima River basin as a whole.

Recreationists visit the Keechelus and Kachess reservoir areas for their 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 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 3-40 shows the location of formal recreation opportunities in the primary study area.

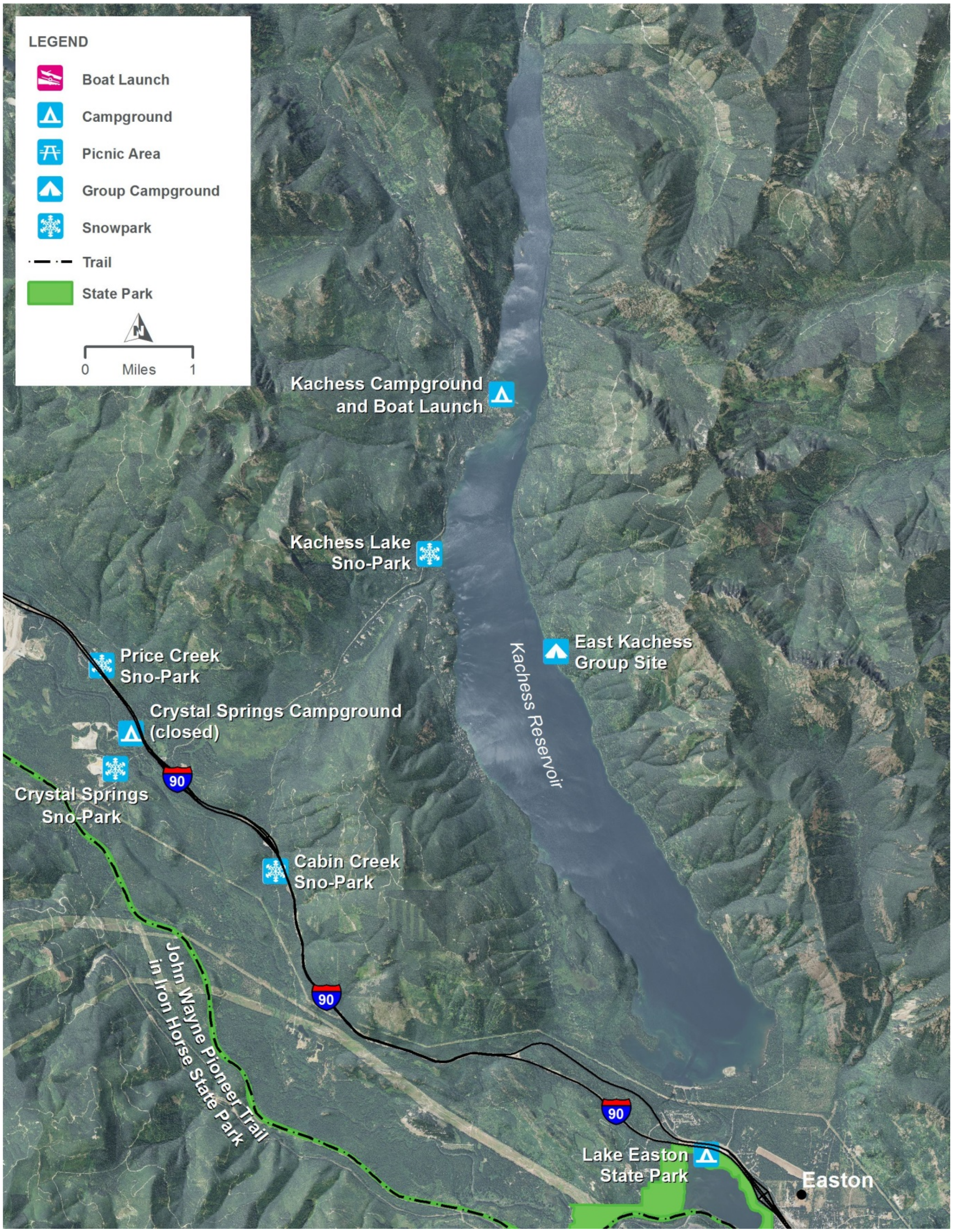



**Figure 3-40. Recreation Facilities in the Primary Study Area**

### 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 3-35.

**Table 3-35. Recreation Facilities Affected by KDRPP**

| Facility | Facilities | Operator | Estimated Average Annual Use (visitors per year) |
|---|---|---|---|
| **Recreation Facilities on Kachess Reservoir** | | | |
| Kachess Campground | • 92 acres<br>• Over 100 campsites and one group campsite<br>• Two boat launches (one paved and one maintained gravel)<br>• Picnic area | USFS | Campground – 23,000<br>Boat launch – 11,000 |
| East Kachess Group Site | • One group campsite with a capacity of 100 people and 25 vehicles<br>• Open by reservation only from Memorial Day to mid-September<br>• Vault toilet | USFS | 700 to 1,000 |

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 during some years (WDFW, 2014b). Figure 3-41 shows the maintained gravel boat launch, and Figure 3-42 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 3-41. Maintained Gravel Boat Launch at Kachess Campground**

**Figure 3-42. Paved Boat Launch at Kachess Campground**

In addition to the facilities listed in Table 3-35, 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 power transmission line for KDRPP would extend from the existing Easton Substation to the proposed pumping plant. The route could cross the Palouse to Cascades State Park 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 3-35. 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 3-36. 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 3-36. 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<br>• Picnic area<br>• Access to Iron Horse Trail and Lake Keechelus Trail | USFS | 5,000 |
| Palouse to Cascades State Park Trail in Iron Horse State Park | Recrational trail | Washington State Parks | 90,000 |
| 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 |

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 Reservoir 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 3-36. Figure 3-43 shows a view of Gold Creek Pond from the ADA-accessible hiking trail.

**Figure 3-43. Gold Creek Pond**

### 3.14.3 KKC North Tunnel Alignment Area

The area along the KKC North Tunnel Alignment is 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 the Washington State Parks Department as part of the State Winter Recreation Program. Information on sno-parks in this area is included in Table 3-37.

**Table 3-37. 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<br>• 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.

## 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 Reservoir
  - Locations of proposed KDRPP facilities and other construction-related sites within 2 miles of the Kachess Reservoir shoreline
  - The Narrows for construction of the Volitional Bull Trout Passage Improvements
- Keechelus Reservoir
  - Locations of proposed KKC facilities
  - The area within 2 miles of the Keechelus Reservoir shoreline
- KKC North Tunnel Alignment
  - Areas overlying the proposed tunnel alignment as described in Chapter 2

The extended study area for land and shoreline use is the Yakima River basin.

The small residential community of Easton is approximately 2 miles south of 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. Private parcels with houses or cabins are located around Kachess Reservoir primarily along Kachess Lake Road and Via Kachess Road and in higher densities approximately 0.5 mile south of the proposed KKC Kachess Reservoir portal. Residential areas with houses and cabins around Kachess Reservoir include Kachess Village homeowners association (HOA), East Kachess HOA, Kachess Ridge, and Kachess Ride.

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, although the latter is not visible from I-90.

While private parcels are scattered throughout the area, the land surrounding the reservoirs is primarily in Federal ownership, and jointly managed by USFS and Reclamation (Figure 3-44). Reclamation manages the reservoirs and land around the dams as part of the Yakima Project. Federal activities on the land are not subject to 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 Palouse to Cascades State Park 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 project area (Section 3.14) 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 land was sold to other private parties for residential development.

In support of the goal of connecting habitat, the USFS has made substantial efforts to acquire private lands in the checkerboard land ownership areas of the Snoqualmie Pass. The USFS also has supported the efforts of conservation groups to buy private lands that have been placed in public ownership for conservation purposes. Together, these public and private efforts have placed thousands of acres of land within the Snoqualmie Pass area into public ownership for conservation purposes.

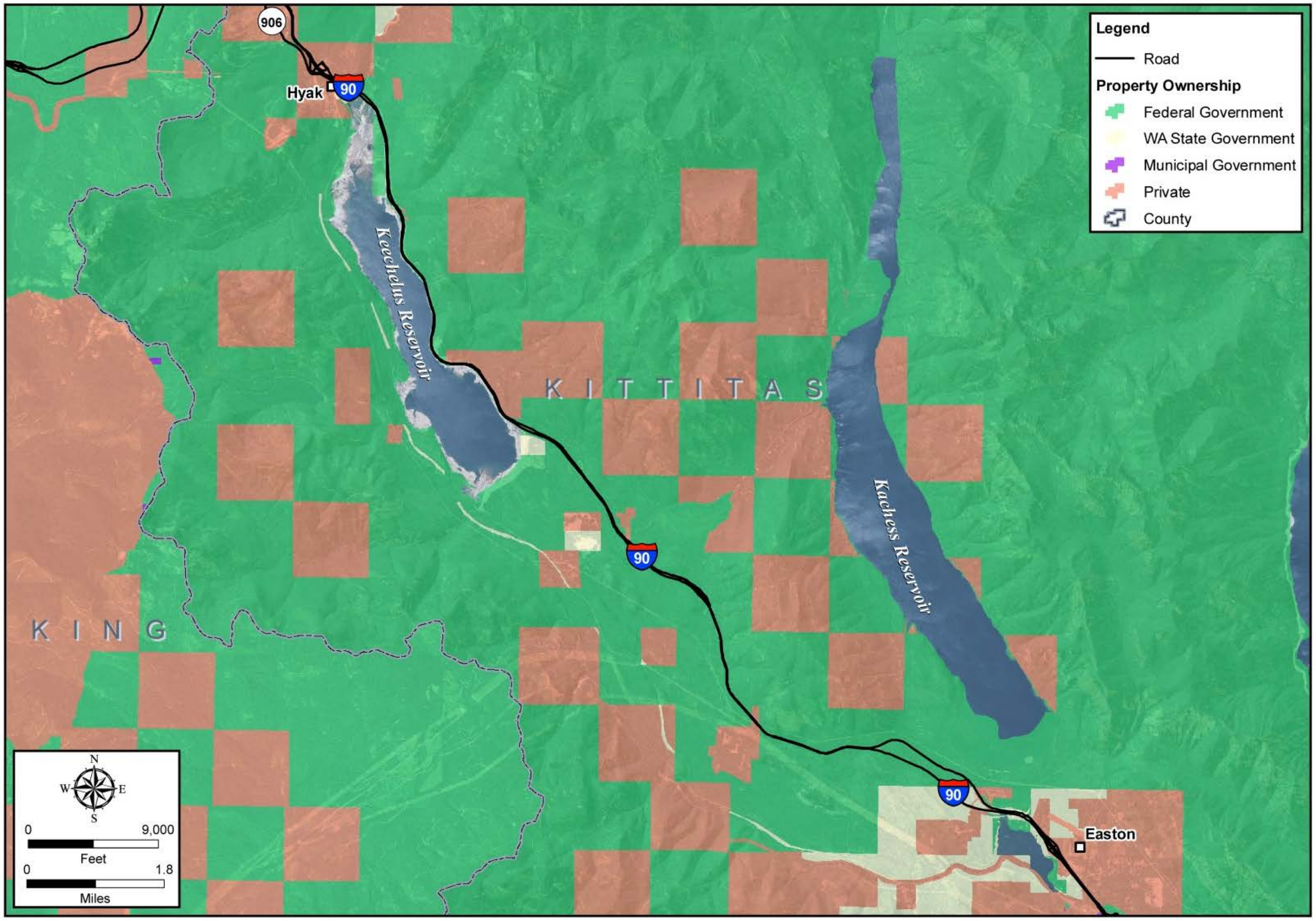



**Figure 3-44. Land Ownership in the Primary Study Area**

## 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 USFS*

Reclamation and 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 USFS regarding areas of mutual interest or responsibility, or both. In addition, Project Supplemental Agreements for Keechelus and Kachess reservoirs guide 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*

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, 2011).[2] USFS plans to prepare an EIS regarding the proposed Forest Plan revision.

#### *3.15.1.4 Riparian Reserves*

USFS maintains Riparian Reserves along the shoreline of reservoirs, streams, and wetlands. The Riparian Reserves along 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*

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, USFS focuses on ecosystem management, primarily restoration of late-successional forests and connecting wildlife habitat. 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.

---

[2] USFS administratively combined the Okanogan and Wenatchee National Forests in 2000. USFS changed the administrative name to Okanogan-Wenatchee National Forest in 2007.

## 3.15.2 State and Local Land Use Planning

With the exception of areas managed by Reclamation and USFS, land use planning in the primary study area is under the jurisdiction of Kittitas County. This section discusses the most relevant State management plans and policies that apply to the land around Kachess and Keechelus reservoirs.

### *3.15.2.1 Kittitas County*

According to Kittitas County Code (KCC), the majority of land in and around Keechelus and Kachess reservoirs is zoned Commercial Forest (KCC Title 17, Zoning) (Figure 3-45), a zone 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…*

### *3.15.2.2 Washington State Parks Department*

The Palouse to Cascades State Park Trail skirts the west side of Keechelus Reservoir. Iron Horse State Park includes the Palouse to Cascades State Park Trail and is operated and maintained by the Washington State Parks and Recreation Commission. Management objectives for the trail were established in the *Iron Horse State Park and the John Wayne Pioneer Trail Management Plan* (WSPRC, 2000) that was jointly developed with the *Iron Horse Master Plan Addendum* (WSPRC, 2014) which outlines how the park and trail would be developed. The majority of the Palouse to Cascades State Park Trail is classified as a Resource Recreation area, which is an area "suited and/or developed for natural and/or cultural resource–based medium-intensity and low-intensity outdoor recreational use".

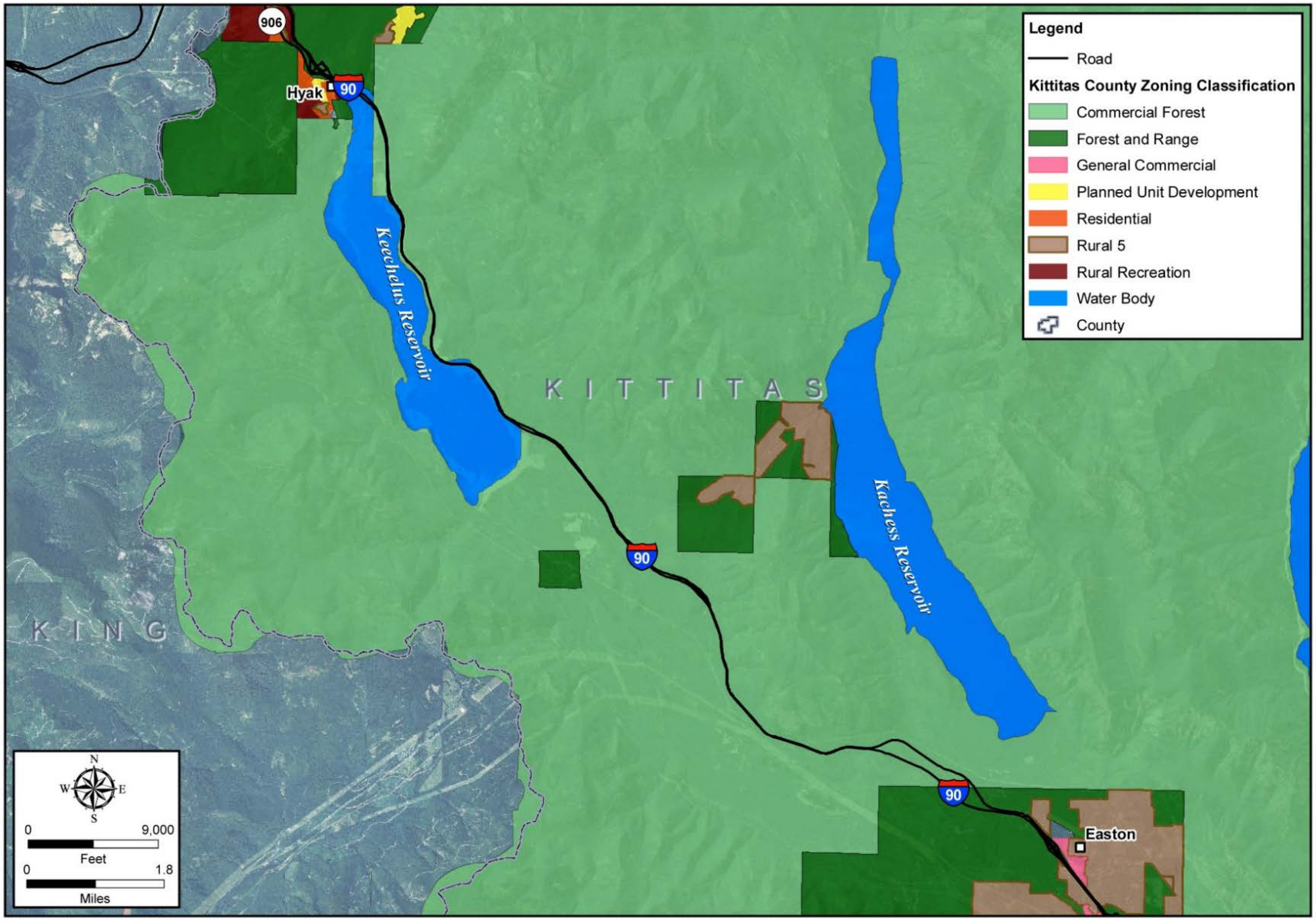



**Figure 3-45. Zoning in the Primary Study Area**

The *Kittitas County Comprehensive Plan* describes the John Wayne Pioneer Trail (now known as Palouse to Cascades State Park Trail) as “a magnificent recreational area” (Kittitas County, 2016a). One of the transportation goals outlined in the comprehensive plan requires transportation methods to blend in with the natural environment, and one of the objectives recommends scenic buffers along the Palouse to Cascades State Park Trail:

> *VI.6 Goal: Provide for transportation methods, which blend with and/or enhance the natural mountain environment, inflicting minimum environmental damage to it and contiguous areas.*
>
> *Objective 7.The Pacific Crest Trail and the John Wayne Trail should be provided with appropriate scenic buffers, parking areas and trail connections to activity centers.*

#### *3.15.2.3 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. 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).

In February 2016, Ecology approved Kittitas County’s updated SMP. Under this draft SMP, the majority of both reservoirs would be designated as rural conservancy. The purpose of the rural conservancy environment is to protect ecological functions, natural resources, and valuable historic and cultural areas in order to provide for sustained resource use, natural flood plain processes, and recreational activities (Kittitas County, 2016). Portions of both the west and east sides of Kachess Reservoir would be designated as shoreline residential. The purpose of the shoreline residential environment is to accommodate residential development and accessory structures as well as public access and recreational uses (Kittitas County, 2016b).

The Kittitas County SMP applies to Federal land, including the portions of the reservoir shorelines owned and managed by Reclamation and USFS, if projects are non-Federally funded. The SMP applies to all privately owned land.

#### *3.15.2.4 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 is currently working on an update to the CAO. The CAO establishes buffers around wetlands and riparian habitat. It also regulates development in frequently flooded areas, geologically hazardous areas, Fish and Habitat Conservation 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 following:

- Kachess Reservoir
  - Locations of proposed KDRPP facilities, and road corridors that may be used for construction and other construction-related sites within 1 mile of the Kachess Reservoir shoreline
- Keechelus Reservoir
  - Locations of proposed KKC facilities and other construction-related sites within 1 mile of the Keechelus Reservoir shoreline
- KKC North Tunnel Alignment
  - Areas overlying the proposed tunnel alignment as described in Chapter 2

The extended study area is the entire Yakima River 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.

### 3.16.1 Electrical Service and Infrastructure

Electric power in Kittitas County is provided by Kittitas County Public Utility District (PUD) No. 1 and 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 that is transformed to three-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 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 Pass Utility District on the north end of the reservoir. See Section 3.5, for information about wells in the project 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 Kachess Reservoir and the 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 waste 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 CenturyLink 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. No transcontinental fiber optic lines exist near Kachess or Keechelus reservoirs. Communications (cellular) towers are present along major travel corridors in the project vicinity.

## 3.17 Transportation

This section addresses the roads, highways, and airports serving the areas where the proposed facilities 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 project covers the following locations:

- Kachess Reservoir
  - The east, west, and south sides of Kachess Reservoir
  - Areas where construction vehicle traffic and operation trips would occur following construction (Figure 3-46)
- Keechelus Reservoir
  - Areas where construction vehicle traffic and operation trips would occur following construction (Figure 3-46), including land on the east side of Keechelus Reservoir
- KKC North Tunnel Alignment
  - Areas overlying the proposed North Tunnel Alignment as described in Chapter 2

The extended study area includes I-90 and 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 is implementing safety and reliability improvements in this portion of I-90 starting (initiated in 2015). The primary planned activities are pavement replacement and the addition of a new lane in each direction as described for Alternative 1 – No Action (see Section 2.2).

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. A BNSF Railroad track runs generally parallel to I-90 in the upper basin, west of the Yakima River.

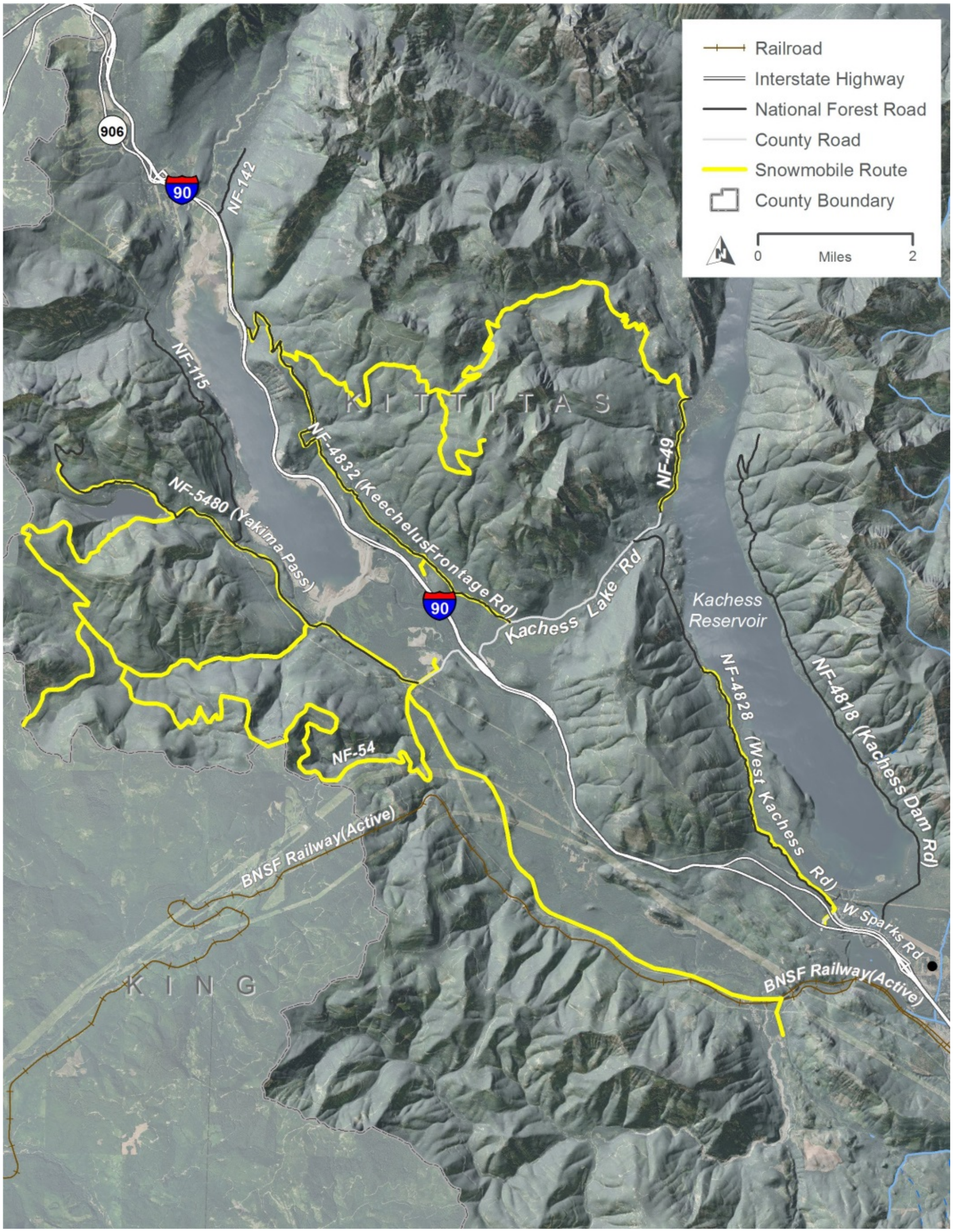



**Figure 3-46. Local Transportation Facilities in the Primary Study Area**

### 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 road 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 road 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. Easton State Airport is approximately 3,500 feet southeast of Kachess Reservoir.

### 3.17.2 Keechelus Reservoir Area

Local access to the Keechelus Reservoir area is provided by NF-4832 and NF-5480. 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. NF-5480 parallels the southwest corner of Keechelus Reservoir. Much of the rest of the primary study area is inaccessible by vehicle.

### 3.17.3 KKC North Tunnel Alignment

Kachess Lake Road is the primary two-lane road that runs east to west between the two reservoirs. Near the west side of Kachess Reservoir, it turns into NF-49 and turns to the north to parallel the reservoir. Kachess Lake Road intersects I-90 southeast of 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. 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. USFS does not plow the roads under its jurisdiction. All USFS maintained roads are assumed to be primitive.

The Kittitas County Road Standards provide standards for roadway design that must also meet WSDOT and American Association of State Highway and Transportation Officials (AASHTO) standards. Table 3-38 describes the major components of the design standards and width requirements of the Kittitas County Road Standards.

**Table 3-38. Roadway Design Standards**

| Average Daily Traffic* | 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 |

*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 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 the purpose of this analysis, it is assumed that the peak period on local roads would occur between 7 and 9 a.m. and 4 and 6 p.m.

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 by 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, provide 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, NF-4828, and NF-49. In addition, snowmobiling is permitted along West Kachess Lake Road/NF-4818 when it has been plowed. Snowmobiling is also anticipated to occur along undesignated routes throughout the area, but since the routes are undesignated, the exact locations are unknown. Sno-parks, described in more detail in Section 3.14, provide parking and access to winter recreation activities. Kachess Sno-park has 100 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 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 on where students are living. In addition, the majority of students are anticipated to live southeast of the primary study area in Easton and Cle Elum (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). Typically synonymous with archaeological and historical sites, cultural resources encompass a broad range, including buildings, structures, sites, districts, and objects. Cultural resources also include traditional cultural properties (TCPs) of religious and cultural significance to Indian Tribes, as well as Native American human remains and funerary objects. Federal agencies are required to identify and evaluate the significance of cultural resources located within the area of potential effects (APE) of a Federal undertaking. For the purposes of this analysis, the APE and immediate surrounds correspond with the primary study area, while the extended study area provides a context for evaluating potential impacts.

The primary sources on cultural resources included in this FEIS are investigations prepared by the Yakama Nation Cultural Resources Program (YCRP) (2014, 2015, 2017, and 2018), and supplemented by input from the Colville Confederated Tribes History/Archaeology Program (Miller, 2018) and other sources and investigations. The investigations represent an inventory of the APE of the project area and provide sufficient data for comparing and evaluating alternatives. Additional surveys and evaluations, as well as tribal and agency consultation, will continue upon the selection and implementation of a preferred alternative and as the project areas are refined.

**Figure 3-47. Archaeological Field Investigations by YCRP at Kachess Reservoir, 2015 (YCRP, 2015).**

### 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 in Section 106, set out the requirements and process to identify and evaluate historical resources, determine effects on these resources, and resolve adverse effects on properties eligible for the National Register of Historic Properties (historic properties) that occur as a result of the agency's permitted undertaking. Federal agencies are to involve the State Historic Preservation Officer (SHPO) and any Indian Tribes that attach traditional religious and cultural importance to historic properties that may be affected by a given undertaking. For the proposed action, Reclamation is consulting with the Washington Department of Archaeology and Historic Preservation (DAHP) which represents the SHPO; and the Yakama Nation and Colville Confederated Tribes who are identified as having a cultural connection to the APE. 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; Executive Order (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 historic properties. 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.

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 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 action alternatives are 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 extended study area is included in the YCRP investigations (2014, 2015, 2017, and 2018). The reports include background research on the reservoirs, and field investigations and evaluations of the structural elements of the proposed facilities.

The prehistory of the upper Yakima River basin is poorly understood. Archaeological evidence indicates that humans have been present in the extended study area for at least 12,000 years. This conclusion is based on the discovery of a Paleo-Indian Clovis point found at the south end of nearby Cle Elum Reservoir (Hurley 2011). In the primary study area, leaf-shaped projectile points characteristic of the prehistoric Cascade/Vantage Phase (8,000 to 4,500 years before present) have been observed along the margins of the historical Kachess and Keechelus lakes. In these earliest human occupations, indigenous groups in the area had a highly mobile lifestyle predominantly based on hunting, foraging, and gathering. From 4,500 to 250 years before present, indigenous groups gradually shifted toward a less mobile lifestyle. An increase in semi-subterranean dwellings, a greater reliance on seasonal fish runs, and the use of food processing and storage occurred during this period. Fishing techniques grew increasingly sophisticated. In the primary study area, villages or encampments appear to have been occupied on a seasonal basis. This is the settlement pattern that existed at the time of European contact.

The extended study area is within the territory of the Kittitas (or Upper Yakama) Tribe, a constituent of the Yakama Nation. The Kittitas Tribe had settlements in the Kittitas Valley and seasonal occupations were in the headwater areas of the Yakima River. The Kittitas used the historical Keechelus and Kachess lakes for summer home-sites annually. The nearest documented winter (permanent) village was located near Cle Elum Lake (YCRP, 2015). Similarly, the project area is within the traditional territory of the Wenatchi, a constituent of the Colville Confederated Tribes. Miller (2018) has identified place names and TCPs associated with the Wenatchi in the extended study area. Descendants of the Wenatchi (also known as the Wenatshapam) are found in both the Colville Confederated Tribes and Yakama Nation. Historical records indicate that Indian trails extended between the historical Kachess and Cle Elum lakes, from Keechelus Lake to Snoqualmie Falls, and from Keechelus Lake to Roaring Creek and the Yakima Pass. It is likely that the trails were used by both the Kittitas and Wenatchi.

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 Lt. George McLellan to find a route for a wagon road over what is now Snoqualmie Pass. When McLellan arrived at Kachess Lake, he observed a native wickerwork "…fish dam, made with much ingenuity…" (YCRP, 2015) (Figure 3-48).

**Figure 3-48. Fish Weir Similar to McClellan's 1853 Description (from YCRP, 2015)**

In 1855, the Tribes and Bands that are known today as the Yakama Nation (which includes the Kittitas and Wenatshapam (Wenatchi)) 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 northern 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. A "Wenatchi Reserve" was to be established to the northeast of the study area per the Treaty of 1855, however it was never established, and this "remains an issue today" Miller (2018).

Passage of the Homestead Act in 1862 and construction of a wagon road over Snoqualmie Pass in 1865 brought 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 areas, 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 of 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

According to the *Origin of Washington Geographic Names*, Kachess is an Indian term, meaning "many fish" or "more fish" (Washington Historical Quarterly, 1920). However, it is likely a derivation of the Kittitas place name *Hah-chesch*, which, according to the Yakama Nation, describes the sound of the water at that location (Lally personal communication, 2017). Prior to the construction of Kachess Dam, there were two natural bodies of water, Kachess Lake and Little Kachess Lake, separated by a constriction known as the Narrows. *Hah-chesch* has spiritual and ceremonial associations to the Yakama Nation. YCRP suggests that archaeological sites on the landscape serve as "physical witnesses of the ancestral use" of the Kachess Lake landscape, and as such the lake and associated precontact archaeological resources may qualify as historic properties (YCRP, 2014, 2015).

YCRP conducted a preliminary cultural resources survey in late 2013 and subsequent surveys in 2015, 2016, and 2017 for the KDRPP action alternatives. The reports included research in the DAHP database of the extended study area, which lists 18 previously recorded archaeological sites at Kachess Reservoir, 8 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, 1 is historical (a Civilian Conservation Corps camp), and 3 are multicomponent, with both historical and precontact elements. Kachess Dam itself is a historic site.

The area field investigated for KDRPP focused on the location of proposed KDRPP facilities and habitat improvements. Once a preferred action alternative is selected, and precisely defined, supplemental surveys of the KDRPP APE will be performed as needed, along with tribal and agency consultation.

One site (45KT1014) is located within the APE for the proposed KDRPP facilities. The site was originally located in 1993 and identified as a fishing camp and dam construction camp. 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 once located at the outlet of the lake (Figure 3-49). Several historical features and artifacts associated with construction of Kachess Dam were also documented. During the 2013 and 2015 surveys, 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.

**Figure 3-49. A Selection of Precontact Artifacts Observed at Kachess Reservoir (From YCRP, 2015)**

Several precontact sites have been recorded in the area of the Narrows. This finding indicates that the Narrows was an important location for indigenous traditional resources procurement, including fishing (YCRP 2018).

## 3.18.4 Known and Reported Resources in the Keechelus Reservoir and KKC Conveyance Areas

According to the *Origin of Washington Geographic Names*, Keechelus is an Indian term, meaning “few fish” or “less fish” (Washington Historical Quarterly 1920). However, it is likely a derivation of the Kittitas place name, “*Hah-chee-luxsh*”, which, according to the Yakama Nation, describes the sound of the water at that location (Lally, personal communication, 2017). The predam natural Keechelus Lake, or *Hah-chee-luxsh*, has legendary associations with the Yakama Nation (YCRP, 2014). As with Kachess Lake, YCRP suggests that Keechelus Lake and associated precontact archaeological resources may qualify as a TCP.

YCRP conducted a preliminary cultural resources survey in 2013 (YCRP, 2014) and subsequent surveys have since been conducted in the area of the proposed locations for the facilities associated with KKC action alternatives. The database search of the extended study area revealed 63 previously recorded 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; 9 are multicomponent, having both historical and precontact elements; and 33 are historic, including Keechelus Dam.

The area investigated in the field for KKC consists of the locations of tunnel portals and associated intake and discharge features (YCRP, 2014). This survey area included 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. Once a preferred action alternative is selected, and precisely defined, supplemental surveys of the KKC APE would likely need to be performed, and additional consultation conducted.

The survey identified one existing site (WF303) within the APE for proposed KKC facilities. Site WF303, also known as the Keechelus Construction Camp, is an extensive historic site consisting of numerous features and artifacts associated with construction of Keechelus Dam.

The construction camp was occupied between 1912 and 1917, the time leading into the First World War (Figure 3-50). There are no longer any standing structures of the construction camp but there are surface remnants. In 2000 to 2001, archaeological excavations were conducted at the Keechelus Construction Camp. The excavations revealed much of the “social and economic conditions of the working class of the early twentieth century in the American West” (AINW, 2002).

**Figure 3-50. View of Keechelus Construction Camp circa 1914**

During the 2013 cultural resources survey for KKC, a scatter of historical debris consistent with the original site documentation was observed. A previously undetected artifact at site WF303 was identified consisting of a modified lithic tool of chert material, and may indicate an earlier precontact component of the site.

On the western side of the Keechelus Dam portion of the KKC APE is a historic railroad bed which predates the construction of Keechelus Dam; it once supported the Chicago Milwaukee St. Paul Pacific Railway (also known as the Milwaukee Road) (Figure 3-51), now a component of the Palouse to Cascades State Park Trail managed by Washington State Parks.


**Figure 3-51. Keechelus Depot of the Milwaukee Road, circa 1910**

## 3.19 Indian Sacred Sites

EO 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. Staff from YCRP prepared a cultural resources report for the project (YCRP, 2014), and the Colville Confederated Tribes prepared a TCP resource study of the upper Yakima River basin (Miller, 2018), to identify sites of religious and cultural significance that could be determined eligible for inclusion in the NRHP. While both Tribes have stated that the two lakes have spiritual and ceremonial associations, and there are areas of cultural sensitivity, no sacred sites as defined under the EO have been identified in the project area.

# 3.20 Indian Trust Assets

Indian Trust Assets (ITAs) are legal interests in property held in trust by the U.S. 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 whether a proposed project has a potential to affect ITAs.

While the majority of ITAs are located on-reservation, ITAs can also be located outside reservation boundaries. Consequently, several Tribes have a historical presence or cultural interest in the project area. These include the Yakama Nation, the Colville Confederated Tribes, and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR).

The proposed project lies within land ceded in the Yakama Treaty of 1855. The treaty established the Yakama Reservation, which lies to the south of the project 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 KDRPP and KKC.

## 3.21 Socioeconomics

Reclamation selected the primary study area for assessing socioeconomic impacts based on the location of KDRPP, KKC 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 FEIS 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 action alternatives (IMPLAN, 2014). IMPLAN is an input-output 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 at the time of initial analysis.

Socioeconomic elements key to the extended study area include income and employment, lodging supply and demand, 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 River basin (Table 3-39 and Table 3-40). 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 3-39. Washington State Economic Sectors, 2012**

| Aggregate Industry Sector | Output (millions) | Personal Income (millions) | Jobs | Average Annual Wage | Output/Job |
|---|---|---|---|---|---|
| Services | $297,514 | $93,446 | 1,959,013 | $47,701 | $151,870 |
| Manufacturing | $158,900 | $25,512 | 296,995 | $85,900 | $535,028 |
| Trade | $60,647 | $23,721 | 529,263 | $44,818 | $114,587 |
| Government | $58,887 | $40,985 | 606,529 | $67,573 | $97,088 |
| Construction | $31,223 | $10,027 | 197,660 | $50,727 | $157,964 |
| Transportation and Information | $17,410 | $5,808 | 108,610 | $53,475 | $160,301 |
| Agriculture | $15,315 | $3,081 | 127,832 | $24,101 | $119,804 |
| Utilities | $5,946 | $589 | 5,310 | $110,915 | $1,119,834 |
| Total | $660,325 | $203,168 | 3,833,798 | $52,994 | $172,238 |

Source: IMPLAN, 2014; 2012 IMPLAN Washington State Data
Note: Rank-ordered by output; totals may not sum due to rounding.

**Table 3-40. Four-County Study Area Economic Sectors, 2012**

| Aggregate Industry Sector | Output (millions) | Personal Income (millions) | Jobs | Average Annual Wage | Output/Job |
|---|---|---|---|---|---|
| Services | $15,844 | $4,934 | 113,746 | $43,378 | $139,295 |
| Manufacturing | $6,959 | $880 | 16,228 | $54,215 | $428,844 |
| Agriculture | $4,391 | $1,019 | 34,948 | $29,158 | $125,653 |
| Trade | $3,996 | $1,260 | 37,022 | $34,035 | $107,926 |
| Government | $3,573 | $2,497 | 44,826 | $55,700 | $79,715 |
| Construction | $2,054 | $621 | 13,114 | $47,349 | $156,630 |
| Transportation and Information | $1,550 | $540 | 12,189 | $44,336 | $127,170 |
| Utilities | $561 | $39 | 510 | $76,956 | $1,100,190 |
| 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).
Note: Rank-ordered by output; totals may not sum due to rounding.

### 3.21.2 Lodging Supply and Demand

The supply of rental housing within commuting distance (approximately 1 hour driving time, or approximately 75 miles) of the project area is shown in Table 3-41. Data on rental vacancy rates from the U.S. Census Bureau are for 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 3.6 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 3-41. 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 project area. Table 3-42 shows the types of accommodations by location. Cle Elum, the largest community closest to the project area, has 9 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 but outside of the area determined to be within reasonable commuting distance to the project.

**Table 3-42. Temporary Accommodations**

| Location | Lodging Services | | | Commuting Distance from Easton, WA[b] (miles) |
|---|---|---|---|---|
| | Hotels/Motels | RV Parks | Campgrounds[a] | |
| Cle Elum, WA | 9 | 3 | 29 | 13 |
| Ellensburg, WA | 14 | 2 | 3 | 37 |
| Yakima, WA | 41 | 3 | 1 | 73 |

Source: Google Maps 2016, yellowpages.com 2016
[a] Campgrounds include sites where RVs and tent camping are permitted
[b] 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) 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 the rest of the year, 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 3-43 and Table 3-44 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 3-43. Characteristics of Properties Surrounding Keechelus Reservoir**

| | Number of Parcels | Acres[a] | Total Market Value |
|---|---|---|---|
| Private | 24 | 147 | $2.4 Million |
| Public | 24 | 5,798 | N/A |

Source: Kittitas County Assessor, 2014
[a] Total acres associated with parcels within 0.1mile of the reservoir.

**Table 3-44. Characteristics of Properties Surrounding Kachess Reservoir**

| | Number of Parcels | Acres[a] | Total Market Value |
|---|---|---|---|
| Private | 197 | 1,394 | $63.2 Million |
| Public | 36 | 9,578 | N/A |

Source: Kittitas County Assessor, 2014
[a] Total acres associated with parcels within 0.1mile of the reservoir.

## 3.22 Environmental Justice

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, or policies. The study area for environmental justice includes populations in the four counties (Benton, Franklin, Kittitas, and Yakima), although the construction effects of the alternatives would occur in Kittitas County where Kachess and Keechelus reservoirs are located.

### 3.22.1 Regulatory Setting

Executive Order 12898 directs Federal agencies to identify and address disproportionately high and adverse effects of proposed actions on minority and low-income populations. Minority populations are people who self-identify as Hispanic, Black or African-American, American Indian, Asian, Native Hawaiian, or some other race alone or combined. Low-income populations are defined following the Office of Management and Budget's poverty thresholds by family size. Guidelines provided by the Federal Interagency Working Group on Environmental Justice and NEPA (2016) recommend identifying environmental justice populations based on "50 percent" or "meaningfully greater" analyses. The "50 percent" analysis ensures that, when minority individuals make up over half the geographic unit of analysis, a minority population is identified for environmental justice purposes, regardless of whether the "meaningfully greater" analysis has a similar outcome. The "meaningfully greater" analysis is recommended to define low-income populations as being 10 or 20 percent greater than the low-income families in a reference community.

### 3.22.2 Study Area Population Characteristics

Table 3-45 shows selected demographic characteristics of the four-county study area compared to the State of Washington. Data are representative of average characteristics during the 2011 to 2015 period.

#### *3.22.2.1 Minority Populations*

Table 3-45 shows the racial category with the highest percent of the population across the four-county study area is white alone (78.3 percent). White alone comprises a majority of each county. The Census Bureau considers "Hispanic" a separate concept from race. People who self-identity as Hispanic or Latino/Latina may be of any race, and Hispanics are one of the fastest growing segments of the U.S. population. In the 2011- to 2015 period, 51.5 percent of Franklin County's population self-identified as Hispanic or Latino/Latina while Kittitas County had the lowest percent of Hispanics (8.5 percent). The percentage of Hispanics in Franklin County defines this county as an environmental justice population.

#### *3.22.2.2 Low-income Families*

Table 3-45 presents the number and percent of families living below the poverty threshold. Fourteen percent of the families in the four-county study area were living in poverty compared to 9 percent in Washington. Of the four counties, Yakima County had the highest percentage of families living below the poverty threshold (16.5 percent); however, none of the counties qualify as low-income for environmental justice purposes.

**Table 3-45. Minority and Low-Income Populations by County**

| Race or Ethnicity | Benton | Franklin | Kittitas | Yakima | Washington |
|---|---|---|---|---|---|
| **Total Population** | 184,930 | 86,443 | 42,204 | 247,408 | 6,985,464 |
| White | 134,307 | 36,603 | 35,720 | 112,714 | 4,943,228 |
| Black | 2,678 | 1,579 | 398 | 1,843 | 243,786 |
| American Indian | 1,173 | 297 | 334 | 8,740 | 80,838 |
| Asian | 4,784 | 1,771 | 948 | 2,421 | 530,928 |
| Hawaiian, Pacific Islander | 190 | 44 | 23 | 121 | 42,532 |
| Other race | 257 | 47 | 28 | 100 | 9,467 |
| Two or more races | 4,638 | 1,586 | 1,178 | 4,892 | 299,197 |
| Hispanic (of any race) | 36,903 | 44,516 | 3,575 | 116,577 | 835,488 |
| **Percentage of Total** | | | | | |
| White | 72.6 | 42.3 | 84.6 | 45.6 | 70.8 |
| Black | 1.4 | 1.8 | 0.9 | 0.7 | 3.5 |
| American Indian | 0.6 | 0.3 | 0.8 | 3.5 | 1.2 |
| Asian | 2.6 | 2.0 | 2.2 | 1.0 | 7.6 |
| Hawaiian, Pacific Islander | 0.1 | 0.1 | 0.1 | 0.0 | 0.6 |
| Other race | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 |
| Two or more races | 2.5 | 1.8 | 2.8 | 2.0 | 4.3 |
| Hispanic (of any race) | 20.0 | 51.5 | 8.5 | 47.1 | 12.0 |
| **Families below poverty** | 4,976 | 2,945 | 1,137 | 9,473 | 152,493 |
| **Percentage of families** | 10.6 | 15.4 | 12 | 16.5 | 8.9 |

Source: U.S. Department of Commerce, Census Bureau, American Community Survey Office. (2015).
Note: Calculated using average American Community Survey (ACS) annual surveys during 2011 through 2015.

## 3.23 Health and Safety

The primary study area for health and safety includes the following locations:

- Kachess Reservoir
  - Locations of proposed KDRPP facilities and other construction-related sites within 1.5 miles of the Kachess Reservoir shoreline
  - The Narrows for construction of the Volitional Bull Trout Passage Improvements
- Keechelus Reservoir
  - Locations of proposed KKC facilities and other construction-related sites within 1.5 miles of the Keechelus Reservoir shoreline.
- KKC North Tunnel Alignment
  - Areas overlying the proposed tunnel alignment as described in Chapter 2

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. These impacts could include exposing hazards, such as steep banks and obstructions in the water. This section describes the results of the National Priorities List and other database searches for known hazardous sites. Around the reservoirs, the public is currently exposed to existing safety hazards such as steep slopes to access the reservoir bed, and submerged hazards to boaters, as well as from wildfire. Refer to Section 3.2 for more information regarding the geology and soil conditions.

The Kittitas County Hazard Mitigation Plan identifies the area on the west shore of Kachess Reservoir as an existing high fire hazard area (Kittitas County 2012). In response to comments on the DEIS, Reclamation has coordinated with Kittitas Fire Department No. 8 and the Washington Department of Natural Resources (DNR) regarding fire hazards and fire suppression capabilities in the area around Kachess Reservoir. Kittitas Fire Department No. 8 relies on volunteer firefighters. In the event of a fire near Kachess Reservoir, a spring located near the Kachess homeowners' community is used as water supply for firefighting. Firefighters also have access to Kachess Reservoir to fill a fire truck; although access via the boat ramp at the Kachess campground is not available when reservoir levels are drawn down during current operations. Aircraft operated by the USFS, DNR, and supporting agencies can be enlisted to fight wildfires in the central Cascade Range and can use water stored in Kachess Reservoir for firefighting.

### 3.23.1 Kachess Reservoir Area

There are no known National Priorities 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 in 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 Priorities List sites in the primary or extended study areas (EPA, 2014b). No hazardous materials sites are present in the primary study area (Ecology, 2014f). One UST is located at the WSDOT maintenance area near Gold Creek.

### 3.23.3 KKC North Tunnel Alignment

No known National Priorities List or hazardous materials sites are located in the primary or extended study areas (EPA, 2014b; Ecology, 2014f).

*(This page intentionally left blank)*

# Chapter 4 Environmental Consequences

## 4.1 Introduction

This Chapter of the FEIS presents information on how the alternatives described in Chapter 2 might directly, indirectly and cumulatively impact the resources described in Chapter 3. Effects are assessed after considering those avoidance, mitigation, and minimization measures described in Chapter 2. Under each resource is a discussion of methods of analysis and indicators of the direct and indirect impacts of implementing the alternatives. Presented at the end of the chapter are sections describing cumulative impacts, short-term uses and long-term productivity, unavoidable adverse impacts, irreversible and irretrievable commitments of resources.

### 4.1.1 Terms Used in this Chapter

The following terms may be useful to readers' understanding of this chapter.

- Effects and Impacts. These terms are synonymous and include cumulative impacts (40 CFR 1508.8).

- Direct and Indirect Impacts. Direct impacts are caused by the action and occur at the same time and place. Indirect effects are also caused by the action but occur later in time or farther removed in distance. 40 CFR 1508.8(a) and (b).

- Duration. This describes the length of time an impact would occur.

- Cumulative Impacts. Cumulative impacts result from the incremental impact of the action/alternative when added to other past, present, and reasonably foreseeable future actions (40 CFR 1508.7). The cumulative impact analysis is in Section 4.25.

- Indicator. An impact indicator is a means of describing or quantifying the intensity of environmental effects to a resource or resource parameter.

- Significance. Refers to both context and intensity. Context refers to the consideration of the significance of effects in relation to several contexts such as society as a whole, the affected region, affected interest, and locality. Intensity refers to the severity of impacts to resources. Context and intensity must both be considered to determine significance of impacts. 40 CFR 1508.27. Where possible, this EIS quantifies intensity of impacts; for example, intensity of effects to soils is measured by acres of potential ground disturbance. Where effects are qualitative, intensity is described using terms such as negligible, minor, moderate, or major and substantial.

# 4.2 Earth

## 4.2.1 Methods and Impact Indicators

Table 4-1 shows impact indicators for earth resources. Impacts for action alternatives were assessed relative to *Alternative 1 – No Action.*

**Methods.** For soils, the method was mapping areas where ground disturbance would occur during construction of tunnel shafts, construction roads, staging areas, etc., the duration of soil exposure, the placement of spoils, the extent of construction activities (e.g., dredging and fill) that alter existing slopes, and the stability of Kachess Reservoir slopes. The short-term is defined as the construction period, projected to last up to 3 years. The long-term is defined as the alternative's footprint or plan view after construction, revegetation or restoration is complete. The acres of short-term disturbance exceed those of long-term disturbance because of avoidance measures or BMPs that would be applied to revegetate or remediate disturbed areas. These effects are quantified in acres of total surface disturbance by alternative as summarized in Table 4-3.

For geologic hazards, the method was quantitative in that Reclamation and Ecology (2014b) conducted a probabilistic seismic hazard analysis for the area as a screening-level engineering analysis (Reclamation and Ecology, 2014h**).** Four seismic sources were considered local active and potentially active faults, background seismicity, megathrust earthquakes on the interface of the Cascadia Subduction Zone, and interslab earthquakes occurring within the subducting slab (Reclamation and Ecology, 2014h). 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) were then used as seismic design criteria for all proposed improvements.

Qualitative methods were also applied. A literature search was conducted which revealed 2 landslides 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 project's area of impact. They are not likely to reactivate owing to project activities; however, if they reactivate by other processes, they could temporarily increase in turbidity and potentially temporarily separate Little Kachess from the Big Kachess.

**Impact Indicators.** The impacts would be influenced primarily by the magnitude of the area of soil exposure, the duration of exposure, and the effectiveness of erosion-control measures.

[1] PHA is typically expressed as the percentage of the acceleration attributable 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.

**Table 4-1. Impact Indicators for Earth Resources**

| Issues | Impact Indicators |
|---|---|
| Erosion associated with construction | Acres of land associated with ground disturbance |
| Long-term reservoir rim stability and erosion associated with drawdown of Kachess Reservoir | Acres of exposed reservoir bed at elevation 2,112.75 |

## 4.2.2 Summary of Impacts

With *Alternative 1*, shoreline erosion, if any, and seismic hazards would continue as under existing conditions. Under the action alternatives, impacts on earth resources (Table 4-2) would be minimized by applying measures described in Chapter 2 and Section 4.2.10.

The Volitional Bull Trout Passage Improvements would be implemented as part of all the action alternatives. Impacts on earth resources would be minimized by applying measures described in Chapter 2.

No long-term erosion issues are expected with the completed Volitional Bull Trout Passage Improvements.

**Table 4-2. Summary of Impacts for Earth Resources**

| Impact Indicator | Summary of Impact |
|---|---|
| Acres of land associated with ground disturbance during construction | Ground disturbance:<br>• *Alternative 1* – no ground disturbance<br>• *Alternative 2* – up to 75.5 acres<br>• *Alternative 3* – up to 44.5 acres<br>• *Alternative 4* – up to 7 acres<br>• *Alternative 5A* – up to 88 acres<br>• *Alternative 5B* – up to 57 acres<br>• *Alternative 5C* – up to 19.5 acres |
| Acres of exposed reservoir bed at elevation 2,112.75 | Under all action alternatives, drawdown associated with the operation of KDRPP would result in exposure of up to about 628 acres of reservoir bed at Kachess Reservoir. If reservoir rim stability or erosion is identified following drawdown, Reclamation would implement erosion control measures to minimize the impacts. |

**Table 4-3. Disturbance Area by Alternative**

| | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5A | Alternative 5B | Alternative 5C |
|---|---|---|---|---|---|---|
| Total Disturbance Area | 75.5 acres | 44.5 acres | 7 acres | 88 acres | 57 acres | 19.5 acres |
| Temporary Disturbance Area | 57 acres | 36.5 acres | 0 acres | 66 acres | 45 acres | 8 acres |
| Permanent Disturbance Area | 18 acres | 8 acres | 7 acres | 22 acres | 12 acres | 11 acres |

### 4.2.3 Alternative 1 – No Action

Under *Alternative 1*, any existing areas of the two reservoirs that experience 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 under existing conditions. Drainage patterns within the Yakima River basin that may currently experience or cause erosion would also continue. Any future seismic activity would expose existing improvements to potential adverse effects or damage depending on the magnitude and duration of the seismic events.

### *4.2.4 Alternative 2 – 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 in both upland areas and on the reservoir floor. These construction activities would expose bare ground through clearing and grading (up to approximately 75.5 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. Project proponents would implement erosion control measures described in Chapter 2 and Section 4.2.10 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 would essentially build a slurry wall around the perimeter of the shaft location to allow for shaft excavation. 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 would separate 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 within the project area, 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 would be 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 attributable to earth loads and groundwater or the estimated grouting pressures (Reclamation and Ecology, 2014h). Construction of the discharge line would consist of more traditional trench excavation for approximately 7,000 feet to the discharge point downstream using conventional equipment such as excavators. Approximately 117,000 cy of material would be excavated under *Alternative 2 – KDRPP East Shore Pumping Plant*.

Reclamation would conduct all construction activities in accordance with a NPDES General Construction Permit. As part of the NPDES permit, the contractor would prepare a SWPPP that would include BMPs that govern construction activities and contain erosion control measures. Implementation of these BMPs would reduce short-term erosion potential because they have proven effective in minimizing erosion for construction projects in similar environments.

*Slope Stability Risks*

Construction would include dredging to remove sediment in a cone-shaped area centered on the intake location. Reclamation would annually 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 (i.e., less than 3-to-1 slopes) may be required. Reclamation would conduct final geotechnical studies of sediment stability and shear strength testing prior to construction 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, 2014h). 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 starting construction in this area (Reclamation and Ecology, 2014g). The geotechnical investigation would include stability measures to reduce any identified slope stability risks. 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 encountering an old excavated coal seam are potential hazards that could compromise tunneling efforts. According to a search of records with the Washington Geological Survey, no coal mines are mapped for this area (Reclamation and Ecology, 2014g). The nearest known coal mine is near Roslyn, approximately 12 miles east of the reservoir. Therefore, it is reasonable to conclude that no substantial hazard is posed by the presence of historical coal mines at the project site.

**Volitional Bull Trout Passage Improvements**

Construction associated with the Volitional Bull Trout Passage Improvements would require clearing and vegetation removal, excavation, hauling, and placement of materials to create the passage. The potential impacts on earth resources would be temporary. Impacts would be minimized by applying BMPs to reduce erosion during construction. The construction sites would be regraded and revegetated immediately following construction, and construction would not increase slope stability or seismic risks.

### *4.2.4.2 Operation*

**KDRPP East Shore Pumping Plant Facilities**

*Long-term Erosion*

During drought years, Reclamation would use KDRPP and draw the reservoir down below the current low pool elevation. This drawdown would expose up to about 628 acres of reservoir bed at Kachess Reservoir and expose previously submerged sediments to the effects of erosion. Precipitation, wave action, or wind could cause 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. It is anticipated that many of the creeks would find their original channels (abandoned about 100 years ago when the reservoir was inundated); however, any erosion as a result would be short-lived as the streams return to equilibrium.

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 would be unlikely to change conditions there because the Little Kachess basin becomes separated from the main reservoir at elevation 2,223 and additional drawdown would not occur in Little Kachess basin (Figure 4-1). The stream channel between the two reservoir 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 erosion control measures as described in Chapter 2. See Section 4.4, for a discussion of sedimentation and water quality.

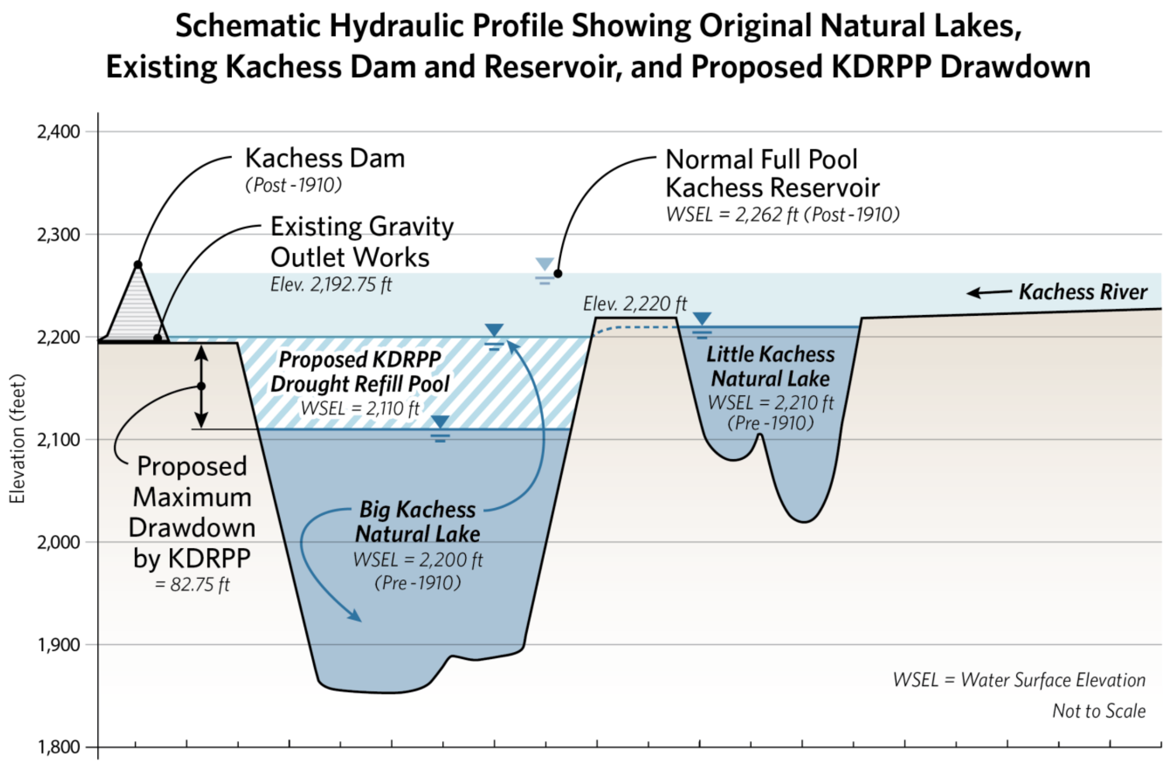



**Figure 4-1. Kachess Reservoir Hydraulic Profile**

*Seismic Risks*

Kachess Reservoir is within a seismically active area that could be susceptible to future earthquakes. Reclamation has conducted a probabilistic seismic hazard analysis for the area as a screening-level engineering analysis (Reclamation and Ecology, 2014h). Four seismic sources were considered local active and potentially active faults, background seismicity, megathrust earthquakes on the interface of the Cascadia Subduction Zone, and interslab earthquakes occurring within the subducting slab (Reclamation and Ecology, 2014h). 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[2] (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) were then used as seismic design criteria for all proposed improvements.

In general, aboveground structures are more susceptible to damage from ground shaking than are subsurface improvements. Incorporation of seismic design criteria in final design would be consistent with current geotechnical practices and international building code standards would minimize 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. Where 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). A Reclamation geologist inspected the currently-exposed lake bed during current low pool conditions in 2015 and reviewed available information on geologic materials and near-shore depths and slopes of the reservoir bed. Based on field observations and review of the available data, the proposed operations of KDRPP would not cause substantial erosion or create a high risk of landslides or slumps. Localized areas of near-surface soil instability would be expected during drought relief pumping, but damage to property or changes in topography in areas that are normally exposed during normal reservoir operation are not expected.

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.

Under rapid drawdown conditions, 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 push the soil 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 failure under these circumstances. This could result in small- to medium-size slumps at the points where the pressures are greatest. However, operational plans would draw down the reservoir at a rate of no more than 1 foot per day. This slow rate of reservoir drawdown makes the occurrence of slumps unlikely.

Heavy rains can saturate exposed surface soils, resulting in shallow, landslides a few to several feet thick. They are likely to move quickly and may create sediment plumes in the lake but would create minor increases in turbidity. During or following prolonged storms, water can infiltrate deeper layers, causing deep-seated, rotational slope failures. Such

[2] PHA is typically expressed as the percentage of the acceleration attributable 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.

landslides 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). Both types of landslides could occur, but are projected to result in minor increases in turbidity.

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 amount of snow quickly, 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. These types of events are not anticipated to increase because of the proposed project.

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 for further discussion of sedimentation and turbidity and Section 4.23 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 project’s area of impact. They are not likely to reactivate owing to project activities; however, if they reactivate by other processes, they could temporarily increase in turbidity and potentially temporarily separate Little Kachess from the Big Kachess.

**Volitional Bull Trout Passage Improvements**

No long-term erosion problems or slope stability or seismic risks are expected with completion of the Volitional Bull Trout Passage Improvements. The design of this feature would incorporate slope stabilization methods in any areas of unconsolidated sedimentary materials. The roughened channel would be constructed of rock that would not be affected by being submerged under water; therefore, no long-term erosion issues are anticipated.

### 4.2.5 Alternative 3 – KDRPP South Pumping Plant

#### 4.2.5.1 Construction

**KDRPP South Pumping Plant Facilities**

Construction activities for *Alternative 3 – KDRPP South Pumping Plant* would be similar to those for *Alternative 2*, 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 44.5 acres, instead of 75.5 acres under *Alternative 2. Alternative 3* also includes a shallower excavation for the pumping plant shaft but a much longer intake tunnel (approximately 3,800 feet compared to 800 feet for *Alternative 2*). In addition, a separate discharge would not be needed, thereby 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 Chapter 2 and Section 4.2.10. 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 *Alternative 2.* Approximately 115,000 cy of materials would be excavated under *Alternative 3.* Any areas that are disturbed during construction would be subject to increased erosion if proper control measures are not implemented. However, erosion control BMPs would be implemented during construction activities.

*Seismic and Slope Stability Risks*

As described for *Alternative 2*, Kachess Reservoir is within a seismically active area that could be susceptible to future earthquakes. Reclamation has conducted a PSHA for the area and determined the PHA values that could be experienced at the site. As for *Alternative 2*, the resultant PHA values would be used to create seismic design criteria for all proposed improvements. *Alternative 3* would require a shallower pumping plant shaft, longer intake tunnel, and no discharge line, but overall would be constructed to meet 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, incorporating 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.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.2.4.1).

### *4.2.5.2 Operation*

**KDRPP South Pumping Plant Facilities**

*Long-term Erosion*

Operational impacts on erosion associated with increased drawdown of the reservoir would be the same as for *Alternative 2.* 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 erosion control measures. See Section 4.4for a discussion of sedimentation and water quality.

*Seismic and Slope Stability Risks*

Landslide and seismic hazards would be similar to those described for *Alternative 2*. Implementing current geotechnical practices and meeting code requirements would minimize the potential risk.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.2.4.2).

### 4.2.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

#### 4.2.6.1 Construction

Construction activities for *Alternative 4 (Preferred Alternative)* would be similar to those for *Alternative 2,* although the impacts on earth resources related specifically to the pump barge would occur underwater within the reservoir, which would reduce the amount of exposed bare ground susceptible to erosion to approximately 7 acres, instead of 75.5 acres under *Alternative 2.*

**KDRPP Floating Pumping Plant Facilities**

*Erosion during Construction*

Construction activities on land would expose bare ground through clearing and grading 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. Reclamation would use erosion control BMPs and manage excavated materials during all construction activities to minimize erosion, as described in Chapter 2 and Section 4.2.10.

*Seismic and Slope Stability Risks*

As described for *Alternative 2,* Kachess Reservoir is within a seismically active area that could be susceptible to future earthquakes. Reclamation has conducted a PSHA for the area and determined PHA values that could be experienced at the site. As for *Alternative 2*, the resultant PHA values would be used to create seismic design criteria for all proposed improvements.

Dredging in Kachess Reservoir at the location of the pump barge would change the slope and surface in a small area of the reservoir floor. Dredging would involve removing 6,000 cy of material to provide a horizontal bench in the sloped reservoir floor at this location, to maintain an acceptable vertical distance between the suction bells of the pumping units and the reservoir floor below. The dredged material would be disposed within the reservoir on the reservoir floor at a nearby location that is an acceptable distance from the dredged bench. Prior to construction, jet grouting may be required on the reservoir floor between the bench to be dredged and the flow control structure to create a stable finished slope.

Construction of the discharge basin and other in-reservoir features would occur on the floor of the reservoir or in water, where the risk of slope failure would be minimal. 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 submerged conditions, flatter slopes may be required.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.2.4.1).

#### 4.2.6.2 Operation

**KDRPP Floating Pumping Plant Facilities**

*Erosion*

Operational impacts on erosion associated with increased drawdown of the reservoir would be similar as for *Alternative 2.* 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 erosion control measures prior to implementation. See Section 4.4, for a discussion of sedimentation and water quality.

*Seismic and Slope Stability Risks*

Landslide and seismic hazards would be similar to those described for *Alternative 2.* Using seismic design criteria and performing annual inspections would minimize the potential risks.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.2.4.2).

### 4.2.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

*Alternative 5A – KDRPP East Shore Pumping Plant with Keechelus-to Kachess Conveyance (KKC) North Tunnel Alignment* would include construction of the KDRPP East Shore Pumping Plant (*Alternative 2*). The impacts from construction and operation of these components of *Alternative 5A* would be the same as described in Section 4.2.4. *Alternative 5A* would also include construction and operation of the KKC North Tunnel Alignment. The impacts of the KKC North Tunnel Alignment are described below.

#### *4.2.7.1 Construction*

**KKC North Tunnel Alignment Facilities**

*Erosion during Construction*

Construction activities would include clearing and grading approximately 12.5 acres. Excavation within the types of soils anticipated should be possible using conventional earthmoving equipment (Reclamation and Ecology, 2014g). 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. Approximately 115,000 cy of materials would be excavated for construction of the KKC North Tunnel Alignment.

Surface deposits in the area of the diversion structure likely include river alluvium overlying outwash (Reclamation and Ecology, 2014g). 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 bgs (Reclamation and Ecology, 2014g). Construction BMPs would be implemented throughout the construction period to minimize the exposure of disturbed areas to the effects of erosion.

*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 using steel sets, which are steel arch supports to ensure the tunnel maintains structural integrity, or pregrouting, which is a method to reduce water inflows during tunnel drilling.

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 minimized.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.2.4.2).

### *4.2.7.2 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 would change their water levels. The range of water levels in Keechelus Reservoir under *Alternative 5A* would be the same as under *Alternative 1*. The range of water levels in Kachess Reservoir would be the same as under *Alternative 2*. Therefore erosion impacts related to reservoir water levels would be the same as described for *Alternative 1* in Keechelus Reservoir and *Alternative 2* in Kachess Reservoir. 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 Kachess Reservoir, discharge flows could erode the 10- to 30-degree newly exposed slopes. The proposed discharge structure would include 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 initial operations and subsequent, regular shoreline monitoring, appropriate erosion control would be implemented. See Section 4.4 for a discussion of sedimentation and water quality.

*Seismic and Slope Stability Risks*

The two reservoirs are 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.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.2.4.2).

### 4.2.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation of *Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment* would be the same as described in Section 4.2.7 (*Alternative 5A*) for the North Tunnel; however, KDRPP would be constructed at the south shore location as described in Section 4.2.5 (*Alternative 3*) rather than at the east shore location. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.2.7 (*Alternative 5A*).

### 4.2.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation of *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment* would be the same as described in Section 4.2.7 (*Alternative 5A*) for the North Tunnel; however, the KDRPP floating pumping plant would be constructed as described in Section 4.2.6 (*Alternative 4 [Preferred Alternative]*). As the floating pumping plant would disturb less of the shoreline, the impacts would be lessened. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.2.7 (*Alternative 5A*).

## 4.2.10 Avoidance, Minimization, and Mitigation Measures

### *4.2.10.1 Construction*

Project proponents would complete further 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. Project proponents responsible for construction would implement the following BMPs to minimize the potential for erosion and sediment production:

- Timing construction activities to avoid disturbing soils during wet weather to the extent practicable
- Using straw bales, silt fencing, or other suitable sedimentation control or containment devices
- Washing truck tires to reduce tracking 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. Project proponents would monitor erosion during construction. Project proponents would implement additional mitigation if needed to address erosion problems.

#### *4.2.10.2 Operation*

Although we do not anticipate ongoing impacts, once the selected alternative has been constructed and becomes operational, 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. The measures that would be implemented to minimize effects include the following:

- Limit drawdown rates to approximately 1 foot per day, to allow for drainage and pore pressure relief
- Perform annual surveys of the reservoir rim to observe whether erosion or slope stability conditions have changed and implement 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 during project operations.

## 4.3 Surface Water Resources

### 4.3.1 Methods and Impact Indicators

This section describes the impacts of the alternatives on water storage in the Keechelus and Kachess reservoirs and on flows in the Yakima and Kachess rivers.

**Methods.** Reclamation used a hydrologic model known as RiverWare to evaluate the 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 River basin; for this process, Reclamation ran the model with daily data for the entire historic record of 1926 to 2015 (referred to as the modeled years). These modeled years include the multiyear drought from 1992 to 1994 and the single-year droughts in 2001, 2005, and 2015. The next step was to simulate the effects of the different alternatives as if they had been operational during the same years. Output from RiverWare included the following quantitative daily data for each alternative:

- Reservoir levels in Keechelus, Kachess, and other Yakima Project reservoirs
- Streamflow in the Yakima River below Keechelus Reservoir, the Kachess River below Kachess Reservoir, and other river reaches in the Yakima River basin, including Umtanum reach, Roza reach, Wapato reach, and Naches reach

- Deliveries to proratable water users along the Yakima and Naches rivers who agree to participate in KDRPP, assumed for the EIS to be KRD, Roza, and WIP

The potential effects of climate change on alternatives' surface water resources are discussed in Section 4.12. The impact indicators for surface water resources are described Table 4-4.

### 4.3.2 Summary of Impacts

Surface water resource impacts for all alternatives would include beneficial changes in water supply for participating Proratable Entities during drought years, changes in reservoir levels for Kachess and Keechelus reservoirs, and changes in streamflow for the Kachess River and upper Yakima River reaches. These impacts are summarized in Table 4-4 and described below.

The impacts reported in Table 4-4 are based on modeling of KDRPP operations as though the participating Proratable Entities would seek to raise their water supply up to the 70 percent level in every drought year, and would take their full entitlement of 100 percent (represented by normal usage) during non-drought years requiring Kachess Reservoir refill operations. There are a number of reasons that the participating Proratable Entities may choose, consistent with contractual operating provisions, to operate KDRPP to receive less than these amounts. Therefore the results summarized in Table 4-4 may overstate impacts on surface water resources.

**Table 4-4. Summary of Impacts for Surface Water Resources**

| Impact Indicator | Summary of Impact |
|---|---|
| Years with prorationing below 70% out of 90 total years (more years is negative impact) | *Alternative 1* – 15 years below 70% proration<br>*Alternatives 2, 3,* and *4* – 13 years below 70% proration<br>*Alternatives 5A, 5B*, and *5C* – 13 years below 70% proration |
| Change in proration (higher proration is positive impact) | *Alternative 1* – No change<br>*Alternatives 2, 3,* and *4* – 4 years 70% proration reached; 2 years proration dropped below 70% (66% and 68% proration); up to 22% improvement in proration levels<br>*Alternatives 5A, 5B*, and *5C* – 4 years 70% proration reached; 2 years proration dropped below 70% (66% and 69% proration); up to 22% improvement in proration levels |
| Days Kachess Reservoir below elevation 2,192.75 out of 91 years modeled (more days is negative impact) | *Alternative 1* – 0 days<br>*Alternatives 2, 3*, and *4* – 6,225 days (occurs in 34 years, 183 days average per year)<br>*Alternatives 5A, 5B*, and *5C* – 4,976 days (occurs in 32 years, 156 days average per year) |

| Impact Indicator | Summary of Impact |
|---|---|
| Days Kachess Reservoir below elevation 2,150 (representing drought relief pumping of about 110,000 AF) out of 91 years modeled (more days is negative impact) | *Alternative 1* – 0 days<br>*Alternatives 2, 3*, and *4* – 2,075 days (occurs in 18 years, 115 days average per year)<br>*Alternatives 5A, 5B*, and *5C* – 1,557 days (occurs in 12 years, 130 days average per year) |
| Days Kachess Reservoir below elevation 2,220 out of 91 years modeled (more days is negative impact) | *Alternative 1* – 5,681 days (occurs in 73 years, 78 days average per year)<br>*Alternatives* 2, *3*, and *4* – 11,692 days (occurs in 76 years, 154 days average per year)<br>*Alternatives 5A, 5B,* and *5C* – 10,626 days (occurs in 76 years, 140 days average per year) |
| Days Kachess Reservoir below elevation 2,226 out of 91 years modeled (more days is negative impact) | *Alternative 1* – 9,196 days (occurs in 83 years, 111 days average per year)<br>*Alternatives* 2, *3*, and *4* – 14,551 days (occurs in 85 years, 171 days average per year)<br>*Alternatives 5A, 5B,* and *5C* – 12,838 days (occurs in 82 years, 157 days average per year) |
| Days Keechelus Reservoir below 2,466 feet out of 91 years modeled (more days is negative impact) | *Alternative 1* – 10,301 days (occurs in 80 years, 129 days average per year)<br>*Alternatives* 2, *3*, and *4* – 10,596 days (occurs in 81 years, 131 days average per year)<br>*Alternatives 5A, 5B,* and *5C* – 9,269 days (occurs in 69 years, 134 days average per year) |
| Days in July that the Keechelus reach of the Yakima River is at or below 500 cfs out of the period modeled (more days is positive impact) | *Alternative 1* – 42 days (occurs in 13 years, 3 days average per year)<br>*Alternatives* 2, *3*, and *4* – 110 days (occurs in 16 years, 7 days average per year)<br>*Alternatives 5A, 5B,* and *5C* – 2,677 days (occurs in 89 years, 30 days average per year) |

**Change in Water Supply.** The Integrated Plan establishes a goal for delivering water to proratable irrigation districts during drought years. The goal is 70 percent of the district's entitlement; below that percentage of entitlement, users are likely to suffer severe economic loss as documented in the FPEIS for the Integrated Plan. KDRPP is intended to improve prorationing toward this target percentage, but additional projects from the Integrated Plan would be needed to fully reach the target 70 percent level in all years.

Presently, water supply for proratable users is inadequate in drought years. *Alternative 1* would result in continued inadequacy of water supply for proratable irrigators, especially during drought years. Under *Alternative* 2 *– KDRPP East Shore Pumping Plant*, A*lternative 3 – KDRPP South Pumping Plant*, and *Alternative 4 (Preferred Alternative)*, KDRPP would improve water supply to participating proratable water users by up to 22 percentage points in the worst single-drought years, raising the proration percentage to about 53 percent of entitlement. This would be a substantial benefit to water supply because it would offer substantial progress toward the Integrated Plan's 70 percent proration goal. In multiyear droughts, such as occurred from 1992 to 1994, the improvement under *Alternatives 2, 3,* and

*4* would be less in the third year (from 24 percent of entitlement under *Alternative 1* to 33 percent of entitlement under *Alternatives 2, 3,* and *4* in 1994) because some of the inactive storage in Kachess Reservoir would be used in the first 1 or 2 years of drought, leaving less for a third year of drought.

*Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment, Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment,* and *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment* would increase water supply for participating Proratable Entities to about 51 to 54 percent of entitlement during the worst single-drought years, also better than *Alternative 1* and offering substantial progress toward the Integrated Plan's 70 percent proration goal. In multiyear droughts, such as occurred from 1992 to 1994, the improvement under *Alternatives 5A, 5B,* and *5C* would be less in the third year (from 24 percent of entitlement under *Alternative 1* to 33 percent entitlement under *Alternatives 5A, 5B,* and *5C* in 1994) for the same reason as that for *Alternatives 2, 3,* and *4*. These potential benefits would accrue to participating Proratable Entities (assumed to include KRD, Roza, and WIP). When Kachess Reservoir is refilling after a drought under all action alternatives, the model shows there is the potential for a slight reduction (2 to 4 percent) in water supply for proratable irrigation districts; in 2 of the 90 years modeled, the water supply was reduced slightly below 70 percent during refill (to 66 to 68 percent).

**Change in Reservoir Levels**. The impacts of each alternative are assessed relative to the impacts of *Alternative 1*, using both frequency (number of years during which the condition occurs) and duration (number of days per year during which the condition occurs). Under all the action alternatives, Reclamation would operate Keechelus Reservoir to help Kachess Reservoir refill following a drought. This action would result in slightly lower mean Keechelus Reservoir pool levels, with a maximum incremental reservoir drawdown of 18 feet in late summer (in 1996) compared with *Alternative 1*.

When Keechelus Reservoir level falls below elevation 2,466, bull trout access to its tributaries is adversely affected. For all alternatives, Keechelus Reservoir typically falls below elevation 2,466 from August to November. *Alternatives 2, 3,* and *4* would be expected to cause this adverse effect for 1 additional year (from 80 years for *Alternative 1* to 81 years for *Alternatives 2, 3,* and *4*, out of 90 total years), and for a longer duration—a mean of 131 days for *Alternatives 2, 3,* and *4* versus 129 days for *Alternative 1*. This would be an adverse impact on fish passage, as described in Section 4.6. Under *Alternatives 5A, 5B,* and *5C*, Keechelus Reservoir levels would fall below elevation 2,466 in 11 fewer years than under *Alternative 1* (from 80 years for *Alternative 1* to 69 years for *Alternatives 5A, 5B,* and *5C*) but for an additional 5 days per year during years when Keechelus Reservoir levels fall below elevation 2,466. In all cases, the pool elevation would remain within the current operating range of the reservoir.

Under all action alternatives, in some years Kachess Reservoir would be drawn down by a maximum of 80 feet below existing minimum pool conditions (elevation 2,192.75). Reservoir levels were simulated to fall below elevation 2,192.75 in about one-third of the model years analyzed, for a mean duration of between 156 and 183 days. The time for

Kachess Reservoir to refill to normal operating levels would be 2 to 5 years following a drought. For *Alternatives 2*, *3*, and *4*, Kachess Reservoir was simulated to refill in 2 years twice, in 3 years four times, in 4 years once, and in 5 years once. For *Alternatives 5A*, *5B*, and *5C*, Kachess Reservoir was simulated to refill in 2 years four times, in 3 years three times, and in 5 years once. Normal operating levels is considered the full range of water storage from elevation 2,192.75 to full pool at elevation 2,262.

Figure 4-2 and Figure 4-3 display drawdown of Kachess Reservoir under two alternate operational conditions for illustration purposes. Figure 4-2 shows drawdown for Roza only, at the end of a 1-year drought similar to the 2001 drought. In this case, a drawdown of approximately 30 feet would be expected, representing 73,000 acre-feet of withdrawal from the inactive pool instead of 200,000 acre-feet. Figure 4-3 shows drawdown at the end of severe, multi-year drought assuming the participating Proratable Entities include Roza, KRD and WIP. The maximum drawdown of 80 feet is shown, representing 200,000 acre-feet withdrawn from the inactive pool.

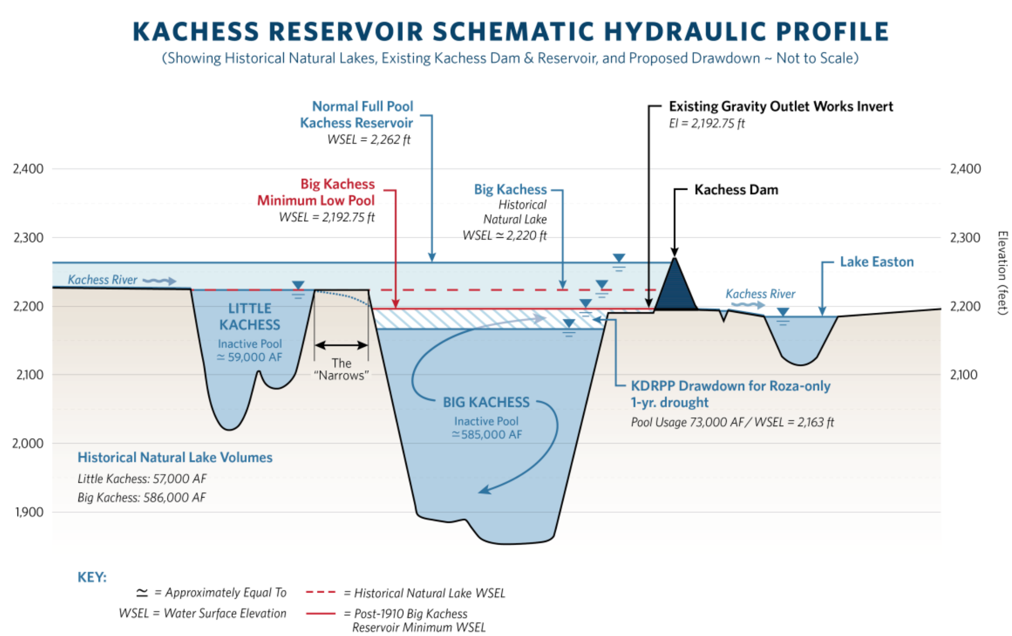



**Figure 4-2. Drawdown at End of 1-year Drought with Use of 73,000 Acre-feet**

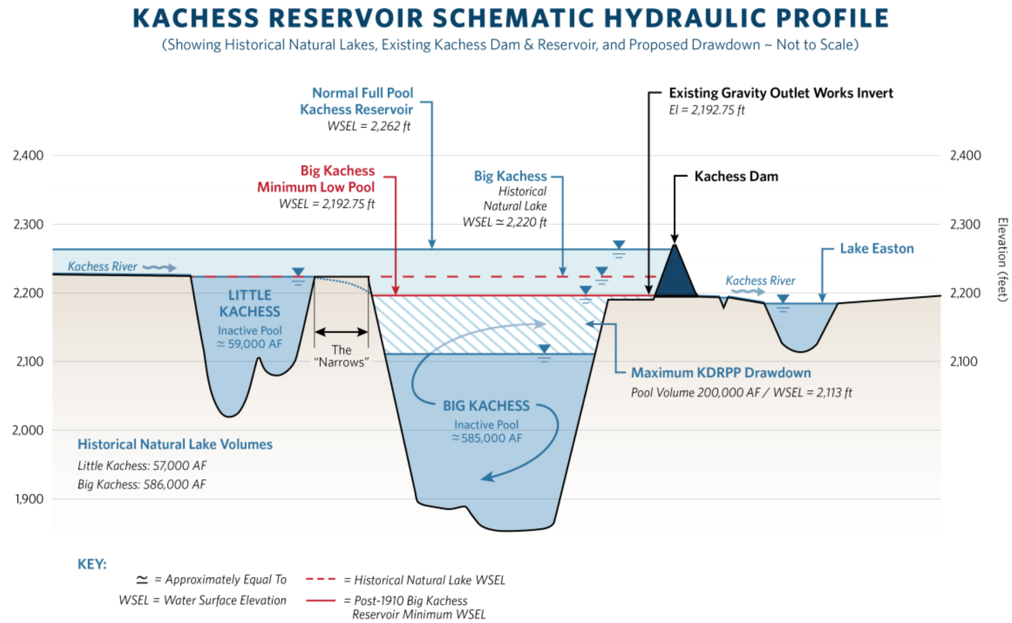



**Figure 4-3. Drawdown at End of Multi-year Drought with Maximum Use of 200,000 Acre-feet**

Kachess Reservoir would not be pumped entirely empty and the proposed project would not be capable of doing so. At least 385,000 acre-feet would always remain in Big Kachess and 59,000 acre-feet in Little Kachess. Kachess reservoir contains a total of about 883,000 acre-feet of water when it is full. Of this, 239,000 acre-feet is stored in the "active pool" that can currently be managed by gravity release operations through the existing outlet works at Kachess Dam. The inactive pool of Big Kachess below the level of the Kachess Dam outlet holds 585,000 acre-feet, and Little Kachess holds 59,000 acre-feet (see Attachment 1). Under current operations without KDRPP, in years when the reservoir reaches its maximum pool level, the active pool of 239,000 acre-feet can be released for water users and instream flows, leaving the remaining 585,000 acre-feet in Big Kachess and 59,000 acre-feet in Little Kachess.

The proposed KDRPP would enable a maximum of 200,000 additional acre-feet to be pumped from Big Kachess. In years when the maximum quantity is pumped out, 385,000 acre-feet of water would remain in Big Kachess (65 percent of the current minimum volume). In years when pumping is activated but does not require the full, additional 200,000 acre feet, water remaining in Big Kachess would be between 385,000 acre-feet and 585,000 acre-feet.

When full, the modern reservoir is 430 feet deep at its deepest point. Current operations are capable of drawing the reservoir down by approximately 70 feet, although drawdown rarely exceeds 60 feet. Operation of KDRPP would enable the reservoir to be drawn down an additional 80 feet. At the new minimum-pool level, the reservoir would still be 280 feet deep at its deepest point. Modeling of operations of KDRPP shows that the minimum pool level would occur only occasionally (for example, see Figure 4-6 where modeling shows the minimum pool level would have been reached only once in the 18 years from 1991 to 2009, which include a 3-year drought and two 1-year droughts). In most years, and in most months of any year, pool levels would remain well above the minimum level. In many years, pool levels would be similar to current conditions.

Little Kachess would not be affected by pumping from KDRPP, because its minimum depth is controlled by the original, natural topography at the Narrows between Little Kachess and Big Kachess. The proposed project, including the volitional fish passage at the Narrows, would not change the original topography controlling hydraulic conditions at the Narrows, and KDRPP would not pump water from Little Kachess. When Big Kachess is drawn down by KDRPP pumping, Little Kachess would continue to hold at least 59,000 acre-feet, the same amount as under current conditions.

The drawdown of Kachess Reservoir under all action alternatives would cause an increase in the occurrence and duration of reservoir pool levels below elevation 2,220, the elevation separating the Big Kachess and Little Kachess basins within Kachess Reservoir (Section 3.3.4). Relative to *Alternative 1,* the frequency would increase by 3 years (from 73 years of separation for *Alternative 1* to 76 years for the action alternatives), and the duration of separation would increase by 62 to 76 days during those years (from 78 days for *Alternative 1* to 154 days for *Alternatives 2, 3,* and *4*, and to 140 days for *Alternatives 5A, 5B,* and *5C).*

The drawdown of Kachess Reservoir as a result of all action alternatives would also increase the duration of reservoir levels below elevation 2,226—the level at which access for bull trout to Kachess Reservoir's tributary streams is affected. Frequency would increase by 2 years for *Alternatives 2, 3,* and *4* (from 83 years for *Alternative 1* to 85 years for *Alternatives 2, 3,* and *4*), but would decrease by 1 year for *Alternatives 5A, 5B,* and *5C* (from 83 years for *Alternative 1* to 82 years for *Alternatives 5A, 5B,* and *5C*). Duration would increase by 46 to 60 days during those years (from 111 days for *Alternative 1* to 171 days for *Alternatives 2, 3,* and *4*, and 157 days for *Alternatives 5A, 5B,* and *5C).*

**Change in Streamflow.** *Alternative 1* would not change summer streamflows in the Keechelus reach of the Yakima River and, therefore, summer flows would remain artificially high. Under *Alternatives 2, 3,* and *4,* all streamflow changes would remain within current operating ranges and would not impact surface water resources. During drought years, high streamflow would decrease slightly. Spring flows would increase slightly in drought years due to spring irrigation flows benefiting outmigrating smolts. *Alternatives 5A, 5B,* and *5C* would reduce summer streamflows in the Keechelus reach by 400 cfs, increasing the number of days when flow in the Keechelus Reach is at or below 500 cfs during July from 42 days with *Alternative 1* to 2,677 days in with *Alternatives 5A, 5B,* and *5C* (out of 2,821 days) for the modeled period of record, greatly improving habitat conditions for fish (Section 4.6.4.2). These conditions would be a benefit to instream flow conditions in the Keechelus reach. Streamflow in the Easton and Umtanum reaches of the Yakima River would increase in drought years and decrease in refill years. Streamflow in the Kachess River for all action alternatives would also change, specifically with higher flows in the summer during drought years and with lower flows during refill years in the winter. Because the altered flows would fall within current operating ranges, no adverse effect on streamflow conditions would result.

### 4.3.3 Alternative 1 – No Action

Under *Alternative 1*, 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). 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* would provide limited flexibility to respond to irrigation needs during increasingly dry years.

*Alternative 1* does not meet the purpose 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. For these reasons, it is not consistent with the Record of Decision for the Integrated Plan (Reclamation, 2013).

### 4.3.4 Alternative 2 – KDRPP East Shore Pumping Plant

#### *4.3.4.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**

Construction of *Alternative 2* would not affect water releases from Kachess Reservoir (or 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* because construction would occur either on land outside of the reservoir or during late summer and fall drawdown. As noted in Section 2.3.2, additional reservoir drawdown is not required for construction of the pumping plant.

The construction of the power transmission line interconnection would have minimal impacts on surface water resources. Construction of the transmission line from the PSE substation in Easton would cross over the downstream end of Lake Easton near the lake outlet; installation of the new line is not expected to affect surface water.

**Volitional Bull Trout Passage Improvements**

Construction of the Volitional Bull Trout Passage Improvements would not affect water levels in or releases from Kachess Reservoir.  Flows in the Narrows would be affected when the channel is rerouted around the construction area to avoid potential sediment input. Construction BMPs would be used to reduce the potential for sediment input during construction.  No impact on Yakima River or Kachess River flows would occur because the rivers are controlled by releases from Keechelus and Kachess reservoirs and because construction of the fish passage 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, the participating Proratable Entities would use KDRPP to access up to 200,000 acre-feet of storage not currently used because the water level is below the existing gravity outlet from Kachess Dam.  The expected change in prorationing percentage for the participating Proratable Entities, assumed for modeling purposes to be Roza, KRD, and WIP, is summarized in Table 4-5.  The percentage shown in Table 4-5 for *Alternative 1* includes the most recent drought years (1992 to 1994, 2001, 2005, and 2015).  During single drought years (e.g., 2001, 2005), the prorationing percentage would increase from 32 percent of entitlement under *Alternative 1* to 53 percent of entitlement under *Alternative 2*.  In 1941, the worst year during the period of record modeled for water supply, the prorationing percentage would increase from 19 to 41 percent, an increase of 22 percentage points.  Although the water supply would not have met the 70 percent goal, it would represent a substantial 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 from 1992 to 1994.  In the third year of such a drought (i.e., 1994 in Table 4-5), a 33 percent water supply would be provided. This would be an increase of 9 percentage points of entitlement and benefit water supply.

When Kachess Reservoir is refilling after a drought year there is the potential for a slight reduction (2 to 4 percent) in water supply for proratable irrigation districts.  In 2 of the 90 years modeled, the water supply was reduced slightly below 70 percent (to 66 to 68 percent) for *Alternative 2*.

**Table 4-5. Percentage of Entitlement Available in Drought Years under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Modeled Drought Year | *Alternative 1 – No Action* | *Alternative 2** | Change (Percentage) |
|---|---|---|---|
| 1992 | 64.3 | 64.1 | –0.2 |
| 1993 | 52.5 | 70.0 | 17.5 |
| 1994 | 24.0 | 33.4 | 9.4 |
| 2001 | 32.7 | 52.7 | 20.0 |
| 2005 | 32.2 | 53.5 | 21.3 |
| 2015 | 51.9 | 70.0 | 18.1 |

* Percentage of prorationing

The results reported above reflect a specific scenario in which the proratable users receiving water from KDRPP include KRD, WIP and Roza; and in which these three users seek to maximize their supply in each individual drought year. Alternate scenarios are also possible. If any of these three users choose not to participate, then the results would change. The non-participants would see no change in prorationing from *Alternative 1*; and the participants could see a larger improvement in prorationing, up to the limit of 70 percent. If a fourth user, such as KID chooses to participate, then the results would also change. Sharing of the available supply would reduce the water supply benefits to each user.

It is also possible that participants eligible to receive improved water supply would choose in the first year of a drought to take less water from the inactive pool at Kachess Reservoir than they could, in order to preserve water for the possibility that drought conditions would continue into the following year. In this case, the prorationing levels could be lower than shown for *Alternative 2* in Table 4-5, reflecting choices made by water users participating in the project.

With the exception of KID, water supply to other water users with water rights under the Yakima Project would not be affected, because TWSA would be calculated with an adjustment for water pumped from the Kachess Reservoir inactive pool. During refill years, the participating Proratable Entities would continue to pump water from the Kachess Reservoir inactive pool during periods when this is needed to ensure that TWSA is the same as it would have been without KDRPP.

KID is a proratable district, but has historically relied upon return flows from upstream users instead of storage releases specifically for its benefit. During drought years when participating Proratable Entities pump water from KDRPP, their return flows could be higher than without KDRPP, so KID may receive an improved supply with KDRPP. During refill years, return flows could be the same or less depending on choices made by the participating Proratable Entities. In a refill year without prorationing, KID would receive its full entitlement just as it would have without KDRPP. In a refill year with prorationing, KID would continue to receive at least its prorated entitlement, but its ability to divert available water in excess of its prorated entitlement may be impacted by any decrease in return flows.

*Kachess Reservoir*

This section describes the impacts on important reservoir elevations at Kachess Reservoir. Pool levels either prevent outflow from the reservoir or preclude bull trout passage. Alternative 2 would change reservoir levels in both Kachess and Keechelus reservoirs compared with Alternative 1. Modeling results indicate Kachess Reservoir levels would be lower than those under Alternative 1 in 44 years out of 90 years modeled. In 31 of the 44 years, Alternative 2 had a lower Kachess Reservoir level than Alternative 1 for every day of the year; in the other 13 years, only a portion of the year had lower Kachess Reservoir levels for Alternative 2 compared to Alternative 1. 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. Modeling results indicate that there are some years that are outside of the drought and refill period where Kachess Reservoir levels are lower in Alternative 2 compared to Alternative 1; these differences are relatively small.

Table 4-6, Figure 4-4, and Figure 4-5 illustrate the pool levels that would be anticipated under operation of the pumping plant under *Alternative 2* under a specific scenario in which the proratable users receiving water from KDRPP include KRD, WIP and Roza; and in which these three users seek to supplement their supply by 200,000 acre-ft in a drought year. Reclamation and Ecology consider this to be a “worst case” scenario that displays the maximum impacts to Kachess Reservoir.

*Alternative 2* would change reservoir levels in both Kachess and Keechelus reservoirs compared with *Alternative 1*. Modeling results indicate Kachess Reservoir levels would be lower than those under *Alternative 1* in 44 years out of 90 years modeled. In 31 of the 44 years, *Alternative 2* had a lower Kachess Reservoir level than *Alternative 1* for every day of the year; in the other 13 years, only a portion of the year had lower Kachess Reservoir levels for *Alternative 2* compared to *Alternative 1*. 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. Modeling results indicate that there are some years that are outside of the drought and refill period where Kachess Reservoir levels are lower in *Alternative 2* compared to *Alternative 1*; these differences are relatively small.

**Table 4-6. Kachess Reservoir Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Kachess Reservoir Levels | Elevation (feet) |
|---|---|
| Current maximum reservoir level | 2,262 |
| Current level of maximum drawdown (reservoir level is below existing gravity outlet) | 2,192.75 |
| Level of maximum draw down with pumping plant | 2,112.75 |
| Level at which bull trout access to Little Kachess tributaries is impeded | 2,226 |
| Level at which upper and lower basins are separated and fish passage is impeded | 2,220 |

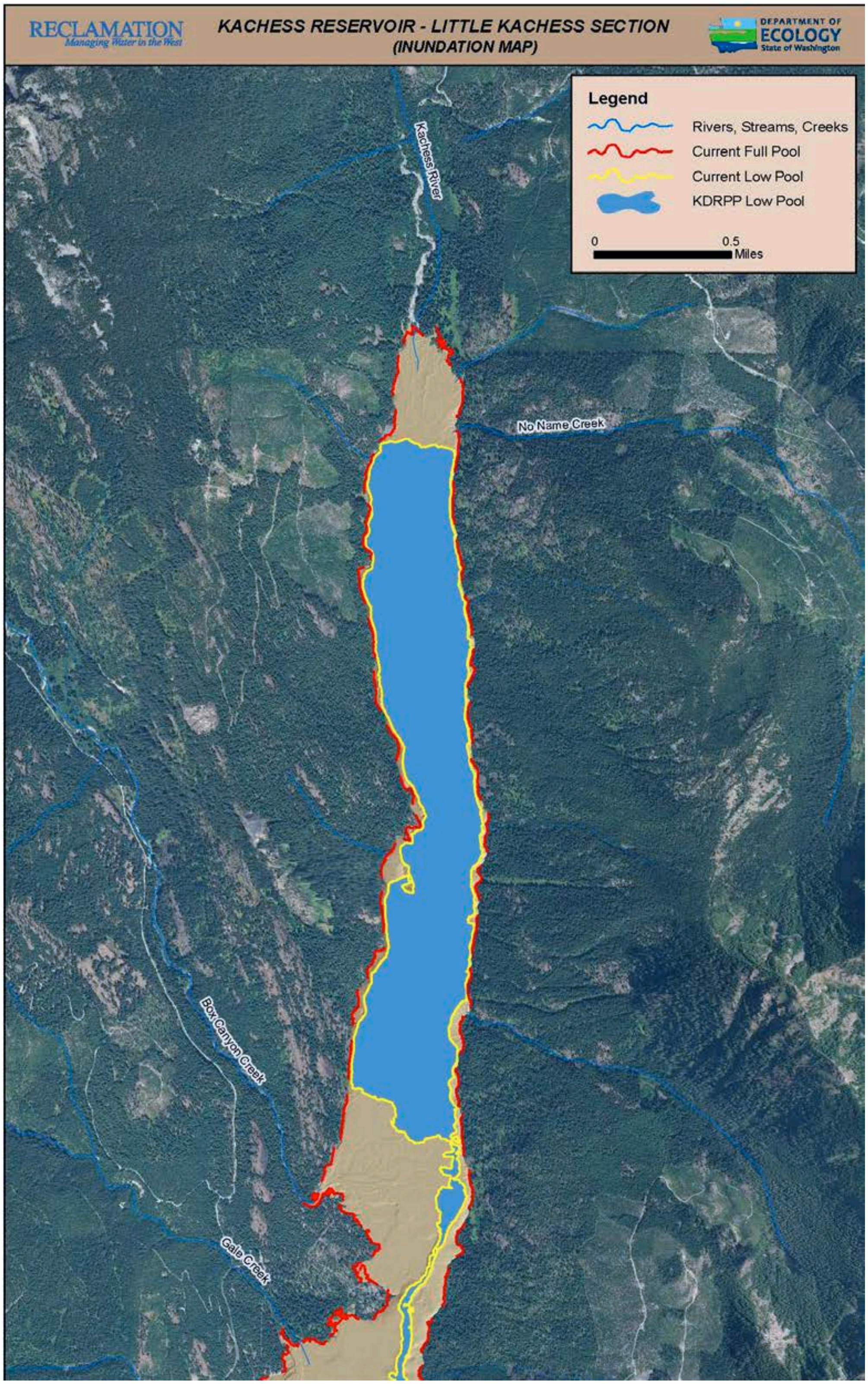



**Figure 4-4. Little Kachess Inundation Map**

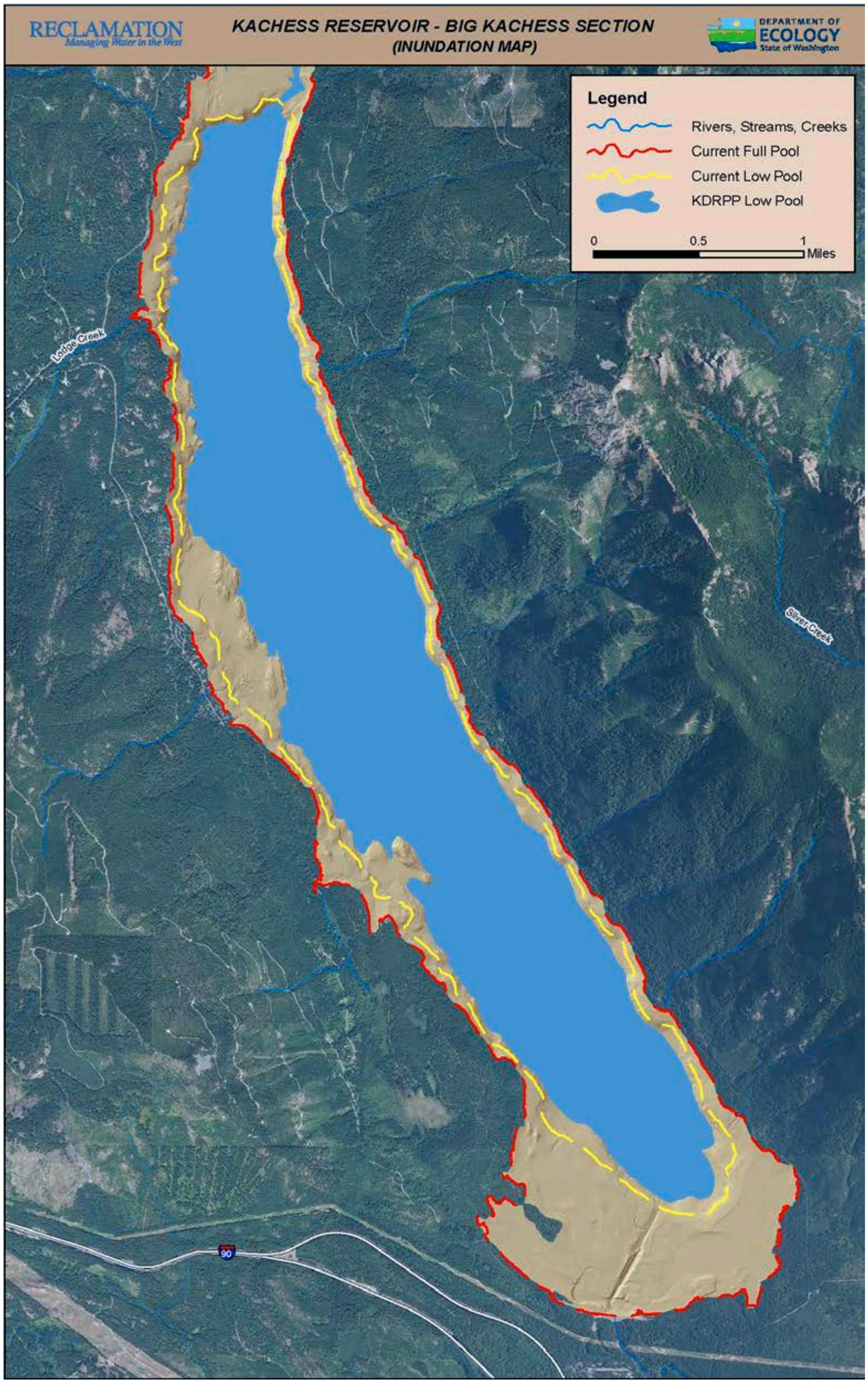



**Figure 4-5. Big Kachess Inundation Map**

Based on the modeling completed, under *Alternative 2*, the pool elevation in Kachess Reservoir would be below the gravity outlet elevation of 2,192.75 in 34 out of 90 years modeled and for a mean duration of 183 days during these years. Current reservoir operations do not draw the reservoir below the outlet elevation.

Kachess Reservoir would be below the level at which the two reservoir basins become separated (elevation 2,220) in 76 out of 90 years modeled years, an increase of 3 years from *Alternative 1*. The mean duration would be 154 days per year, an increase of 76 days per year compared with *Alternative 1*. At pool elevations below 2,220, fish passage between the reservoir basins is inhibited (see Section 4.6.4.2). The duration would increase during all months under *Alternative 2*; under *Alternative 1*, the separation of the lake reservoir occurs from September to March.

Kachess Reservoir would be below the level at which bull trout access to upstream tributary streams is impeded (elevation 2,226) in 85 out of 90 years modeled, an increase of 1 year from *Alternative 1*. The mean duration would be 171 days per year, an increase of 60 days per year.

Figure 4-6 illustrates the difference in Kachess Reservoir levels between *Alternatives 1* and *2* from November 1991 to October 2009, which includes drought, refill, and normal years. During multiyear drought conditions such as those in 1992 to 1994, Reclamation would draw the reservoir down a maximum of 80 feet below the existing outlet elevation. At this pool level, 385,000 acre-feet would remain in Big Kachess and 59,000 acre-feet (same as under existing conditions) would remain in Little Kachess. At maximum drawdown Big Kachess would be 280 feet deep at its deepest point. Figure 4-7 illustrates the percent of time that the Kachess Reservoir would fall below a given elevation.

Kachess Reservoir would not be drawn down 80 feet in every drought year. As shown in Figure 4-6, drought conditions in 2001 and 2005 would have required drawdowns of only 40 feet below the existing gravity outlet rather than 80 feet below the existing gravity outlet.

Following a severe, multiyear 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. Following a single-year drought, such as occurred in 2001, the reservoir would be drawn down less. Recovery of reservoir pool levels into the range of current operations under existing conditions would have occurred in the following year, however recovery to full maximum pool level would not have been achieved until 2008, because of a series of dry years (2003, 2004, and 2005).

Using the historical record of droughts Kachess Reservoir was simulated to refill to its normal operating ranges in 2 to 5 years following a drought (2 years twice, 3 years four times, 4 years once, and 5 years once). Modeled water levels are tabulated in Table 4-7.

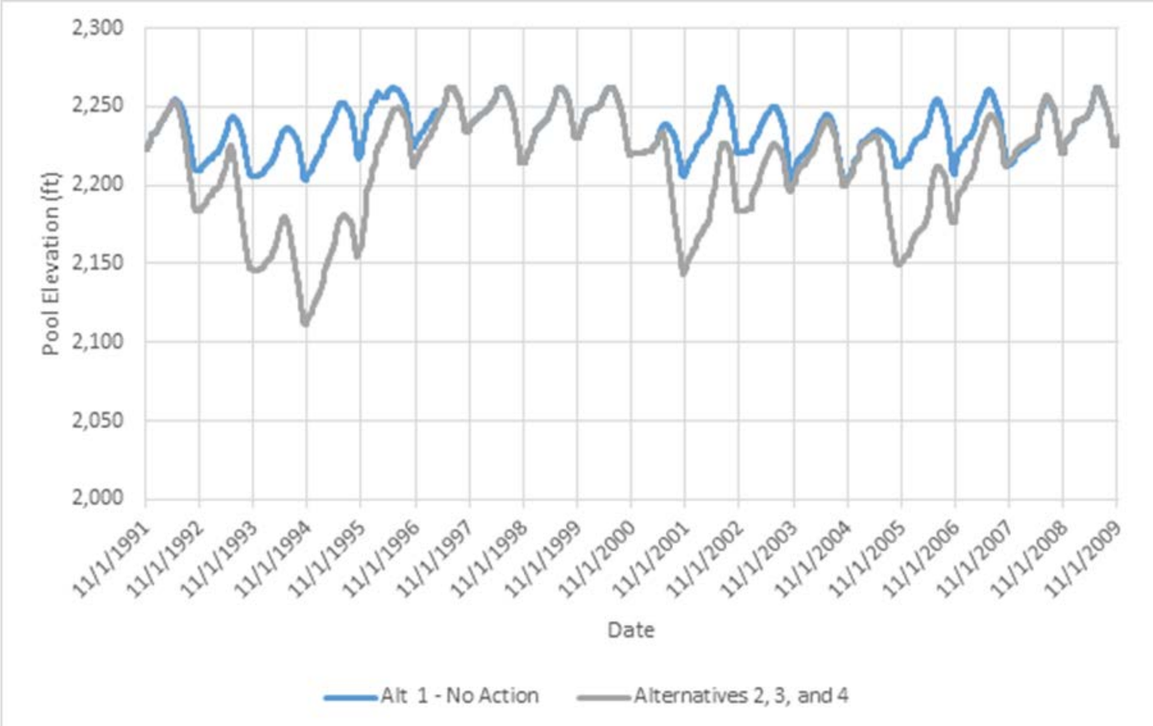



**Figure 4-6. Kachess Reservoir Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

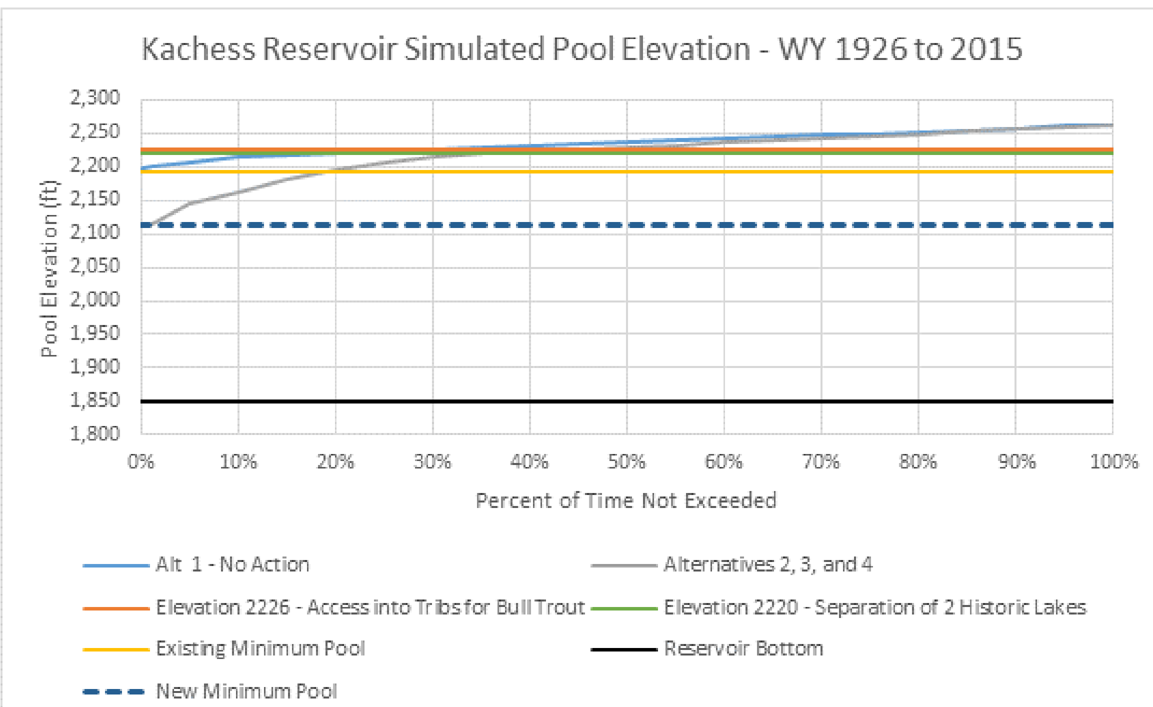



**Figure 4-7. Percent of time that the Kachess Reservoir Pool Elevations would fall below the Existing and New Minimum Pool under each Alternative**

**Table 4-7. Kachess Reservoir Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Modeled Year | Pool Elevation (feet) *Alternative 1 – No Action* | Pool Elevation (feet) *Alternative 2* | Change |
|---|---|---|---|
| **1926–2015** | | | |
| Mean | 2,236.3 | 2,220.4 | –15.9 |
| Mean of annual maximum | 2,254.5 | 2,242.5 | –12.0 |
| Mean of annual minimum | 2,212.1 | 2,189.5 | –22.6 |
| **1994 (Drought Year)** | | | |
| Mean | 2,219.6 | 2,152.0 | –67.6 |
| Maximum | 2,236.6 | 2,180.6 | –56.0 |
| Minimum | 2,202.9 | 2,111.2 | –91.7 |
| **2001 (Drought Year)** | | | |
| Mean | 2,224.9 | 2,207.3 | –17.6 |
| Maximum | 2,239.0 | 2,234.2 | –4.8 |
| Minimum | 2,205.4 | 2,143.6 | –61.8 |

Seasonal levels for Kachess Reservoir under *Alternative 2* would be lower than those under *Alternative 1* for all seasons. The lowest seasonal elevations would decrease by 85 feet under *Alternative 2* compared with *Alternative* 1. Median elevations (50 percent exceedance; half of the elevations in the category fall above the value and half of the elevations in the category fall below the value) would decrease by 4 to 10 feet under *Alternative 2* compared with *Alternative 1*. Modeled seasonal water levels are tabulated in Table 4-8.

**Table 4-8. Kachess Reservoir Seasonal Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Season | Pool Elevation (feet) *Alternative 1 – No Action* | Pool Elevation (feet) *Alternative 2* | Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Range | 2,197.0-2,259.9 | 2,111.4-2,259.5 | |
| Median (50% exceedance) | 2,228.3 | 2,223.1 | –5.2 |
| High (10% exceedance) | 2,246.4 | 2,244.4 | –2.0 |
| Low (90% exceedance) | 2,209.7 | 2,152.5 | –57.2 |
| **Spring (Mar 15–Jun 15)** | | | |
| Range | 2,208.6-2,262.0 | 2,125.1-2,262.0 | |
| Median (50% exceedance) | 2,245.7 | 2,241.3 | –4.4 |
| High (10% exceedance) | 2,259.3 | 2,257.7 | –1.6 |
| Low (90% exceedance) | 2,227.5 | 2,174.9 | –52.6 |

| Season | Pool Elevation (feet) | Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 2* | |
| **Summer (Jun 16–Oct 31)** | | | |
| Range | 2,196.3-2,262.0 | 2,111.2-2.262.0 | |
| Median (50% exceedance) | 2,241.0 | 2,231.3 | –9.7 |
| High (10% exceedance) | 2,260.6 | 2,259.6 | –1.0 |
| Low (90% exceedance) | 2,212.4 | 2,162.8 | –49.6 |

Kachess Reservoir annual maximum pool elevations during nonprorated and non-refill years would be similar under *Alternative 2* compared with *Alternative 1*; the lowest annual maximum pool elevation would be 4 feet lower in *Alternative 2* compared to *Alternative 1* in those years. During prorated years and refill years, maximum pool elevations would be as much as 77 feet lower under *Alternative 2* compared with *Alternative 1*. Modeled maximum pool elevations for the types of years are tabulated in Table 4-9.

**Table 4-9. Kachess Reservoir Annual Maximum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Annual Maximum Pool Elevation (feet) | Annual Maximum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 2* | |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,245.3-2,262.0 | 2,241.2-2,262.0 | |
| Median (50% exceedance) | 2,262.0 | 2,262.0 | 0.0 |
| High (10% exceedance) | 2,262.0 | 2,262.0 | 0.0 |
| Low (90% exceedance) | 2,249.5 | 2,248.3 | –1.2 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,225.0-2,256.5 | 2,153.0-2,256.5 | |
| Median (50% exceedance) | 2,237.9 | 2,226.3 | –11.6 |
| High (10% exceedance) | 2,251.7 | 2,251.5 | –0.2 |
| Low (90% exceedance) | 2,230.1 | 2,169.0 | –61.1 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,238.0-2,262.0 | 2,161.2-2,249.5 | |
| Median (50% exceedance) | 2,254.8 | 2,221.1 | –33.7 |
| High (10% exceedance) | 2,262.0 | 2,245.4 | –16.6 |
| Low (90% exceedance) | 2,244.0 | 2,187.0 | –57.0 |

Kachess Reservoir annual minimum pool elevations during nonprorated and non-refill years would be lower (up to 16 feet) under *Alternative 2* compared with *Alternative 1*. During prorated years and refill years, minimum pool elevations would be up to 86 feet lower under

*Alternative 2* compared with *Alternative 1*. Modeled minimum pool elevations for the types of years are tabulated in Table 4-10.

**Table 4-10. Kachess Reservoir Annual Minimum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| | Annual Minimum Pool Elevation (feet) | Annual Minimum Pool Elevation (feet) | |
|---|---|---|---|
| **Year** | ***Alternative 1 – No Action*** | ***Alternative 2*** | **Change** |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,199.3-2,235.1 | 2,183.4-2,235.1 | |
| Median (50% exceedance) | 2,218.4 | 2,217.4 | –1.0 |
| High (10% exceedance) | 2,229.2 | 2,229.2 | 0.0 |
| Low (90% exceedance) | 2,204.4 | 2,200.6 | –3.8 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,197.1-2,216.2 | 2,111.2-2,197.0 | |
| Median (50% exceedance) | 2,205.6 | 2,150.4 | –55.2 |
| High (10% exceedance) | 2,211.5 | 2,183.6 | –27.9 |
| Low (90% exceedance) | 2,197.6 | 2,111.2 | –86.4 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,196.3-2,224.4 | 2,111.2-2,183.3 | |
| Median (50% exceedance) | 2,207.1 | 2,154.8 | –52.3 |
| High (10% exceedance) | 2,219.6 | 2,182.0 | –37.6 |
| Low (90% exceedance) | 2,198.9 | 2,111.2 | –87.7 |

As noted previously, the results reported above reflect a specific scenario in which the proratable users receiving water from KDRPP include KRD, WIP and Roza; and in which these three users seek to maximize their supply in each individual drought year. Alternate scenarios are also possible. If any of these three users choose not to participate, then the results would change. Less water would be needed in the first year of a drought, and the drawdown affecting reservoir pool levels in that year would be less. Figure 4-8 (hydrograph of Roza-only – to be added) displays information similar to Figure 4-6 covering an alternate scenario in which only Roza participates in KDRPP. In this case, water would be pumped only to raise Roza's supply to 70 percent of its entitlement. The other proratable and nonproratable entities would receive the same amount of water as under current conditions. Because less water would be pumped, the effect on pool levels would be less than displayed in Figure 4-6.

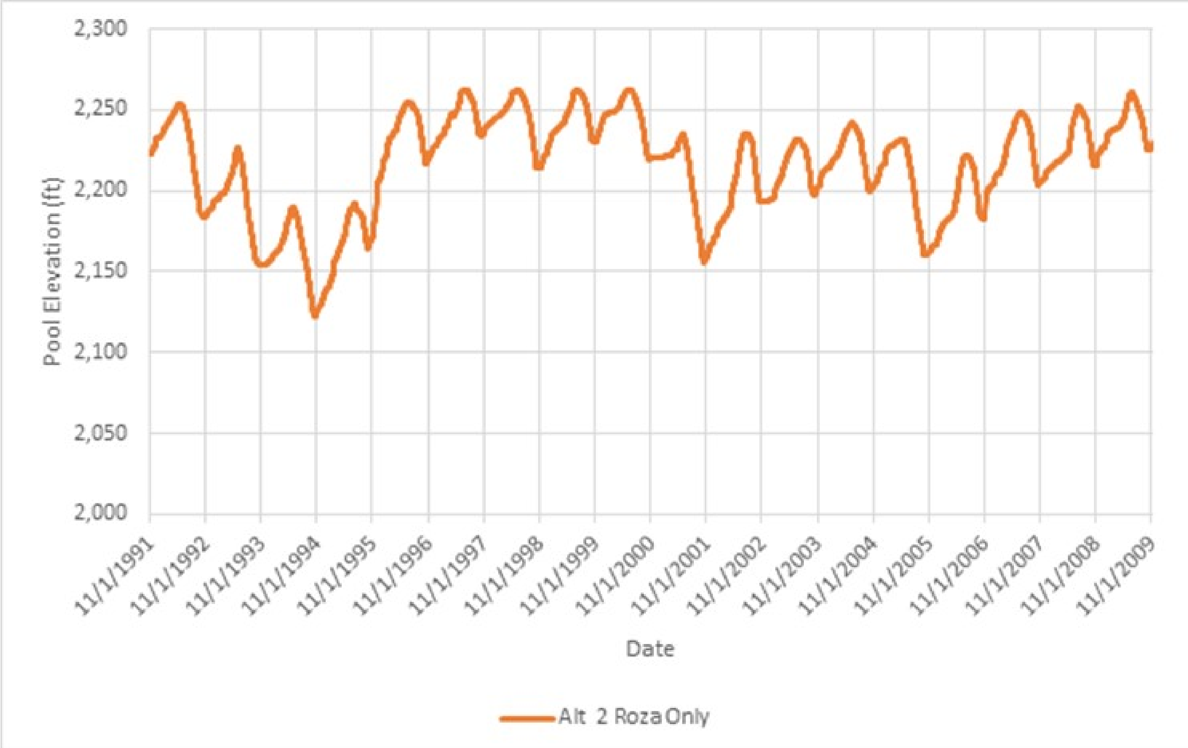



**Figure 4-8. Kachess Reservoir Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant* in which Roza Irrigation District is the Only Participant**

It is also possible that participants eligible to receive improved water supply would choose in the first year of a drought to take less water from the inactive pool at Kachess Reservoir than allowed, in order to preserve water for the possibility that drought conditions would continue into the following year. A choice to take less water would cause less drawdown affecting reservoir pool levels in that year. If a particular drought were limited to a single year, the reduced drawdown would also enable the reservoir to refill more. However, in cases where drought conditions persist into a second year or additional faster years, then the full drawdown shown in Tables 4-7 to 4-10 and in Figure 4-6 would likely occur.

This FEIS does not analyze conditions involving future implementation of the full set of projects and programs included in the Final Programmatic EIS for the Integrated Plan. If additional projects and programs are implemented, they will provide additional flexibility for managing the overall Yakima Project, and this may reduce the extent of impacts from Alternative 2 reported in this section. During less severe droughts lasting for a single year, other projects proposed for development may be less costly to users, and therefore may be prioritized ahead of water supply from Alternative 2. In this event, the impacts to reservoir pool levels from operation of Alternative 2 would be reduced.

*Keechelus Reservoir*

Keechelus Reservoir levels under *Alternative 2* would be lower than those under *Alternative 1* because Reclamation would release more water from Keechelus Reservoir after a drought to substitute for some of the release from Kachess Reservoir while it is refilling (this is independent of whether KKC is constructed). Simulations indicate that Keechelus Reservoir levels would be lower than those of *Alternative 1* in 44 out of 90 modeled years and for a mean duration of 225 days during those years. Figure 4-9 illustrates the difference in Keechelus Reservoir levels between *Alternatives 1* and *2*. During a 2- to 3-year period following a drought (1994, 2001, 2005, and 2015), the peak water levels in Keechelus Reservoir would be close to those of *Alternative 1*, and the lowest level would be about 18 feet lower. In other years, the reservoir level would be the same as *Alternative 1*. Table 4-11 summarizes and compares annual mean, maximum, and minimum water levels for the period of record and during drought years. Keechelus Reservoir levels under *Alternative 2* would be within current operating levels.

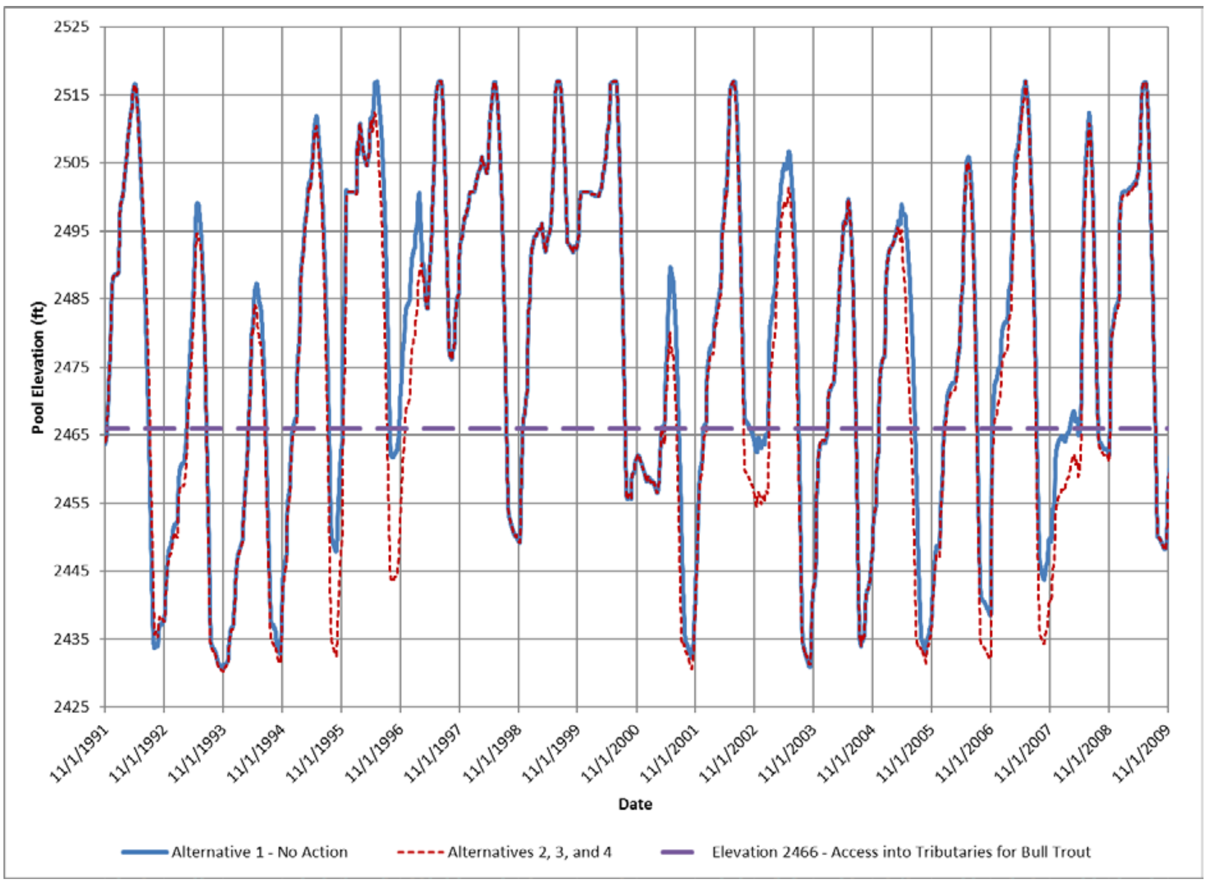



**Figure 4-9. Change in Keechelus Reservoir Pool Elevation under *Alternative 2 – KDRPP East Shore Pumping Plant***

**Table 4-11. Change in Keechelus Reservoir Levels under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Modeled Year | Pool Elevation (feet) *Alternative 1 – No Action* | Pool Elevation (feet) *Alternative 2* | Change |
|---|---|---|---|
| **1926–2015** | | | |
| Mean | 2,479.5 | 2,479.0 | –0.5 |
| Mean of annual maximum | 2,509.1 | 2,508.4 | –0.7 |
| Mean of annual minimum | 2,445.8 | 2,445.3 | –0.5 |
| **1994 (Drought Year)** | | | |
| Mean | 2,453.4 | 2,451.5 | –1.9 |
| Maximum | 2,487.3 | 2,484.2 | –3.1 |
| Minimum | 2,430.7 | 2,430.3 | –0.4 |
| **2001 (Drought Year)** | | | |
| Mean | 2,459.5 | 2,455.8 | –3.7 |
| Maximum | 2,489.6 | 2,480.1 | –9.5 |
| Minimum | 2,432.2 | 2,430.7 | –1.5 |

Keechelus Reservoir would be below the level at which bull trout access to tributary streams is impeded (elevation 2,466) in 81 out of the 90 years modeled, an increase of 1 year from *Alternative 1*. There would be a 2-day increase in duration, to a mean of 131 days.

Seasonal levels for Keechelus Reservoir under *Alternative 2* would be slightly lower (up to 5 feet than those under *Alternative 1* during the spring). Summer median elevations would be reduced by about 1 foot under *Alternative 2* compared with *Alternative 1*. Modeled seasonal water levels are tabulated in Table 4-12.

**Table 4-12. Keechelus Reservoir Seasonal Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Season | Pool Elevation (feet) *Alternative 1 – No Action* | Pool Elevation (feet) *Alternative 2* | Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Range | 2,427.5-2,513.1 | 2,427.5-2,513.1 | |
| Median (50% exceedance) | 2,476.8 | 2,476.5 | –0.3 |
| High (10% exceedance) | 2,500.8 | 2,500.8 | 0.0 |
| Low (90% exceedance) | 2,446.7 | 2,446.4 | –0.3 |
| **Spring (Mar 15–Jun 15)** | | | |
| Range | 2,448.1-2,517.0 | 2,443.5-2,517.0 | |
| Median (50% exceedance) | 2,498.8 | 2,498.5 | –0.3 |
| High (10% exceedance) | 2,513.1 | 2,513.0 | –0.1 |
| Low (90% exceedance) | 2,474.9 | 2,473.3 | –1.6 |

| Season | Pool Elevation (feet) | Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 2* | |
| **Summer (Jun 16–Oct 31)** | | | |
| Range | 2,428.8-2,517.0 | 2,428.7-2,517.0 | |
| Median (50% exceedance) | 2,471.1 | 2,469.8 | –1.3 |
| High (10% exceedance) | 2,512.4 | 2,511.5 | –0.9 |
| Low (90% exceedance) | 2,434.1 | 2,434.1 | 0.0 |

Keechelus Reservoir annual maximum pool elevations during nonprorated and non-refill years would be similar under *Alternative 2* compared with *Alternative 1*. During prorated years and refill years, the range of maximum pool elevations under *Alternative 2* would be within 1 foot compared with *Alternative 1*. Modeled maximum pool elevations for the types of years are tabulated in Table 4-13.

**Table 4-13. Keechelus Reservoir Annual Maximum Pool Elevations *under Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Annual Maximum Pool Elevation (feet) | Annual Maximum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 2* | |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,497.8-2,517.0 | 2,497.8-2,517.0 | |
| Median (50% exceedance) | 2,516.9 | 2,516.9 | 0.0 |
| High (10% exceedance) | 2,517.0 | 2,517.0 | 0.0 |
| Low (90% exceedance) | 2,501.4 | 2,501.4 | 0.0 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,467.9-2,517.0 | 2,466.8-2,517.0 | |
| Median (50% exceedance) | 2,489.6 | 2,486.7 | –2.9 |
| High (10% exceedance) | 2,513.4 | 2,512.9 | –0.5 |
| Low (90% exceedance) | 2,480.1 | 2,476.8 | –3.3 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,495.3-2,517.0 | 2,495.9-2,517.0 | |
| Median (50% exceedance) | 2,511.9 | 2,512.0 | 0.1 |
| High (10% exceedance) | 2,517.0 | 2,517.0 | 0.0 |
| Low (90% exceedance) | 2,500.3 | 2,497.8 | –2.5 |

Keechelus Reservoir annual minimum pool elevations during nonprorated years would be slightly lower (up to 1 foot) under *Alternative 2* compared with *Alternative 1*. During prorated years and refill years, minimum pool elevations under *Alternative 2* would be within 4 feet of *Alternative 1* minimum pool elevations. Modeled minimum pool elevations for these types of years are tabulated in Table 4-14.

**Table 4-14. Keechelus Reservoir Annual Minimum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Annual Minimum Pool Elevation (feet) *Alternative 1 – No Action* | Annual Minimum Pool Elevation (feet) *Alternative 2* | Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,430-7-2,488.1 | 2,430.7-2,488.1 | |
| Median (50% exceedance) | 2,449.4 | 2,448.5 | –0.9 |
| High (10% exceedance) | 2,475.9 | 2,475.9 | 0.0 |
| Low (90% exceedance) | 2,432.2 | 2,431.6 | –0.6 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,427.5-2,434.0 | 2,427.5-2,437.7 | |
| Median (50% exceedance) | 2,432.3 | 2,431.2 | –1.1 |
| High (10% exceedance) | 2,433.6 | 2,435.2 | 1.6 |
| Low (90% exceedance) | 2,430.4 | 2,430.4 | 0.0 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,429.2-2,464.4 | 2,430.7-2,465.6 | |
| Median (50% exceedance) | 2,434.4 | 2,433.1 | –1.3 |
| High (10% exceedance) | 2,452.7 | 2,453.8 | 1.1 |
| Low (90% exceedance) | 2,431.0 | 2,431.8 | 0.8 |

*Other Reservoirs*

Hydrologic modeling indicates water levels in other Yakima Project reservoirs (Cle Elum, Bumping, and Rimrock) would be affected by *Alternative 2*. The changes are likely due to reservoir balancing in the modeling that may not occur in actual operations. Real-time operations would likely minimize those changes (Lynch, 2017). The impact discussion in this section is based upon the hydrologic modeling which predicts greater impacts on water levels than would likely occur.

Based on the modeling Cle Elum Reservoir and Rimrock Reservoir maximum pool elevations would be affected by *Alternative 2* compared with *Alternative 1* in prorated years. No impact on Bumping Reservoir would occur in prorated years. Cle Elum Reservoir maximum pool elevations would be up to 11 feet higher, and those of Rimrock Reservoir would be up to 6.3 feet lower. Maximum pool elevations for Cle Elum, Bumping, and Rimrock reservoirs are tabulated in Table 4-15to Table 4-17.

**Table 4-15. Cle Elum Reservoir Annual Maximum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Annual Maximum Pool Elevation (feet) *Alternative 1 – No Action* | Annual Maximum Pool Elevation (feet) *Alternative 2* | Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,225.3-2,243.0 | 2,225.3-2,243.0 | |
| Median (50% exceedance) | 2,243.0 | 2,243.0 | 0.0 |
| High (10% exceedance) | 2,243.0 | 2,243.0 | 0.0 |
| Low (90% exceedance) | 2,233.8 | 2,233.8 | 0.0 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,191.6-2,243.0 | 2,202.6-2,243.0 | |
| Median (50% exceedance) | 2,221.2 | 2,223.5 | 2.3 |
| High (10% exceedance) | 2,235.6 | 2,235.7 | 0.1 |
| Low (90% exceedance) | 2,205.9 | 2,210.3 | 4.4 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,215.2-2,243.0 | 2,215.8-2,243.0 | |
| Median (50% exceedance) | 2,243.0 | 2,243.0 | 0.0 |
| High (10% exceedance) | 2,243.0 | 2,243.0 | 0.0 |
| Low (90% exceedance) | 2,234.9 | 2,235.6 | 0.7 |

**Table 4-16. Bumping Reservoir Annual Maximum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Annual Maximum Pool Elevation (feet) *Alternative 1 – No Action* | Annual Maximum Pool Elevation (feet) *Alternative 2* | Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Range | 3,426.2-3,434.5 | 3,426.2-3,434.5 | |
| Median (50% exceedance) | 3,426.6 | 3,426.6 | 0.0 |
| High (10% exceedance) | 3,430.3 | 3,430.3 | 0.0 |
| Low (90% exceedance) | 3,426.2 | 3,426.2 | 0.0 |
| **Prorated Year (15 of 90)** | | | |
| Range | 3,422.8-3,428.3 | 3,422.8-3,428.3 | |
| Median (50% exceedance) | 3,426.2 | 3,426.2 | 0.0 |
| High (10% exceedance) | 3,426.4 | 3,426.4 | 0.0 |
| Low (90% exceedance) | 3,426.2 | 3,426.2 | 0.0 |
| **Refill Year (19 of 90)** | | | |
| Range | 3,426.2-3,430.2 | 3,426.2-3,430.2 | |

| Year | Annual Maximum Pool Elevation (feet) | Annual Maximum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 2* | |
| Median (50% exceedance) | 3,426.4 | 3,426.4 | 0.0 |
| High (10% exceedance) | 3,428.3 | 3,428.3 | 0.0 |
| Low (90% exceedance) | 3,426.2 | 3,426.2 | 0.0 |

**Table 4-17. Rimrock Reservoir Annual Maximum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Annual Maximum Pool Elevation (feet) | Annual Maximum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 2* | |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,912.8-2,926.0 | 2,913.3-2,926.0 | |
| Median (50% exceedance) | 2,926.0 | 2,926.0 | 0.0 |
| High (10% exceedance) | 2,926.0 | 2,926.0 | 0.0 |
| Low (90% exceedance) | 2,923.6 | 2,924.7 | 1.1 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,860.6-2,926.0 | 2,860.8-2,926.0 | |
| Median (50% exceedance) | 2,895.4 | 2,889.1 | –6.3 |
| High (10% exceedance) | 2,919.1 | 2,918.4 | –0.7 |
| Low (90% exceedance) | 2,875.7 | 2,873.5 | –2.2 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,896.5-2,926.0 | 2,890.1-2,926.0 | |
| Median (50% exceedance) | 2,926.0 | 2,926.0 | 0.0 |
| High (10% exceedance) | 2,926.0 | 2,926.0 | 0.0 |
| Low (90% exceedance) | 2,922.0 | 2,920.5 | –1.5 |

Cle Elum, Bumping, and Rimrock reservoirs’ minimum pool elevations would be affected by *Alternative 2* compared with *Alternative 1* in prorated years. Cle Elum Reservoir minimum pool elevations would be up to 9 feet lower in refill years and would range from 20 feet higher to 2 feet lower in prorated years. Bumping Reservoir minimum pool elevations would be up to 0.3 foot lower in prorated years and refill years. Rimrock Reservoir minimum pool elevations would be up to 9 feet higher in prorated years and up to 3 feet higher in refill years. Minimum pool elevations for Cle Elum, Bumping, and Rimrock reservoirs are tabulated in Table 4-18 to Table 4-20.

**Table 4-18. Cle Elum Reservoir Annual Minimum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Annual Minimum Pool Elevation (feet) *Alternative 1 – No Action* | Annual Minimum Pool Elevation (feet) *Alternative 2* | Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,129.9-2,204.2 | 2,130.3-2,204.2 | |
| Median (50% exceedance) | 2,158.9 | 2,157.8 | –1.1 |
| High (10% exceedance) | 2,191.5 | 2,191.5 | 0.0 |
| Low (90% exceedance) | 2,138.1 | 2,139.2 | 1.1 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,119.5-2,154.2 | 2,117.5-2,173.9 | |
| Median (50% exceedance) | 2,129.6 | 2,128.7 | –0.9 |
| High (10% exceedance) | 2,143.8 | 2,154.1 | 0.3 |
| Low (90% exceedance) | 2,124.7 | 2,120.0 | –4.7 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,122.6-2,181.8 | 2,116.4-2,172.4 | |
| Median (50% exceedance) | 2,141.2 | 2,141.0 | –0.2 |
| High (10% exceedance) | 2,159.4 | 2,165.5 | 6.1 |
| Low (90% exceedance) | 2,124.8 | 2,117.3 | –7.5 |

**Table 4-19. Bumping Reservoir Annual Minimum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Annual Minimum Pool Elevation (feet) *Alternative 1 – No Action* | Annual Minimum Pool Elevation (feet) *Alternative 2* | Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Range | 3,391.6-3,409.4 | 3,391.6-3,409.4 | |
| Median (50% exceedance) | 3,404.8 | 3,404.9 | 0.1 |
| High (10% exceedance) | 3,408.4 | 3,408.4 | 0.0 |
| Low (90% exceedance) | 3,394.2 | 3,394.2 | 0.0 |
| **Prorated Year (15 of 90)** | | | |
| Range | 3,391.3-3,407.8 | 3,391.0-3,407.8 | |
| Median (50% exceedance) | 3,392.3 | 3,392.0 | –0.3 |
| High (10% exceedance) | 3,405.4 | 3,402.4 | –3.0 |
| Low (90% exceedance) | 3,391.5 | 3,391.2 | –0.3 |
| **Refill Year (19 of 90)** | | | |
| Range | 3,391.9-3,408.6 | 3,391.6-3,408.6 | |
| Median (50% exceedance) | 3,402.6 | 3,398.1 | –4.5 |
| High (10% exceedance) | 3,408.0 | 3,406.5 | –1.5 |
| Low (90% exceedance) | 3,392.3 | 3,391.9 | –0.4 |

**Table 4-20. Rimrock Reservoir Annual Minimum Pool Elevations under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Annual Minimum Pool Elevation (feet) *Alternative 1 – No Action* | Annual Minimum Pool Elevation (feet) *Alternative 2* | Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,791.6-2,871.3 | 2,788.8-2,871.3 | |
| Median (50% exceedance) | 2849.2 | 2849.2 | 0.0 |
| High (10% exceedance) | 2861.1 | 2862.7 | 1.6 |
| Low (90% exceedance) | 2824.9 | 2826.0 | 1.1 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,766.0-2,844.9 | 2,766.0-2,854.1 | |
| Median (50% exceedance) | 2827.5 | 2766.5 | –61.0 |
| High (10% exceedance) | 2843.3 | 2826.4 | –16.9 |
| Low (90% exceedance) | 2777.4 | 2766.0 | –11.4 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,766.0-2,862.3 | 2,766.0-2,865.1 | |
| Median (50% exceedance) | 2826.2 | 2819.4 | –6.8 |
| High (10% exceedance) | 2854.4 | 2858.5 | –4.1 |
| Low (90% exceedance) | 2788.7 | 2766.0 | –22.7 |

*Streamflow*

Under *Alternative 2,* 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 KRD, Roza, and WIP). Streamflow under *Alternative 2* would change in the Kachess and Yakima rivers during post-drought refilling of 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 2.*

*Kachess River*

Changes in Kachess River streamflow are summarized in Table 4-21 and depicted in Appendix E, Figure E-1. Overall, Kachess River streamflow would remain within current operating ranges. The overall summer flow (i.e., July to August) would increase slightly because the river would convey additional water during drought years to downstream proratable water users when inactive storage is used. The overall 16 percent decrease in winter (i.e., January) flow from 46.7 to 39.3 cfs would occur because minimum flows would be provided for a longer period when the reservoir is either drawn down or refilling after a drought. During drought years (represented in Table 4-21 by 1994 and 2001), summer streamflow would be substantially higher (by about 460 to 660 cfs) because of releases from Kachess Reservoir. The maximum discharge to the Kachess River from the KDRPP would be about 1,000 cfs, which is the capacity of KDRPP. Total flows released during that period from existing outlets would typically range up to 1,300 cfs and possibly up to 1,500 cfs.

**Table 4-21. Change in Kachess River Flow below Kachess Reservoir under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Modeled Year | Mean Flow (cfs) *Alternative 1 – No Action* | Mean Flow (cfs) *Alternative 2* | Percentage Change |
|---|---|---|---|
| **1926–2015** | | | |
| July–August | 537.0 | 566.0 | 5.3 |
| January | 46.7 | 39.3 | –16.0 |
| **1994 (Drought Year)** | | | |
| July–August | 324.0 | 783.0 | 141.9 |
| January | 32.2 | 31.4 | –2.5 |
| **2001 (Drought Year)** | | | |
| July–August | 430.0 | 1,088.0 | 153.0 |
| January | 64.7 | 64.7 | 0.0 |

*Yakima River*

*Alternative 2* would change streamflow in the Keechelus reach, the Easton reach, and the Yakima River downstream to the Columbia River (Figure 3-2). Summer flows would increase during droughts because KDRPP would supply additional water to downstream proratable water users when inactive storage is used to supply proratable water users.

For the Keechelus Reach, streamflows would change slightly, as summarized in Table 4-22 and Appendix E, Figure E-2. Annually, flows would 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 50 to 140 cfs, from a mean of 614 to 673 cfs to a mean of 564 to 534 cfs, respectively. By comparison, normal mean operating flows during summer are approaching 900 cfs. Since the streamflow in Keechelus Reach under *Alternative 2* would remain within current operating ranges with no decrease in most years, no benefit to instream flow in the Keechelus reach would occur.

**Table 4-22. Change in Keechelus Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Modeled Year | Mean Flow (cfs) *Alternative 1 – No Action* | Mean Flow (cfs) *Alternative 2* | Percentage Change |
|---|---|---|---|
| **1926–2015** | | | |
| July–August | 866 | 856 | –1.2 |
| January | 154 | 151 | –2.2 |
| **1994 (Drought Year)** | | | |
| July–August | 614 | 564 | –8.1 |
| January | 81.1 | 81.0 | –0.1 |
| **2001 (Drought Year)** | | | |
| July–August | 673 | 534 | –20.6 |
| January | 132 | 132 | 0.0 |

Median and high spring flow exceedances for the Keechelus reach under *Alternative 2* would be slightly higher compared with *Alternative 1*. Median summer flows would be lower under *Alternative 2* compared with *Alternative 1*. Low-flow exceedances and winter flows would not have been affected. Modeled seasonal flows are tabulated in Table 4-23.

**Table 4-23. Seasonal Change in Keechelus Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Season | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 2* | Percentage Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 100 | 100 | 0.0 |
| High (10% exceedance) | 153 | 153 | 0.0 |
| Low (90% exceedance) | 80 | 80 | 0.0 |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 350 | 357 | 2.0 |
| High (10% exceedance) | 675 | 701 | 3.9 |
| Low (90% exceedance) | 100 | 100 | 0.0 |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 527 | 490 | –7.0 |
| High (10% exceedance) | 1,070 | 1,073 | 0.0 |
| Low (90% exceedance) | 80 | 80 | 0.0 |

Keechelus reach flow exceedances during nonprorated years and refill years would be within 3.4 percent of *Alternative 1* flow exceedances for all seasons. During prorated years, high flows would be reduced. Modeled Keechelus reach flows for the types of years are tabulated in Table 4-24.

**Table 4-24. Keechelus Reach Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Flow (cfs) | Flow (cfs) | Flow (cfs) |
|---|---|---|---|
| | ***Alternative 1 – No Action*** | ***Alternative 2*** | **Percentage Change** |
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 125 | 123 | –1.6 |
| High (10% exceedance) | 954 | 948 | –0.6 |
| Low (90% exceedance) | 89 | 92 | 3.4 |
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 100 | 100 | 0.0 |
| High (10% exceedance) | 732 | 682 | –6.8 |
| Low (90% exceedance) | 80 | 80 | 0.0 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 120 | 120 | 0.0 |
| High (10% exceedance) | 917 | 922 | 0.5 |
| Low (90% exceedance) | 80 | 80 | 0.0 |

For the Easton reach, streamflows would change slightly from *Alternative 1*, as summarized in Table 4-25 and illustrated in Appendix E, Figure E-3. The increase in summer (July to August) flow during drought years would be 224 to 250 cfs. Water for the KRD would be diverted at Lake Easton, and water for Roza would be diverted at Roza Dam. Any remaining increased supply could be diverted by WIP at Wapato Dam. The 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. Downstream from Roza Dam to the 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 be diverted. The small change in streamflow downstream from the 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 *Alternatives 2* and *1* at the Parker gage. The drought-year changes in flow downstream from Roza Dam would remain within current operating flows experienced in most years.

**Table 4-25. Change in Yakima River Flow at Easton under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Modeled Year | Mean Flow (cfs) *Alternative 1 – No Action* | Mean Flow (cfs) *Alternative 2* | Percentage Change |
|---|---|---|---|
| **1926–2015** | | | |
| July–August | 530 | 522 | –1.5 |
| January | 450 | 440 | –2.4 |
| **1994 (Drought Year)** | | | |
| July–August | 534 | 784 | 46.7 |
| January | 306 | 305 | –0.3 |
| **2001 (Drought Year)** | | | |
| July–August | 694 | 918 | 32.3 |
| January | 250 | 250 | 0.0 |

In the winter and spring, higher flows in the Easton reach under *Alternative 2* would be slightly lower compared with *Alternative 1*, while lower flows would be higher. In the summer, high flows would be higher and median flows would be lower under *Alternative 2* compared with *Alternative 1*. Modeled seasonal flows are tabulated in Table 4-26.

**Table 4-26. Seasonal Change in Easton Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Season | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 2* | Percentage Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 305 | 305 | 0.0 |
| High (10% exceedance) | 712 | 698 | –2.0 |
| Low (90% exceedance) | 222 | 231 | 4.1 |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 393 | 406 | 3.3 |
| High (10% exceedance) | 1,100 | 1,094 | –0.1 |
| Low (90% exceedance) | 193 | 250 | 29.5 |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 310 | 274 | –11.6 |
| High (10% exceedance) | 735 | 772 | 5.0 |
| Low (90% exceedance) | 196 | 196 | 0.0 |

Easton reach flow exceedances during nonprorated years would be similar under *Alternative 2* compared with *Alternative 1*. During prorated years, flows would increase under *Alternative 2* compared with *Alternative 1*. During refill years, median and high flows would decrease under *Alternative 2* compared with *Alternative 1*. Modeled Easton reach flows for the types of years are tabulated in Table 4-27.

**Table 4-27. Easton Reach Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Flow (cfs) | Flow (cfs) | Percentage Change |
|---|---|---|---|
| | ***Alternative 1 – No Action*** | ***Alternative 2*** | |
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 353 | 350 | –0.8 |
| High (10% exceedance) | 879 | 873 | –0.7 |
| Low (90% exceedance) | 250 | 250 | 0.0 |
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 274 | 284 | 3.6 |
| High (10% exceedance) | 629 | 871 | 38.5 |
| Low (90% exceedance) | 190 | 196 | 3.2 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 306 | 273 | –10.8 |
| High (10% exceedance) | 734 | 634 | –13.6 |
| Low (90% exceedance) | 190 | 190 | 0.0 |

Flows in the Umtanum reach under *Alternative 2* would be within 2.5 percent of *Alternative 1* flow exceedances for all seasons. Higher flows would be slightly lower and lower flows would be slightly higher. Modeled seasonal flows are tabulated in Table 4-28.

**Table 4-28. Seasonal Change in Umtanum Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Season | Flow (cfs) | Flow (cfs) | Percentage Change |
|---|---|---|---|
| | ***Alternative 1 – No Action*** | ***Alternative 2*** | |
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 1,260 | 1,259 | –0.1 |
| High (10% exceedance) | 2,875 | 2,840 | –1.2 |
| Low (90% exceedance) | 803 | 804 | 0.1 |

| Season | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 2* | Percentage Change |
|---|---|---|---|
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 2,669 | 2,674 | 0.2 |
| High (10% exceedance) | 5,333 | 5,273 | –1.1 |
| Low (90% exceedance) | 1,568 | 1,607 | 2.5 |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 2,706 | 2,763 | 2.1 |
| High (10% exceedance) | 4,090 | 4,063 | –0.7 |
| Low (90% exceedance) | 1,131 | 1,130 | –0.1 |

Umtanum reach flow exceedances during nonprorated years would be similar under *Alternative 2* compared with *Alternative 1*. During prorated years, flows would increase under *Alternative 2* compared with *Alternative 1*. During refill years, median and high flows would decrease under *Alternative 2* compared with *Alternative 1*. Modeled Umtanum reach flows for the types of years are tabulated in Table 4-29.

**Table 4-29. Umtanum Reach Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 2* | Percentage Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 2,157 | 2,154 | –0.1 |
| High (10% exceedance) | 4,320 | 4,301 | –0.4 |
| Low (90% exceedance) | 1,050 | 1,047 | –0.3 |
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 1,436 | 1,492 | 3.9 |
| High (10% exceedance) | 2,900 | 3,115 | 7.4 |
| Low (90% exceedance) | 759 | 767 | 1.4 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 2,003 | 1,979 | –1.2 |
| High (10% exceedance) | 4,060 | 3,974 | –2.1 |
| Low (90% exceedance) | 885 | 900 | 1.7 |

Flows in the Roza reach under *Alternative 2* would be within 2.2 percent of *Alternative 1* flow exceedances for all seasons. Higher flows would be slightly lower. Modeled seasonal flows are tabulated in Table 4-30.

**Table 4-30. Seasonal Change in Roza Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Season | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 2* | Percentage Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 432 | 431 | –0.2 |
| High (10% exceedance) | 1,976 | 1,932 | –2.2 |
| Low (90% exceedance) | 400 | 400 | 0.0 |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 916 | 917 | –0.1 |
| High (10% exceedance) | 3,593 | 3,534 | –1.6 |
| Low (90% exceedance) | 401 | 402 | 0.2 |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 1,129 | 1,113 | –1.4 |
| High (10% exceedance) | 2,198 | 2,172 | –1.2 |
| Low (90% exceedance) | 403 | 403 | 0.0 |

Roza reach flow exceedances during nonprorated years would be similar under *Alternative 2* compared with *Alternative 1*. During prorated years, median and high flows would increase under *Alternative 2* compared with *Alternative 1*. During refill years, median and high flows would decrease under *Alternative 2* compared with *Alternative 1*. Modeled Roza reach flows for the types of years are tabulated in Table 4-31.

**Table 4-31. Roza Reach Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 2* | Percentage Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 955 | 954 | –0.1 |
| High (10% exceedance) | 2,649 | 2,621 | –1.1 |
| Low (90% exceedance) | 402 | 402 | 0.0 |
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 414 | 417 | 0.7 |
| High (10% exceedance) | 1,292 | 1,400 | 8.4 |
| Low (90% exceedance) | 400 | 400 | 0.0 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 785 | 776 | –1.1 |
| High (10% exceedance) | 2,245 | 2,188 | –2.5 |
| Low (90% exceedance) | 402 | 401 | –0.2 |

Flows in the Wapato reach (at Parker) under *Alternative 2* would be within 1.3 percentage points of *Alternative 1* flow exceedances for all seasons. Summer high flows would be slightly higher, while other flows would be slightly lower. Modeled seasonal flows are tabulated in Table 4-32.

**Table 4-32. Seasonal Change in Wapato Reach (Parker) Flow under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Season | Flow (cfs) | Flow (cfs) | Percentage Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 2* | |
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 2,162 | 2,163 | 0.0 |
| High (10% exceedance) | 5,375 | 5,324 | –0.9 |
| Low (90% exceedance) | 1,404 | 1,403 | –0.1 |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 2,564 | 2,549 | –0.6 |
| High (10% exceedance) | 7,334 | 7,285 | –0.7 |
| Low (90% exceedance) | 422 | 417 | –1.2 |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 465 | 463 | –0.4 |
| High (10% exceedance) | 1,750 | 1,772 | 1.3 |
| Low (90% exceedance) | 381 | 380 | –0.3 |

Wapato reach (Parker) flow exceedances during nonprorated years would be similar under *Alternative 2* compared with *Alternative 1*. During prorated years, median and high flows would increase under *Alternative 2* compared with *Alternative 1*. During refill years, low and high flows would decrease under *Alternative 2* compared with *Alternative 1*. Modeled Wapato reach (Parker) flows for the types of years are tabulated in Table 4-33.

**Table 4-33. Wapato Reach (Parker) Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Flow (cfs) | Flow (cfs) | Percentage Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 2* | |
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 1,831 | 1,830 | –0.1 |
| High (10% exceedance) | 5,883 | 5,863 | –0.3 |
| Low (90% exceedance) | 402 | 403 | 0.2 |

| Year | Flow (cfs) Alternative 1 – No Action | Flow (cfs) Alternative 2 | Percentage Change |
|---|---|---|---|
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 960 | 1,027 | 7.0 |
| High (10% exceedance) | 2,245 | 2,249 | 0.2 |
| Low (90% exceedance) | 382 | 380 | –0.5 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 1,705 | 1,720 | 0.9 |
| High (10% exceedance) | 5,162 | 5,012 | –2.9 |
| Low (90% exceedance) | 392 | 384 | –2.0 |

The July 1 TWSA estimated by the model is reduced in some years, which could affect Title XII instream flow targets at Parker and Prosser. The simulations found that changes in the July 1 TWSA in 9 out of the 19 refill years were sufficient to reduce the Title XII instream flow target numbers. However, the simulations found the average July-to-August flow at Parker were more than 100 cfs greater than the instream flow targets in 4 out of the 9 years, bringing the average flow to or above the instream flow targets that occurred for *Alternative 1*. Title XII instream flow targets are unchanged for *Alternative 2* in all nonprorated years and prorated years compared to *Alternative 1*.

*Other Locations*

Flows in the Naches reach under *Alternative 2* would be within 1.5 percentage points of *Alternative 1* flow exceedances for all seasons. Modeled seasonal flows are tabulated in Table 4-34.

**Table 4-34. Seasonal Change in Naches Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Season | Flow (cfs) Alternative 1 – No Action | Flow (cfs) Alternative 2 | Percentage Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 669 | 668 | –0.1 |
| High (10% exceedance) | 2,015 | 2,017 | 0.1 |
| Low (90% exceedance) | 449 | 449 | 0.0 |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 2,186 | 2,185 | 0.0 |
| High (10% exceedance) | 4,799 | 4,796 | –0.1 |
| Low (90% exceedance) | 839 | 826 | –1.5 |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 1,020 | 1,029 | 0.9 |
| High (10% exceedance) | 2,304 | 2,292 | –0.5 |
| Low (90% exceedance) | 412 | 413 | 0.2 |

Naches reach flow exceedances during nonprorated years would be similar under *Alternative 2* compared with *Alternative 1*. During prorated years, median and high flows would increase and low flows would decrease under *Alternative 2* compared with *Alternative 1*. During refill years, median and low flows would decrease under *Alternative 2* compared with *Alternative 1*. Modeled Naches reach flows for the types of years are tabulated in Table 4-35.

**Table 4-35. Naches Reach Flows by Year Type under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Year | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 2* | Percentage Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 1,189 | 1,186 | –0.3 |
| High (10% exceedance) | 3,616 | 3,618 | 0.1 |
| Low (90% exceedance) | 498 | 498 | 0.0 |
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 599 | 630 | 5.2 |
| High (10% exceedance) | 1,620 | 1,656 | 2.2 |
| Low (90% exceedance) | 344 | 335 | –2.6 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 1,050 | 1,038 | –1.1 |
| High (10% exceedance) | 3,333 | 3,333 | 0.0 |
| Low (90% exceedance) | 481 | 475 | –1.2 |

#### Volitional Bull Trout Passage Improvements

Installation of the Volitional Bull Trout Passage Improvements would not affect streamflow or surface water in the channel. No change in Kachess Reservoir levels or releases or Yakima River flows would occur because the enhancement actions would not affect reservoir operations.

## 4.3.5 Alternative 3 – KDRPP South Pumping Plant

### *4.3.5.1 Construction*

#### KDRPP South Pumping Plant Facilities

Construction would cause no impacts on reservoir levels or releases. No construction would occur at the current outlet or spillway gates. Construction would occur either on land outside the reservoir and above the Kachess River shoreline or when the reservoir is drawn down in late summer and fall. As in *Alternative 2*, additional reservoir drawdown is not required for construction of the pumping plant.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.3.4.1).

#### *4.3.5.2 Operation*

**KDRPP South Pumping Plant Facilities**

Operational impacts from *Alternative 3* would be the same as those for *Alternative 2* because operations would be the same regardless of the location of KDRPP facilities.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.2.4.2).

### 4.3.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

#### *4.3.6.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

Construction may affect reservoir levels in Kachess Reservoir. Reclamation would need to modify Kachess Reservoir operation during the 1-year construction period. During flow control structure construction, temporary cofferdams would be placed, but a temporary flume capable of conveying up to 50 cfs would be installed to maintain minimum instream flows in the Kachess River, so flow releases would not be impacted. Reclamation would work with the Proratable Entities and others with Yakima Project entitlements to develop a detailed operations plan for the construction period that would enable the various features of the Floating Pumping Plant to be installed while minimizing effects on water supply downstream.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.3.4.1).

#### *4.3.6.2 Operation*

**KDRPP Floating Pumping Plant Facilities**

Operational impacts from *Alternative 4 (Preferred Alternative)* would be the same as those for *Alternative 2* because operations would be the same regardless of the location and configuration of KDRPP facilities.

The means of providing for minimum stream flow in the Kachess River below Kachess Dam would be different under *Alternative 4 (Preferred Alternative)* compared with *Alternatives 2* *and 3*. Instead of having a smaller, dedicated pump for minimum instream flows when the drought-relief pumps are not being used, the sealed outlet channel from Kachess Reservoir will be used to store water pumped intermittently by one of the drought-relief pumps. Water that has been pumped into the outlet channel can be released gradually through the existing gravity outlet, no matter what the pool level is in Kachess Reservoir. Moreover, the storage capacity within the outlet channel would be sufficient to enable continued releases even in the event of a typical, short-duration power outage affecting the pumping plant.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.3.4.2).

### 4.3.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

*Alternative 5A* would include construction of the KDRPP East Shore Pumping Plant. The impacts from construction of these components of *Alternative 5A* would be the same as described in Section 4.3.4 *(Alternative 2)*. *Alternative 5A* would also include construction and operation of KKC North. The construction impacts of KKC North are described below. The operational impacts discussed below include operation of KKC North and KDRPP.

#### *4.3.7.1 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* conditions.

**Volitional Bull Trout Passage Improvements**

Volitional Bull Trout Passage Improvements are not part of KKC construction activity and therefore will not be discussed in this section.

#### *4.3.7.2 Operation*

**KKC North Tunnel Alignment Facilities and KDRPP**
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 does Kachess Reservoir (runoff to storage ratio of 1.55 to 1 for Keechelus compared with 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 4-36 provides additional detail on the modeled water transfers under KKC for the 90-year 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 4-36. Volume of Water Transferred by KKC under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Parameter | Quantity |
|---|---|
| Average annual volume transferred (1926–2015) (acre-feet) | 81,170 |
| Number of years flow is transferred (out of 90 model years) | 88 |
| Average number of days volume transfer occurs (of 90 years) | 156 |
| Maximum annual volume transferred (1932) (acre-feet) | 143,758 |
| Minimum annual volume transferred (1930, 1944) (acre-feet) | 0 |
| Volume transferred in water year 1994 (acre-feet) | 4,651 |
| Volume transferred in water year 2001 (acre-feet) | 63,603 |

*Water Supply*

Depending on the year, improvements in the percentage of proratable entitlements available from KKC and KDRPP together would range from nominal (0.3 percent) to almost 22 percent, as summarized in Table 4-37. The resulting prorationing percentages during single-drought years (51 to 54 percent) would represent an increase in water supply. During the third year of a multiyear drought like that of 1992 to 1994, water supply would also improve by 9 percentage points (from 24 to 33 percent of entitlements). The increase in prorationing for drought years would be a benefit to water supply.

When Kachess Reservoir is refilling after a drought year, there is the potential for a slight reduction (1 to 4 percent) in water supply for proratable irrigation districts. In two of the 90 years modeled, the water supply was reduced slightly below 70 percent (to 66 to 69 percent) for *Alternative 5A*.

**Table 4-37. Change in Prorationing under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Modeled Drought Year | Percent of Proratable Entitlements | Percent of Proratable Entitlements | Percentage Change |
|---|---|---|---|
| | ***Alternative 1 – No Action*** | ***Alternative 5A*** | |
| 1992 | 64.3 | 64.6 | 0.3 |
| 1993 | 52.5 | 70.0 | 17.5 |
| 1994 | 24.0 | 32.7 | 8.7 |
| 2001 | 32.7 | 51.2 | 18.5 |
| 2005 | 32.2 | 53.9 | 21.7 |

*Reservoir Levels*

*Alternative 5A* would change reservoir levels in both Kachess and Keechelus reservoirs from *Alternative 1*.

**Kachess Reservoir.** Kachess Reservoir levels would be lower than *Alternative 1* 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 4-38 and Figure 4-10 summarize modeled Kachess Reservoir levels under *Alternative 5A*. 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 eventually 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 40 feet below the existing minimum pool level. Kachess Reservoir was simulated to refill in 2 to 5 years following a drought (2 years four times, 3 years three times, and 5 years once).

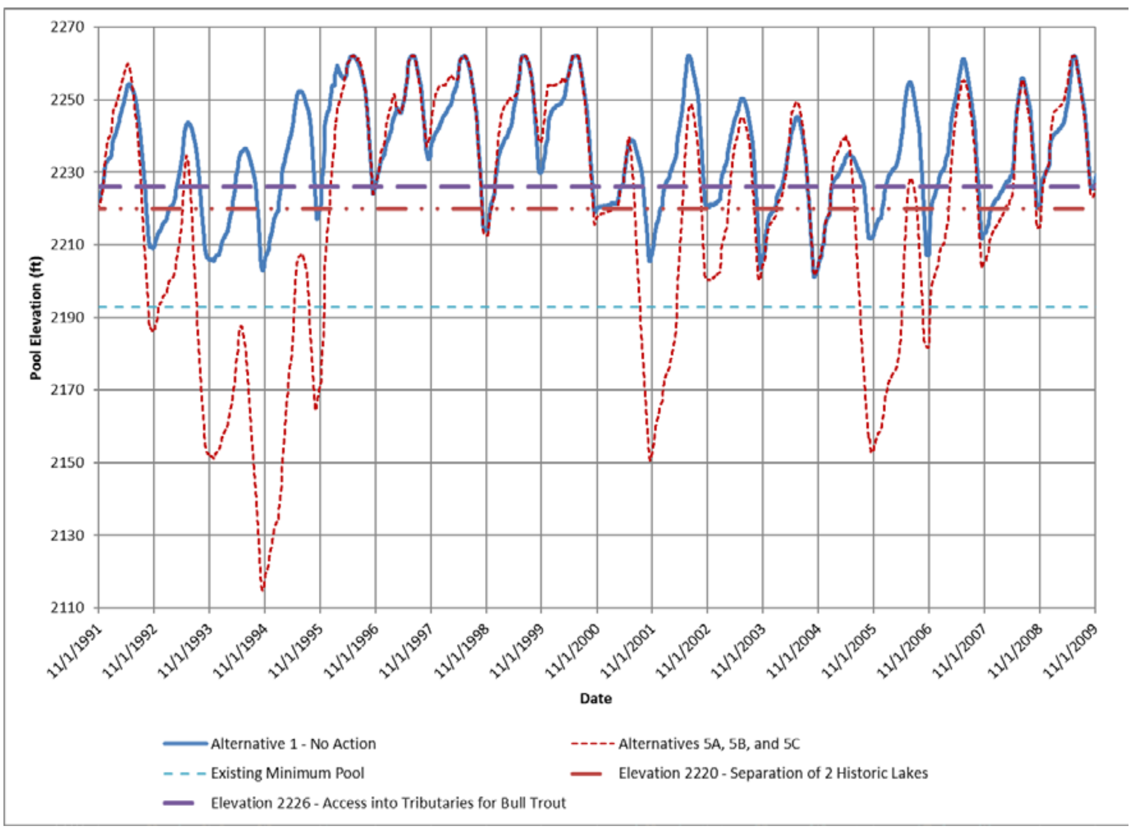



**Figure 4-10. Kachess Reservoir Pool Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

**Table 4-38. Kachess Reservoir Pool Elevations under All Alternatives**

| Modeled Year | *Alternative 1 – No Action* | *Alternatives 2, 3,* and *4* | Change* *(feet)* | *Alternatives 5A, 5B,* and *5C* | Change* (feet) |
|---|---|---|---|---|---|
| **1926–2015** | | | | | |
| Mean | 2,236.3 | 2,220.4 | –15.9 | 2,225.9 | –10.4 |
| Mean of annual maximum | 2,254.5 | 2,242.5 | –12.0 | 2,248.9 | –5.6 |
| Mean of annual minimum | 2,212.1 | 2,189.5 | –22.6 | 2,192.5 | –19.6 |
| **1994 (Drought Year)** | | | | | |
| Mean | 2,219.6 | 2,152.0 | –67.6 | 2,157.9 | –61.7 |
| Maximum | 2,236.6 | 2,180.6 | –56.0 | 2,187.7 | –48.9 |
| Minimum | 2,202.9 | 2,111.2 | –91.7 | 2,114.7 | –88.2 |
| **2001 (Drought Year)** | | | | | |
| Mean | 2,224.9 | 2,207.3 | –17.6 | 2,209.6 | –15.3 |
| Maximum | 2,239.0 | 2,234.2 | –4.8 | 2,239.8 | 0.8 |
| Minimum | 2,205.4 | 2,143.6 | –61.8 | 2,150.5 | –54.9 |

Note: All pool elevations in feet
*Change from *Alternative 1 – No Action*

Kachess Reservoir levels under *Alternative 5A* would be similar to those for *Alternatives 2*, *3*, and *4*; however, the magnitude of change from *Alternative 1* would be reduced by up to 7.1 feet.

Three pool elevations serve as benchmarks for potential impacts:

- 2,192.75, elevation of the existing gravity outlet, minimum pool
- 2,220, pool level that separates the two reservoir 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 4-39.

**Table 4-39. Frequency and Duration of Kachess Pool Elevation below Benchmark Elevations, All Alternatives**

| Elevation | Unit | *Alternative 1 – No Action* | *Alternatives 2, 3,* and *4* | Change[a] | *Alternatives 5A, 5B,* and *5C* | Change[a] |
|---|---|---|---|---|---|---|
| 2,192.75[b] | Years | 0 | 34 | 34 | 32 | 32 |
| 2,192.75[b] | Mean duration, days | 0 | 183 | 183 | 156 | 156 |
| 2,220[c] | Years | 73 | 76 | 3 | 76 | 3 |
| 2,220[c] | Mean duration, days | 78 | 154 | 76 | 140 | 62 |
| 2,226[d] | Years | 83 | 85 | 2 | 82 | –1 |
| 2,226[d] | Mean duration, days | 111 | 171 | 60 | 157 | 46 |

[a] Change compared with *Alternative 1 – No Action*
[b] Elevation of existing gravity outlet; minimum pool
[c] Elevation at which the two lake basins separate
[d] Elevation at which bull trout access to tributary streams is impeded

For *Alternative 5A*, Kachess Reservoir would be below the existing minimum pool elevation of 2,192.75 for 32 years out of the 90 years modeled, with a mean duration of 156 days. Under *Alternative 1*, the pool would not fall below this elevation.

The number of years during which the two basins of Kachess Reservoir would become separated (elevation 2,220) would be 3 years more under *Alternative 5A* than under *Alternative 1* (76 versus 73 years), and for an additional 62 days (140 versus 78 days). Bull trout access to tributary streams would be impeded (elevation 2,226) in 82 years, representing a 1 year decrease from *Alternative 1*. However, the mean duration would be 157 days, an increase of 46 days.

Although *Alternative 5A* would affect the ability of bull trout to access the Little Kachess and tributary streams, it would perform slightly better than *Alternatives 2*, *3*, and *4*.

Seasonal low levels for Kachess Reservoir under *Alternative 5A* would be up to 85 feet lower than those under *Alternative 1* for all seasons because of KDRPP pumping. Winter and summer median elevations would be reduced by 3 to 4 feet under *Alternative 5A* compared with *Alternative 1*. Spring median levels would increase by 3 feet under *Alternative 5A* compared with *Alternative 1*. Modeled seasonal water levels are tabulated in Table 4-40.

**Table 4-40. Kachess Reservoir Seasonal Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Season | Pool Elevation (feet) | Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Winter (Nov 1–Mar 14)** | | | |
| Range | 2,197.0-2,259.9 | 2,112.2-2,260.0 | |
| Median (50% exceedance) | 2,228.3 | 2,225.2 | –2.9 |
| High (10% exceedance) | 2,246.4 | 2,253.9 | 7.5 |
| Low (90% exceedance) | 2,209.7 | 2,157.7 | –52.0 |
| **Spring (Mar 15–Jun 15)** | | | |
| Range | 2,208.6-2,262.0 | 2,125.0-2,262.0 | |
| Median (50% exceedance) | 2,245.7 | 2,248.8 | 3.1 |
| High (10% exceedance) | 2,259.3 | 2,260.0 | 0.7 |
| Low (90% exceedance) | 2,227.5 | 2,185.4 | –42.1 |
| **Summer (Jun 16–Oct 31)** | | | |
| Range | 2,196.3-2,262.0 | 2,111.2-2,262.0 | |
| Median (50% exceedance) | 2,241.0 | 2,237.2 | –3.8 |
| High (10% exceedance) | 2,260.6 | 2,260.8 | 0.2 |
| Low (90% exceedance) | 2,212.4 | 2,173.6 | –38.8 |

Kachess Reservoir annual maximum pool elevations during nonprorated years would be increased in lower elevations under *Alternative 5A* compared with *Alternative 1*. During prorated years, maximum pool elevations would be as much as 69 feet lower under *Alternative 5A* compared with *Alternative 1*. During refill years they would be as much as 57 feet lower. Modeled maximum pool elevations for the types of years are tabulated in Table 4-41.

**Table 4-41. Kachess Reservoir Annual Maximum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Annual Maximum Pool Elevation (feet) | Annual Maximum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,245.3-2,262.0 | 2,249.4-2,262.0 | |
| Median (50% exceedance) | 2,262.0 | 2,262.0 | 0.0 |
| High (10% exceedance) | 2,262.0 | 2,262.0 | 0.0 |
| Low (90% exceedance) | 2,249.5 | 2,254.7 | 5.2 |

| Year | Annual Maximum Pool Elevation (feet) | Annual Maximum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,225.0-2,256.5 | 2,156.7-2,262.0 | |
| Median (50% exceedance) | 2,237.9 | 2,234.6 | –3.3 |
| High (10% exceedance) | 2,251.7 | 2,257.7 | 6.0 |
| Low (90% exceedance) | 2,230.1 | 2,174.7 | –55.4 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,238.0-2,262.0 | 2,181.8-2,262.0 | |
| Median (50% exceedance) | 2,254.8 | 2,241.5 | –13.3 |
| High (10% exceedance) | 2,262.0 | 2,259.8 | –2.2 |
| Low (90% exceedance) | 2,244.0 | 2,213.1 | –30.9 |

Kachess Reservoir annual minimum pool elevations during nonprorated years would be up to 12 feet lower under *Alternative 5A* compared with *Alternative 1*. During prorated years and refill years, minimum pool elevations would be up to 86 feet lower under *Alternative 5A* compared with *Alternative 1*. Modeled minimum pool elevations for the types of years are tabulated in Table 4-42.

**Table 4-42. Kachess Reservoir Annual Minimum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Annual Minimum Pool Elevation (feet) | Annual Minimum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,199.3-2,235.1 | 2,187.5-2,238.1 | |
| Median (50% exceedance) | 2,218.4 | 2,217.9 | –0.5 |
| High (10% exceedance) | 2,229.2 | 2,232.1 | 2.9 |
| Low (90% exceedance) | 2,204.4 | 2,203.1 | –1.3 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,197.1-2,216.2 | 2,111.2-2,201.1 | |
| Median (50% exceedance) | 2,205.6 | 2,156.4 | –49.4 |
| High (10% exceedance) | 2,211.5 | 2,187.1 | –24.4 |
| Low (90% exceedance) | 2,197.6 | 2,115.3 | –82.3 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,196.3-2,224.4 | 2,111.5-2,200.3 | |
| Median (50% exceedance) | 2,207.1 | 2,164.3 | –42.8 |
| High (10% exceedance) | 2,219.6 | 2,189.9 | –29.7 |
| Low (90% exceedance) | 2,198.9 | 2,119.3 | –79.6 |

**Keechelus Reservoir.** Under *Alternative 5A*, Keechelus Reservoir levels would be lower following a drought than under *Alternative 1* 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 4-43 and Figure 4-11, the peak water levels in Keechelus Reservoir would be reduced by 10 to 25 feet and the lowest level reduced by as much as 15 feet during the post-drought refilling years. Keechelus Reservoir levels would still be within its current operating range.

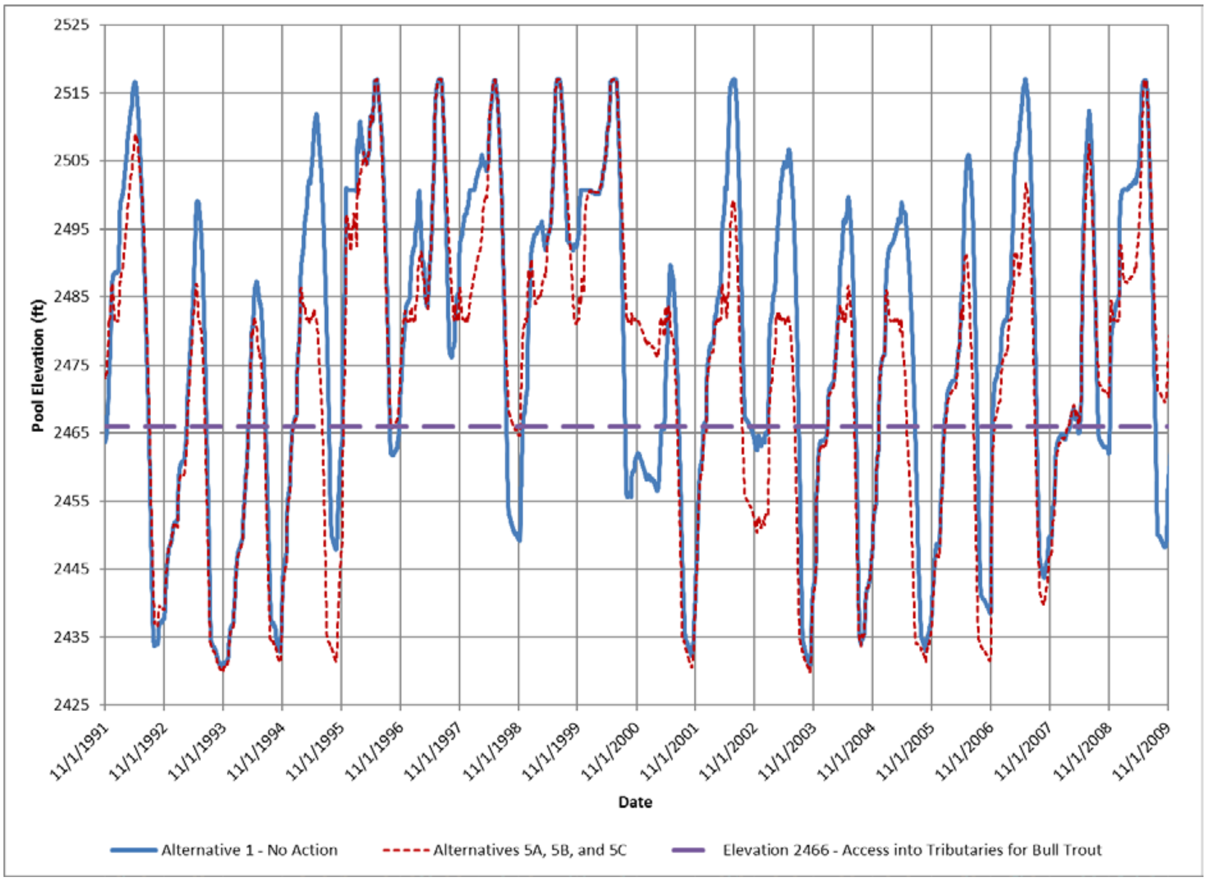



**Figure 4-11. Keechelus Reservoir Pool Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

**Table 4-43. Keechelus Reservoir Pool Elevations under All Alternatives**

| Modeled Year | *Alternative 1 – No Action* | *Alternatives 2, 3,* and *4* | Change[a] (feet) | *Alternatives 5A, 5B,* and *5C* | Change[a] (feet) |
|---|---|---|---|---|---|
| **1926–2015** | | | | | |
| Mean | 2,479.5 | 2,479.0 | –0.5 | 2,477.1 | –2.4 |
| Mean of annual maximum | 2,509.1 | 2,508.4 | –0.7 | 2,503.2 | –5.9 |
| Mean of annual minimum | 2,445.8 | 2,445.3 | –0.5 | 2,449.0 | 3.7 |
| **1994 (Drought Year)** | | | | | |
| Mean | 2,453.4 | 2,451.5 | –1.9 | 2,450.7 | –2.7 |
| Maximum | 2,487.3 | 2,484.2 | –3.1 | 2,482.1 | –5.2 |
| Minimum | 2,430.7 | 2,430.3 | –0.4 | 2,430.1 | –0.6 |
| **2001 (Drought Year)** | | | | | |
| Mean | 2,459.5 | 2,455.8 | –3.7 | 2,466.4 | 6.9 |
| Maximum | 2,489.6 | 2,480.1 | –9.5 | 2,483.8 | –5.8 |
| Minimum | 2,432.2 | 2,430.7 | –1.5 | 2,430.5 | –1.7 |

Note: All pool elevations in feet
[a] Change from *Alternative 1 – No Action*

Mean Keechelus Reservoir levels for *Alternative 5A* would be lower than those for other alternatives by 2.5 feet (relative to *Alternatives 2, 3,* and *4*) to 3.7 feet (relative to *Alternative 1*), although the annual minimum would be slightly (0.5 feet) higher than that for *Alternative 1*. During drought years, Keechelus Reservoir levels would differ by a maximum of 2 feet from those for *Alternatives 2, 3,* and *4* (i.e., with KDRPP alone in place). Modeled reservoir levels for all alternatives would fall within the range that would occur under *Alternative 1*.

As summarized in Table 4-44, bull trout access to tributary streams of Keechelus Reservoir would be impeded (below elevation 2,466) in 69 years for *Alternative 5A*, a decrease of 11 years from *Alternative 1*. The duration of this condition would be 134 days per year, an increase of 5 days per year, representing a greater change than would occur under any other action alternative.

**Table 4-44. Frequency and Duration of Keechelus Pool Level below Elevation 2,466, All Alternatives**

| Unit | *Alternative 1 – No Action* | *Alternatives 2, 3,* and *4* | Change[a] | *Alternatives 5A, 5B,* and *5C* | Change[a] |
|---|---|---|---|---|---|
| Years | 80 | 81 | 1 | 69 | –11 |
| Mean duration, days | 129 | 131 | 2 | 134 | 5 |

Note: At elevation 2,466, bull trout access to tributary streams is impeded.
[a] Change from *Alternative 1 – No Action*

Seasonal levels for Keechelus Reservoir under *Alternative 5A* would range similar to those under *Alternative 1*. Modeled seasonal water levels are tabulated in Table 4-45.

**Table 4-45. Keechelus Reservoir Seasonal Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Season | Pool Elevation (feet) *Alternative 1 – No Action* | Pool Elevation (feet) *Alternative 5A* | Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Range | 2,427.5-2,513.1 | 2,428.1-2,513.0 | |
| Median (50% exceedance) | 2,476.8 | 2,481.0 | 4.2 |
| High (10% exceedance) | 2,500.8 | 2,495.6 | –5.2 |
| Low (90% exceedance) | 2,446.7 | 2,446.8 | 0.1 |
| **Spring (Mar 15–Jun 15)** | | | |
| Range | 2,448.1-2,517.0 | 2,446.5-2,517.0 | |
| Median (50% exceedance) | 2,498.8 | 2,488.6 | –10.2 |
| High (10% exceedance) | 2,513.1 | 2,510.4 | –2.7 |
| Low (90% exceedance) | 2,474.9 | 2,474.3 | –0.6 |
| **Summer (Jun 16–Oct 31)** | | | |
| Range | 2,428.8-2,517.0 | 2,429.9-2,517.6 | |
| Median (50% exceedance) | 2,471.1 | 2,473.8 | 2.7 |
| High (10% exceedance) | 2,512.4 | 2,509.3 | –3.1 |
| Low (90% exceedance) | 2,434.1 | 2,433.9 | –0.2 |

Keechelus Reservoir annual maximum pool elevations during nonprorated years would be up to 11 feet lower under *Alternative 5A* compared with *Alternative 1*. During prorated years, the maximum pool elevation would range up to 4 feet lower under *Alternative 5A* compared with *Alternative 1*. During refill years, the maximum pool elevation range would be up to 12 feet lower under *Alternative 5A* compared with *Alternative 1*. Modeled maximum pool elevations for the types of years are tabulated in Table 4-46.

**Table 4-46. Keechelus Reservoir Annual Maximum Pool Elevations under *Alternative 5A – KKC North Tunnel Alignment***

| Year | Annual Maximum Pool Elevation (feet) | Annual Maximum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,497.8-2,517.0 | 2,486.7-2,517.6 | |
| Median (50% exceedance) | 2,516.9 | 2,516.9 | 0.0 |
| High (10% exceedance) | 2,517.0 | 2,517.0 | 0.0 |
| Low (90% exceedance) | 2,501.4 | 2,496.3 | –5.1 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,467.9-2,517.0 | 2,463.5-2,517.0 | |
| Median (50% exceedance) | 2,489.6 | 2,483.8 | –5.8 |
| High (10% exceedance) | 2,513.4 | 2,504.8 | –8.6 |
| Low (90% exceedance) | 2,480.1 | 2,470.3 | –9.8 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,495.3-2,517.0 | 2,482.9-2,517.0 | |
| Median (50% exceedance) | 2,511.9 | 2,489.8 | –22.1 |
| High (10% exceedance) | 2,517.0 | 2,503.6 | –13.4 |
| Low (90% exceedance) | 2,500.3 | 2,485.7 | –14.6 |

The Keechelus Reservoir annual minimum pool elevation range during nonprorated years would be up to 7 feet lower under *Alternative 5A* compared with *Alternative 1*. During prorated years, minimum pool elevations under *Alternative 5A* would range up to 7 feet higher than *Alternative 1* minimum pool elevations. During refill years, minimum pool elevations under *Alternative 5A* would be up to 19 feet lower than *Alternative 1* minimum pool elevations. Modeled minimum pool elevations for the types of years are tabulated in Table 4-47.

**Table 4-47. Keechelus Reservoir Annual Minimum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Annual Minimum Pool Elevation (feet) | Annual Minimum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,430.7-2,488.1 | 2,429.9-2,481.5 | |
| Median (50% exceedance) | 2,449.4 | 2,457.5 | 8.1 |
| High (10% exceedance) | 2,475.9 | 2,480.7 | 4.8 |
| Low (90% exceedance) | 2,432.2 | 2,432.4 | 0.2 |

| Year | Annual Minimum Pool Elevation (feet) | Annual Minimum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,427.5-2,434.0 | 2,428.1-2,441.5 | |
| Median (50% exceedance) | 2,432.3 | 2,431.2 | –0.9 |
| High (10% exceedance) | 2,433.6 | 2,435.9 | 1.7 |
| Low (90% exceedance) | 2,430.4 | 2,430.1 | –0.3 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,429.2-2,464.4 | 2,430.5-2,445.1 | |
| Median (50% exceedance) | 2,434.4 | 2,432.7 | –1.7 |
| High (10% exceedance) | 2,452.7 | 2,437.7 | –15.0 |
| Low (90% exceedance) | 2,431.0 | 2,431.2 | 0.2 |

*Other Reservoirs*

Water levels in other Yakima Project reservoirs (Cle Elum, Bumping, and Rimrock) may be affected by *Alternative 5A* to order to balance overall system operations from changes in the upper reservoirs.

Based on modeling results Cle Elum Reservoir pool elevations would be affected and Rimrock Reservoir and Bumping Reservoir pool elevations would be slightly affected by *Alternative 5A* compared with *Alternative 1* from balancing releases and refills, specifically during low periods. Cle Elum Reservoir would have up to 7 feet lower pool elevations. Median pool elevations for Rimrock Reservoir would be up to 6 feet lower under *Alternative 5A* compared with *Alternative 1*. Many of these differences are likely due to reservoir balancing in the modeling that may not occur during actual operation. Seasonal levels for Cle Elum, Bumping, and Rimrock reservoirs are tabulated in Table 4-48 to Table 4-50.

**Table 4-48. Cle Elum Reservoir Seasonal Pool Elevations under A*lternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Season | Pool Elevation (feet) | Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Winter (Nov 1–Mar 14)** | | | |
| Range | 2,122.6-2,237.4 | 2,115.8-2,238.1 | |
| Median (50% exceedance) | 2,185.5 | 2,183.7 | –1.8 |
| High (10% exceedance) | 2,218.4 | 2,218.3 | –0.1 |
| Low (90% exceedance) | 2,146.4 | 2,151.6 | 5.2 |
| **Spring (Mar 15–Jun 15)** | | | |
| Range | 2,136.6-2,243.0 | 2,130.4-2,243.0 | |
| Median (50% exceedance) | 2,214.7 | 2,214.9 | 0.2 |
| High (10% exceedance) | 2,239.7 | 2,239.7 | 0.0 |
| Low (90% exceedance) | 2,175.6 | 2,178.2 | 2.6 |

| Season | Pool Elevation (feet) Alternative 1 – No Action | Pool Elevation (feet) Alternative 5A | Change |
|---|---|---|---|
| **Summer (Jun 16–Oct 31)** | | | |
| Range | 2,119.5-2,243.0 | 2,116.3-2,243.0 | |
| Median (50% exceedance) | 2,192.8 | 2,193.0 | 0.2 |
| High (10% exceedance) | 2,241.4 | 2,241.3 | –0.1 |
| Low (90% exceedance) | 2,142.6 | 2,144.9 | 1.7 |

**Table 4-49. Bumping Reservoir Seasonal Pool Elevations under Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment**

| Season | Pool Elevation (feet) Alternative 1 – No Action | Pool Elevation (feet) Alternative 5A | Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Range | 3,391.3-3,427.1 | 3,391.0-3,427.1 | |
| Median (50% exceedance) | 3,409.2 | 3,409.1 | –0.1 |
| High (10% exceedance) | 3,410.7 | 3,410.7 | 0.0 |
| Low (90% exceedance) | 3,395.6 | 3,394.9 | –0.7 |
| **Spring (Mar 15–Jun 15)** | | | |
| Range | 3,391.6-3,431.9 | 3,391.6-3,431.9 | |
| Median (50% exceedance) | 3,410.7 | 3,410.7 | 0.0 |
| High (10% exceedance) | 3,426.2 | 3,426.2 | 0.0 |
| Low (90% exceedance) | 3,403.5 | 3,403.5 | 0.0 |
| **Summer (Jun 16–Oct 31)** | | | |
| Range | 3,399.6-3,434.5 | 3,391.3-3,434.5 | |
| Median (50% exceedance) | 3,417.5 | 3,417.2 | –0.3 |
| High (10% exceedance) | 3,426.2 | 3,426.2 | 0.0 |
| Low (90% exceedance) | 3,408.8 | 3,407.8 | –1.0 |

**Table 4-50. Rimrock Reservoir Seasonal Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Season | Pool Elevation (feet) Alternative 1 – No Action | Pool Elevation (feet) Alternative 5A | Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Range | 2,766.2-2,922.2 | 2,766.2-2,922.4 | |
| Median (50% exceedance) | 2,870.1 | 2,863.7 | –6.4 |
| High (10% exceedance) | 2,897.5 | 2,896.5 | –1.0 |
| Low (90% exceedance) | 2,835.4 | 2,818.6 | –16.8 |

| Season | Pool Elevation (feet) | Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Spring (Mar 15–Jun 15)** | | | |
| Range | 2,804.3-2,926.0 | 2,804.3-2.926.0 | |
| Median (50% exceedance) | 2,896.8 | 2,894.5 | –1.7 |
| High (10% exceedance) | 2,921.8 | 2,921.3 | –0.5 |
| Low (90% exceedance) | 2,866.9 | 2,859.3 | –7.6 |
| **Summer (Jun 16–Oct 31)** | | | |
| Range | 2,766.0-2,926.0 | 2,766.0-2,926.0 | |
| Median (50% exceedance) | 2,906.1 | 2,901.8 | –4.3 |
| High (10% exceedance) | 2,926.0 | 2,926.0 | 0.0 |
| Low (90% exceedance) | 2,844.0 | 2,832.1 | –11.9 |

Cle Elum Reservoir and Rimrock Reservoir maximum pool elevations would be affected by *Alternative 5A* compared with *Alternative 1* in prorated years. No impact on Bumping Reservoir would occur. Cle Elum Reservoir maximum pool elevations would be up to 14 feet higher and Rimrock Reservoir would be up to 18 feet lower during prorated years. Maximum pool elevations for Cle Elum, Bumping, and Rimrock reservoirs are tabulated in Table 4-51 to Table 4-53.

**Table 4-51. Cle Elum Reservoir Annual Maximum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Annual Maximum Pool Elevation (feet) | Annual Maximum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,225.3-2,243.0 | 2,226.3-2,243.0 | |
| Median (50% exceedance) | 2,243.0 | 2,243.0 | 0.0 |
| High (10% exceedance) | 2,243.0 | 2,243.0 | 0.0 |
| Low (90% exceedance) | 2,233.8 | 2,233.3 | –0.5 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,191.6-2,243.0 | 2,205.4-2,243.0 | |
| Median (50% exceedance) | 2,221.2 | 2,223.2 | 2.0 |
| High (10% exceedance) | 2,235.6 | 2,235.5 | –0.1 |
| Low (90% exceedance) | 2,205.9 | 2,208.2 | 2.3 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,215.2-2,243.0 | 2,215.4-2,243.0 | |
| Median (50% exceedance) | 2,243.0 | 2,243.0 | 0.0 |
| High (10% exceedance) | 2,243.0 | 2,243.0 | 0.0 |
| Low (90% exceedance) | 2,234.9 | 2,234.1 | –0.8 |

**Table 4-52. Bumping Reservoir Annual Maximum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Annual Maximum Pool Elevation (feet) *Alternative 1 – No Action* | Annual Maximum Pool Elevation (feet) *Alternative 5A* | Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Range | 3,426.2-3,434.5 | 3,426.2-3,434.5 | |
| Median (50% exceedance) | 3,426.6 | 3,426.6 | 0.0 |
| High (10% exceedance) | 3,430.3 | 3,430.3 | 0.0 |
| Low (90% exceedance) | 3,426.2 | 3,426.2 | 0.0 |
| **Prorated Year (15 of 90)** | | | |
| Range | 3,422.8-3,428.3 | 3,422.8-3,428.3 | |
| Median (50% exceedance) | 3,426.2 | 3,426.2 | 0.0 |
| High (10% exceedance) | 3,426.4 | 3,426.4 | 0.0 |
| Low (90% exceedance) | 3,426.2 | 3,426.2 | 0.0 |
| **Refill Year (19 of 90)** | | | |
| Range | 3,426.2-3,430.2 | 3,426.2-3,430.2 | |
| Median (50% exceedance) | 3,426.4 | 3,426.4 | 0.0 |
| High (10% exceedance) | 3,428.3 | 3,428.3 | 0.0 |
| Low (90% exceedance) | 3,426.2 | 3,426.2 | 0.0 |

**Table 4-53. Rimrock Reservoir Annual Maximum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Annual Maximum Pool Elevation (feet) *Alternative 1 – No Action* | Annual Maximum Pool Elevation (feet) *Alternative 5A* | Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,912.8-2,926.0 | 2,908.5-2,926.0 | |
| Median (50% exceedance) | 2,926.0 | 2,926.0 | 0.0 |
| High (10% exceedance) | 2,926.0 | 2,926.0 | 0.0 |
| Low (90% exceedance) | 2,923.6 | 2,918.8 | –4.8 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,860.6-2,926.0 | 2,842.8-2,926.0 | |
| Median (50% exceedance) | 2,895.4 | 2,885.0 | –10.4 |
| High (10% exceedance) | 2,919.1 | 2,918.4 | –0.7 |
| Low (90% exceedance) | 2,875.7 | 2,866.4 | –9.3 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,896.5-2,926.0 | 2,889.9-2,926.0 | |
| Median (50% exceedance) | 2,926.0 | 2,926.0 | 0.0 |
| High (10% exceedance) | 2,926.0 | 2,926.0 | 0.0 |

| Year | Annual Maximum Pool Elevation (feet) | Annual Maximum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| Low (90% exceedance) | 2,922.0 | 2,919.9 | –2.1 |

Cle Elum and Rimrock reservoirs' minimum pool elevation ranges would be affected by *Alternative 5A* compared with *Alternative 1* in prorated years. Cle Elum Reservoir minimum pool elevations would be up to 11 feet lower in refill years and would be up to 16 feet higher in prorated years. Rimrock Reservoir minimum pool elevations would be up to 6 feet higher in prorated years and up to 25 feet lower in nonprorated years. Minimum pool elevations for Cle Elum, Bumping, and Rimrock reservoirs are tabulated in Table 4-54 to Table 4-56.

**Table 4-54. Cle Elum Reservoir Annual Minimum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Annual Minimum Pool Elevation (feet) | Annual Minimum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,129.9-2,204.2 | 2,131.8-2,204.2 | |
| Median (50% exceedance) | 2,158.9 | 2,158.4 | –0.5 |
| High (10% exceedance) | 2,191.5 | 2,190.8 | –0.7 |
| Low (90% exceedance) | 2,138.1 | 2,140.2 | 2.1 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,119.5-2,154.2 | 2,117.7-2,170.4 | |
| Median (50% exceedance) | 2,129.6 | 2,127.4 | –2.2 |
| High (10% exceedance) | 2,143.8 | 2,155.5 | 11.7 |
| Low (90% exceedance) | 2,124.7 | 2,119.0 | –4.3 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,122.6-2,181.8 | 2,115.8-2,170.4 | |
| Median (50% exceedance) | 2,141.2 | 2,139.1 | –1.9 |
| High (10% exceedance) | 2,159.4 | 2,164.2 | 4.8 |
| Low (90% exceedance) | 2,124.8 | 2,117.3 | –6.5 |

**Table 4-55. Bumping Reservoir Annual Minimum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Annual Minimum Pool Elevation (feet) | Annual Minimum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 3,391.6-3,409.4 | 3,391.6-3,409.4 | |
| Median (50% exceedance) | 3,404.8 | 3,404.9 | 0.1 |
| High (10% exceedance) | 3,408.4 | 3,408.5 | 0.1 |

| Year | Annual Minimum Pool Elevation (feet) | Annual Minimum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| Low (90% exceedance) | 3,394.2 | 3,394.2 | 0.0 |
| **Prorated Year (15 of 90)** | | | |
| Range | 3,391.3-3,407.8 | 3,391.0-3,407.7 | |
| Median (50% exceedance) | 3,392.3 | 3,392.0 | –0.3 |
| High (10% exceedance) | 3,405.4 | 3,401.9 | –3.5 |
| Low (90% exceedance) | 3,391.5 | 3,391.2 | –0.3 |
| **Refill Year (19 of 90)** | | | |
| Range | 3,391.9-3,408.6 | 3,391.9-3,408.6 | |
| Median (50% exceedance) | 3,402.6 | 3,395.2 | –6.6 |
| High (10% exceedance) | 3,408.0 | 3,406.5 | –1.5 |
| Low (90% exceedance) | 3,392.3 | 3,391.9 | –0.4 |

**Table 4-56. Rimrock Reservoir Annual Minimum Pool Elevations under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Annual Minimum Pool Elevation (feet) | Annual Minimum Pool Elevation (feet) | Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Nonprorated Year (56 of 90)** | | | |
| Range | 2,791.6-2,871.3 | 2,766.0-2,868.8 | |
| Median (50% exceedance) | 2849.2 | 2838.9 | –10.3 |
| High (10% exceedance) | 2861.1 | 2855.8 | –5.3 |
| Low (90% exceedance) | 2824.9 | 2798.8 | –26.1 |
| **Prorated Year (15 of 90)** | | | |
| Range | 2,766.0-2,844.9 | 2,766.0-2,850.7 | |
| Median (50% exceedance) | 2827.5 | 2766.0 | –61.5 |
| High (10% exceedance) | 2843.3 | 2828.3 | –15.0 |
| Low (90% exceedance) | 2777.4 | 2766.0 | –11.4 |
| **Refill Year (19 of 90)** | | | |
| Range | 2,766.0-2,862.3 | 2,766.0-2,862.4 | |
| Median (50% exceedance) | 2826.2 | 2823.9 | –2.3 |
| High (10% exceedance) | 2854.4 | 2855.9 | 1.5 |
| Low (90% exceedance) | 2788.7 | 2766.0 | –22.7 |

### *Streamflow*

Under *Alternative 5A*, Reclamation would pump water from the inactive storage of Kachess Reservoir and discharge it to the Kachess River for delivery to participating Proratable Entities. Streamflow in the Kachess and Yakima rivers would change compared with

*Alternative 1* conditions. In addition, streamflow would change as Kachess Reservoir is being refilled after droughts. Appendix E includes hydrographs depicting streamflow under *Alternative 5A.*

**Kachess River.** Table 4-57 summarizes the change in Kachess River streamflow. In general, pumping inactive storage in the reservoir would increase flow in the Kachess River. Overall, the mean flow would increase by 58 cfs (19.8 percent), with an increase in the July-to-August mean of 170 cfs (31.6 percent). During a drought year, the July-to-August streamflow in the Kachess River would more than double relative to *Alternative 1*. With existing summertime flow releases typically ranging up to 1,300 cfs and possibly up to 1,500 cfs, the maximum discharge of 1,000 cfs (capacity of KDRPP) would not alter the normal operating range of river flow.

**Table 4-57. Kachess River Flow below Kachess Reservoir under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Modeled Year | Mean Flow (cfs) *Alternative 1 – No Action* | Mean Flow (cfs) *Alternative 5A* | Percentage Change |
|---|---|---|---|
| **1926–2015** | | | |
| Annual | 295.0 | 353.0 | 19.8 |
| July–August | 537.0 | 707.0 | 31.6 |
| January | 46.7 | 67.7 | 44.9 |
| **1994 (Drought Year)** | | | |
| Annual | 205.0 | 325.0 | 59.0 |
| July–August | 324.0 | 820.0 | 153.2 |
| January | 32.2 | 31.6 | –2.0 |
| **2001 (Drought Year)** | | | |
| Annual | 230.0 | 453.0 | 96.8 |
| July–August | 430.0 | 1,118.0 | 160.0 |
| January | 64.7 | 57.8 | –10.6 |

The mean winter flow would increase by about 21 cfs (45 percent). During drought years, winter flows would be very similar to those of *Alternative 1* because, in the interest of conserving storage and promoting refill, Reclamation would release only minimum flows. Kachess River streamflow conditions under *Alternative 5A* would be similar to those of *Alternatives 2, 3,* and *4,* remaining within the current operating range of flows in the river.

**Yakima River.** *Alternative 5A* 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 4-58 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. The peak flow in July in the Keechelus reach would be 500 cfs. 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 5A* 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 benefit to instream flow conditions in the Keechelus reach.

**Table 4-58. Change in Yakima River Flow in Keechelus Reach under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Modeled Year | Mean Flow (cfs) | Mean Flow (cfs) | Percentage Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **1926–2015** | | | |
| Annual | 337.0 | 225.0 | –33.3 |
| July–August | 866.0 | 394.0 | –54.5 |
| January | 154.0 | 105.0 | –32.2 |
| **1994 (Drought Year)** | | | |
| Annual | 230.0 | 225.0 | –2.2 |
| July–August | 614.0 | 533.0 | –13.2 |
| January | 81.1 | 81.1 | 0.0 |
| **2001 (Drought Year)** | | | |
| Annual | 261.0 | 220.0 | –15.6 |
| July–August | 673.0 | 372.0 | –44.7 |
| January | 132.0 | 80.0 | –39.3 |

Median and high-flow exceedances for the Keechelus reach under *Alternative 5A* would be up to 70 percent lower compared with *Alternative 1*. Low-flow exceedances and median winter flows would not be affected. Modeled seasonal flows are tabulated in Table 4-59.

**Table 4-59. Seasonal Change in Keechelus Reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Season | Flow (cfs) | Flow (cfs) | Percentage Change |
|---|---|---|---|
| | *Alternative 1 – No Action* | *Alternative 5A* | |
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 100 | 100 | 0.0 |
| High (10% exceedance) | 153 | 120 | –21.6 |
| Low (90% exceedance) | 80 | 80 | 0.0 |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 350 | 288 | –17.7 |
| High (10% exceedance) | 675 | 594 | –12.0 |
| Low (90% exceedance) | 100 | 100 | 0.0 |

| Season | Flow (cfs) Alternative 1 – No Action | Flow (cfs) Alternative 5A | Percentage Change |
|---|---|---|---|
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 527 | 161 | –69.4 |
| High (10% exceedance) | 1,070 | 500 | –53.3 |
| Low (90% exceedance) | 80 | 80 | 0.0 |

Keechelus reach high-flow exceedances during all year types (nonprorated, prorated, and refill) would be reduced by 30 to 48 percent (220 to 450 cfs) under *Alternative 5A* compared with *Alternative 1*. Median and low-flow exceedances during prorated and refill years would not change under *Alternative 5A* compared with *Alternative 1*. During nonprorated years, median and low flows would decrease 4 to 10 percent (5 to 9 cfs). Modeled Keechelus reach flows for the types of years are tabulated in Table 4-60.

**Table 4-60. Keechelus Reach Flows by Year Type under *Alternative 5A – KKC North Tunnel Alignment***

| Year | Flow (cfs) Alternative 1 – No Action | Flow (cfs) Alternative 5A | Percentage Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 125 | 120 | –4.0 |
| High (10% exceedance) | 954 | 500 | –47.6 |
| Low (90% exceedance) | 89 | 80 | –10.1 |
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 100 | 100 | 0.0 |
| High (10% exceedance) | 732 | 509 | –30.5 |
| Low (90% exceedance) | 80 | 80 | 0.0 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 120 | 120 | 0.0 |
| High (10% exceedance) | 917 | 500 | –45.5 |
| Low (90% exceedance) | 80 | 80 | 0.0 |

Overall, for the Easton reach, streamflows would change from *Alternative 1*, as summarized in Table 4-61, and would be similar to conditions under *Alternatives 2*, *3*, and *4*. In drought-year summers, flow would increase 260 to 290 cfs (42 to 49 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.

**Table 4-61. Change in Yakima River Flow at Easton with *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Modeled Year | Mean Flow (cfs) *Alternative 1 – No Action* | Mean Flow (cfs) *Alternative 5A* | Percentage Change |
|---|---|---|---|
| **1926–2015** | | | |
| Annual | 458 | 454 | –0.9 |
| July–August | 530 | 475 | –10.5 |
| January | 450 | 437 | –3.0 |
| **1994 (Drought Year)** | | | |
| Annual | 366 | 430 | 17.6 |
| July–August | 534 | 794 | 48.5 |
| January | 306 | 306 | –0.2 |
| **2001 (Drought Year)** | | | |
| Annual | 398 | 530 | 32.9 |
| July–August | 694 | 984 | 41.8 |
| January | 250 | 250 | 0.0 |

In the spring, flows in the Easton reach under *Alternative 5A* would be 4 to 28 percent (18 to 138 cfs) higher compared with *Alternative 1*. In the summer and winter, low flows would be slightly higher (less than 10 cfs or 4 percent) and median and high flows would be lower (up to 11 percent or 35 cfs) under *Alternative 5A* compared with *Alternative 1*. Modeled seasonal flows are tabulated in Table 4-62.

**Table 4-62. Seasonal Change in Easton Reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Season | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 5A* | Percentage Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 305 | 304 | –0.3 |
| High (10% exceedance) | 712 | 693 | –2.7 |
| Low (90% exceedance) | 222 | 228 | 2.7 |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 393 | 411 | 4.6 |
| High (10% exceedance) | 1,100 | 1,138 | 3.5 |
| Low (90% exceedance) | 193 | 246 | 27.5 |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 310 | 275 | –11.3 |
| High (10% exceedance) | 735 | 715 | –2.7 |
| Low (90% exceedance) | 196 | 203 | 3.6 |

Easton reach flow exceedances during nonprorated years would be similar under *Alternative 5A* compared with *Alternative 1*. During prorated years, high flows would increase by up to 232 cfs or 37 percent under *Alternative 5A* compared with *Alternative 1*. During refill years, median and high flows would decrease by up to 154 cfs or 21 percent under *Alternative 5A* compared with *Alternative 1*. Modeled Easton reach flows for the types of years are tabulated in Table 4-63.

**Table 4-63. Easton Reach Flows by Year Type under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 5A* | Percentage Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 353 | 347 | –1.7 |
| High (10% exceedance) | 879 | 881 | 0.2 |
| Low (90% exceedance) | 250 | 250 | 0.0 |
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 274 | 288 | 5.1 |
| High (10% exceedance) | 629 | 861 | 36.9 |
| Low (90% exceedance) | 190 | 196 | 3.2 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 306 | 268 | –12.4 |
| High (10% exceedance) | 734 | 580 | –21.0 |
| Low (90% exceedance) | 190 | 190 | 0.0 |

Flows in the Umtanum reach under *Alternative 5A* would be within 2.6 percent of *Alternative 1* flow exceedances for all seasons. Higher flows would be slightly lower and lower flows would be slightly higher. Modeled seasonal flows are tabulated in Table 4-64.

**Table 4-64. Seasonal Change in Umtanum Reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Season | Flow (cfs)<br>*Alternative 1 – No Action* | Flow (cfs)<br>*Alternative 5A* | Percentage Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 1,260 | 1,260 | 0.0 |
| High (10% exceedance) | 2,875 | 2,850 | –0.9 |
| Low (90% exceedance) | 803 | 804 | 0.1 |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 2,669 | 2,674 | 0.2 |
| High (10% exceedance) | 5,333 | 5,357 | 0.5 |
| Low (90% exceedance) | 1,568 | 1,609 | 2.6 |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 2,706 | 2,750 | 1.6 |
| High (10% exceedance) | 4,090 | 3,986 | –2.5 |
| Low (90% exceedance) | 1,131 | 1,142 | 1.0 |

Umtanum reach flow exceedances during nonprorated years would be similar under *Alternative 5A* compared with *Alternative 1*. During prorated years, flows would increase by up to 7 percent or 213 cfs under *Alternative 5A* compared with *Alternative 1*. During refill years, median and high flows would slightly decrease (less than 3 percent or 112 cfs) under *Alternative 5A* compared with *Alternative 1*. Modeled Umtanum reach flows for the types of years are tabulated in Table 4-65.

**Table 4-65. Umtanum Reach Flows by Year Type under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Flow (cfs)<br>*Alternative 1 – No Action* | Flow (cfs)<br>*Alternative 5A* | Percentage Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 2,157 | 2,160 | 0.1 |
| High (10% exceedance) | 4,320 | 4,265 | –1.3 |
| Low (90% exceedance) | 1,050 | 1,052 | 0.2 |
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 1,436 | 1,506 | 4.9 |
| High (10% exceedance) | 2,900 | 3,113 | 7.3 |
| Low (90% exceedance) | 759 | 769 | 1.3 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 2,003 | 1,966 | –1.8 |
| High (10% exceedance) | 4,060 | 3,948 | –2.8 |
| Low (90% exceedance) | 885 | 900 | 1.7 |

The increase in flow caused by operation of KDRPP would be further moderated at Roza Dam, at the diversion for Roza. Any remaining increased flow would be diverted by WIP at Wapato Dam.

Summer flows in the Roza reach under *Alternative 5A* would be slightly lower (less than 5 percent or 103 cfs) compared with *Alternative 1*. Winter and spring flows would be minimally affected. Modeled seasonal flows are tabulated in Table 4-66.

**Table 4-66. Seasonal Change in Roza Reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Season | Flow (cfs)<br>*Alternative 1 – No Action* | Flow (cfs)<br>*Alternative 5A* | Percentage Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 432 | 431 | –0.2 |
| High (10% exceedance) | 1,976 | 1,950 | –1.3 |
| Low (90% exceedance) | 400 | 400 | 0.0 |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 916 | 916 | 0.0 |
| High (10% exceedance) | 3,593 | 3,578 | –0.4 |
| Low (90% exceedance) | 401 | 402 | 0.2 |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 1,129 | 1,100 | –2.6 |
| High (10% exceedance) | 2,198 | 2,095 | –4.7 |
| Low (90% exceedance) | 403 | 403 | 0.0 |

Roza reach flow exceedances during nonprorated years would be similar under *Alternative 5A* compared with *Alternative 1*. During prorated years, median and high flows would increase by up to 8 percent or 107 cfs under *Alternative 5A* compared with *Alternative 1*. During refill years, median and high flows would decrease by up to 5 percent or 109 cfs under *Alternative 5A* compared with *Alternative 1*. Modeled Roza reach flows for the types of years are tabulated in Table 4-67.

**Table 4-67. Roza Reach Flows by Year Type under A*lternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 5A* | Percentage Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 955 | 954 | –0.1 |
| High (10% exceedance) | 2,649 | 2,671 | 0.8 |
| Low (90% exceedance) | 402 | 402 | 0.0 |
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 414 | 417 | 0.7 |
| High (10% exceedance) | 1,292 | 1,399 | 8.3 |
| Low (90% exceedance) | 400 | 400 | 0.0 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 785 | 769 | –2.0 |
| High (10% exceedance) | 2,245 | 2,136 | –4.9 |
| Low (90% exceedance) | 402 | 402 | 0.0 |

A small decrease in streamflow downstream from 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 from Parker gage is summarized in Table 4-68.

Overall, streamflow in the Yakima River in the Easton reach and in downstream reaches under all action alternatives would not cause flows to extend outside current operational ranges.

**Table 4-68. Change in Yakima River Flow at Parker under *Alternative 5A – KKC North Tunnel Alignment***

| Modeled Year | Mean Flow (cfs) *Alternative 1 – No Action* | Mean Flow (cfs) *Alternative 5A* | Percentage Change |
|---|---|---|---|
| **1926–2015** | | | |
| Annual | 2,305 | 2,293 | –0.5 |
| July–August | 654 | 656 | 0.3 |
| January | 3,033 | 3,004 | –1.0 |
| **1994 (Drought Year)** | | | |
| Annual | 981 | 1,009 | 2.8 |
| July–August | 386 | 385 | –0.4 |
| January | 1,481 | 1,483 | 0.2 |

| Modeled Year | Mean Flow (cfs) *Alternative 1 – No Action* | Mean Flow (cfs) *Alternative 5A* | Percentage Change |
|---|---|---|---|
| **2001 (Drought Year)** | | | |
| Annual | 852 | 887 | 4.2 |
| July–August | 390 | 390 | 0.1 |
| January | 1,279 | 1,279 | 0.0 |

Flows in the Wapato reach (at Parker) under *Alternative 5A* would be within 1.6 percent of *Alternative 1* flow exceedances for all seasons. Summer median and high flows would be slightly higher, while other flows would be slightly lower. Modeled seasonal flows are tabulated in Table 4-69.

**Table 4-69. Seasonal Change in Wapato Reach (Parker) Flow under *Alternative 5A – KKC North Tunnel Alignment***

| Season | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 5A* | Percentage Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 2,162 | 2,160 | –0.1 |
| High (10% exceedance) | 5,375 | 5,287 | –1.6 |
| Low (90% exceedance) | 1,404 | 1,404 | 0.0 |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 2,564 | 2,538 | –1.0 |
| High (10% exceedance) | 7,334 | 7,308 | –0.4 |
| Low (90% exceedance) | 422 | 416 | –1.4 |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 465 | 466 | 0.2 |
| High (10% exceedance) | 1,750 | 1,754 | 0.2 |
| Low (90% exceedance) | 381 | 380 | –0.3 |

Wapato reach (Parker) low-flow exceedances during nonprorated years would be higher by 9 percent or 37 cfs under *Alternative 5A* compared with *Alternative 1*. During prorated years, median flows would increase by 7 percent or 71 cfs under *Alternative 5A* compared with *Alternative 1*. During refill years, high flows would decrease by 5 percent or 239 cfs under *Alternative 5A* compared with *Alternative 1*. Modeled Wapato reach (Parker) flows for the types of years are tabulated in Table 4-70.

**Table 4-70. Wapato Reach (Parker) Flows by Year Type under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 5A* | Percentage Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 1,831 | 1,828 | –0.2 |
| High (10% exceedance) | 5,883 | 5,879 | –0.1 |
| Low (90% exceedance) | 402 | 439 | 9.2 |
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 960 | 1,031 | 7.4 |
| High (10% exceedance) | 2,245 | 2,251 | 0.3 |
| Low (90% exceedance) | 382 | 380 | –0.5 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 1,705 | 1,708 | 0.2 |
| High (10% exceedance) | 5,162 | 4,923 | –4.6 |
| Low (90% exceedance) | 392 | 386 | –1.5 |

The July 1 TWSA estimated in the model is reduced in some years, which could affect Title XII instream flow targets at Parker and Prosser. The simulations found that changes in the July 1 TWSA in 9 out of the 19 refill years and 1 of the 56 nonprorated years were sufficient to reduce the Title XII instream flow target numbers. However the simulations found the average July-August flow at Parker were more than 100 cfs greater than the instream flow targets in 5 of the 9 refill years and the 1 nonprorated year, bringing the average flow to or above the instream flow targets that occurred for *Alternative 1*. The simulations found that changes in the July 1 TWSA in 4 out of the 56 nonprorated years were sufficient to increase the Title XII instream flow target numbers. Title XII instream flow targets are unchanged for *Alternative 5A* in all prorated years compared to *Alternative 1*.

*Other Locations*

Flows in the Naches reach under *Alternative 5A* would be lower by up to 2 percent or 43 cfs in the winter and spring and higher by up to 5 percent or 49 cfs in the summer compared with *Alternative 1*. Modeled seasonal flows are tabulated in Table 4-71.

Naches reach flow exceedances during nonprorated years would be similar under *Alternative 5A* compared with *Alternative 1*. During prorated years, median and high flows would increase by up to 7 percent or 39 cfs and low flows would decrease by 2 percent or 6 cfs under *Alternative 5A* compared with *Alternative 1*. During refill years, median and low flows would decrease by up to 2 percent or 23 cfs under *Alternative 5A* compared with *Alternative 1*. Modeled Naches reach flows for the types of years are tabulated in Table 4-72.

### Volitional Bull Trout Passage Improvements

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.3.4.2).

**Table 4-71. Seasonal Change in Naches Reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Season | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 5A* | Percentage Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 669 | 667 | –0.3 |
| High (10% exceedance) | 2,015 | 1,972 | –2.1 |
| Low (90% exceedance) | 449 | 447 | –0.4 |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 2,186 | 2,163 | –1.1 |
| High (10% exceedance) | 4,799 | 4,788 | –0.2 |
| Low (90% exceedance) | 839 | 831 | –1.0 |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 1,020 | 1,069 | 4.8 |
| High (10% exceedance) | 2,304 | 2,283 | –0.9 |
| Low (90% exceedance) | 412 | 423 | 2.7 |

**Table 4-72. Naches Reach Flows by Year Type under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Year | Flow (cfs) *Alternative 1 – No Action* | Flow (cfs) *Alternative 5A* | Percentage Change |
|---|---|---|---|
| **Nonprorated Year (56 of 90)** | | | |
| Median (50% exceedance) | 1,189 | 1,213 | 2.0 |
| High (10% exceedance) | 3,616 | 3,560 | –1.5 |
| Low (90% exceedance) | 498 | 501 | 0.6 |
| **Prorated Year (15 of 90)** | | | |
| Median (50% exceedance) | 599 | 638 | 6.5 |
| High (10% exceedance) | 1,620 | 1,645 | 1.5 |
| Low (90% exceedance) | 344 | 338 | –1.7 |
| **Refill Year (19 of 90)** | | | |
| Median (50% exceedance) | 1,050 | 1,027 | –2.2 |
| High (10% exceedance) | 3,333 | 3,337 | 0.1 |

| Year | Flow (cfs) Alternative 1 – No Action | Flow (cfs) Alternative 5A | Percentage Change |
|---|---|---|---|
| Low (90% exceedance) | 481 | 480 | –0.2 |

### 4.3.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation of *Alternative 5B* would be the same as described in Section 4.3.7 (*Alternative 5A*) for the North Tunnel; however, KDRPP would be constructed at the south location as described in Section 4.3.5 (*Alternative 3*) rather than the east shore location. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.3.7 (*Alternative 5A*).

### 4.3.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation of *Alternative 5C* would be the same as described in Section 4.3.7 (*Alternative 5A*) for the North Tunnel; however, the KDRPP floating pumping plant would be constructed as described in Section 4.3.6 (*Alternative 4 [Preferred Alternative]*) rather than the east shore location. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.3.7 (*Alternative 5A*).

The means of providing for minimum stream flow under Alternative 5C in the Kachess River below Kachess Dam would be the same as under Alternative 2 (see Section 4.3.4.2).

### 4.3.10 Avoidance, Minimization, and Mitigation Measures

Implementation of *Alternatives 2* through *5* would have a positive impact on water supply, which is consistent with the goals of the Proposed Action. Instream flows would remain within current operations, so no mitigation would be needed. Pool levels would be reduced below existing conditions and no mitigation is proposed for this change.

In lengthening the period of drawdown below benchmark elevations in Kachess Reservoir, implementation of *Alternatives 2* through *5* could cause adverse effects to bull trout, which would not be able to access upstream tributaries below elevation 2,226. Mitigation in the form of fish passage improvements is described in Section 4.6.10, Fish.

In lengthening the period of drawdown below elevation 2,466 in Keechelus Reservoir, implementation of *Alternatives 2* through *5* could cause adverse effects to bull trout by preventing access to upstream tributaries.

# 4.4 Surface Water Quality

## 4.4.1 Methods and Impact Indicators

This section describes the impacts of the alternatives on water quality in Keechelus and Kachess reservoirs and in the Kachess and Yakima rivers.

**Methods.** The assessment of potential water quality impacts on surface waters is based on existing water quality data collected by Reclamation and WDFW and water body characteristics (e.g., reservoir depth and river flow) (Polack, 2016). Additionally, water quality modeling was conducted for Kachess Reservoir (PSU, 2017b,). The Kachess Reservoir CE-QUAL-W2 model was developed to generate mechanistic models of hydrodynamics and water quality in the reservoir and evaluate the impacts of KDRPP on the reservoir food web and water quality. The model domain was calibrated from 2014 to 2016 using local meteorological information and data collected by WDFW (Polacek 2016). Additional, simulations were conducted to evaluate specific scenarios with regard to the 2015 drought operations and how they could potentially impact water quality. Simulations were not conducted for the entire period of record, because there was not enough water quality data to ensure proper model calibration.

Existing water quality data includes on-going sampling and temperature profiles collected by the Department of Ecology’s Environmental Assessment Program and Reclamation Regional Office Water Quality Lab at Kachess and Keechelus Reservoirs.

**Impact Indicators.** Water quality methodology was used to determine changes to water quality. Significance of water quality changes were assessed based on water quality impact indicators that relate to applicable State surface water quality standards (Table 4-73) (WAC 173-201A) and the water resource conditions in Keechelus Reservoir and in Kachess Reservoir during drought operations and drought recovery for two areas: (1) within the reservoir pool, and (2) downstream from the reservoir (Table 4-74). State water quality standards (WAC 173-201A) specify limits for numerous physical and chemical water quality parameters. Water quality data and modeling conducted as part of the UW/PSU Foodweb study determined that parameters of concern were temperature and turbidity; therefore these are the parameters assessed in this FEIS (PSU, 2017a). Other State water quality standards (Such as DO, pH and nutrients) are not addressed in this FEIS because the project is not expected to affect those water quality parameters.

**Table 4-73. State Surface Water Quality Standards (173-201A)**

| Applicable Parameters | State Standard |
|---|---|
| Turbidity | State standard is maximum of 5 NTUs over background; values above this standard considered a negative impact |
| Temperature | State standards are as follows:<br><16°C (60.8°F) suitable for aquatic life use for core summer salmonid habitat[a]<br><12°C (53.6°F) suitable for aquatic life use for char spawning and rearing (Little Kachess basin)[a]<br>13°C (55.4°F) from September 15 to June 15 for the Yakima River downstream from Keechelus Reservoir to confluence of Kachess River<br>13°C (55.4°F) from September 15 to May 15 for the Yakima River downstream from the Kachess River confluence to the confluence with the Cle Elum River<br>Noncompliance with these standards considered a negative impact |

[a] When the background condition of the water is cooler than the standards defined in WAC 173-201A, the allowable rate of warming up to, but not exceeding, the numeric criteria from human actions are restricted as follows:

- 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).
- 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 (37.04°F).

### 4.4.2 Summary of Impacts

This section provides a summary of the water quality impacts for each of the alternatives and *Alternative 1 – No Action* (Table 4-74). The application of BMPs, which are part of each alternative (and compliance with permit requirements) would minimize water quality impacts of the action alternatives.

**Table 4-74. Summary of Impacts for Surface Water Quality**

| Impact Indicator | Summary of Impact |
|---|---|
| When the Kachess Reservoir pool level falls below the existing gravity outlet, turbidity or temperature exceeds State water quality standards | State water temperature criterion: 16°C (60.8°F)<br>*Alternative 1*: No change<br>All action alternatives: are less than 16°C(60.8°F)State turbidity criterion: State standard is maximum of 5 NTUs over background<br>*Alternative 1*: No change<br>All action alternatives: Localized, short-term exceedance of the standard |
| When the Keechelus Reservoir pool level is lowered due to water transfers to Kachess | State water temperature criterion: 16°C(60.8°F) |

| Impact Indicator | Summary of Impact |
|---|---|
| Reservoir, temperature exceeds State water quality standards | *Alternatives 1, 2, 3*, and *4:* No change<br>*Alternatives 5A*, *5B*, and *5C* are less than 16°C(60.8°F) |
| When water in the Yakima River or the Kachess River downstream from the dams exceeds the State water quality standard for temperature | State Water Temperature Criterion: 16°C(60.8°F)<br>*Alternative 1*: No change<br>All action alternatives: are less than 16°C(60.8°F) |

*Kachess Reservoir and Kachess River*

**Alternative 1- No Action.** No changes would occur in existing water quality conditions with *Alternative 1 – No Action*. Exceedances of State water quality standards in Keechelus Reservoir, in Kachess Reservoir or downstream in the Kachess River, Lake Easton or the Yakima River would continue (as summarized in Section 3.4).

**Alternative 2 and Alternative 3 – KDRRP East Shore and South Pumping Plants**. During drought operations, the KDRRP would pump from a lower level in the reservoir. Based on water temperature modeling results (PSU, 2017b), reservoir surface temperatures are predicted to increase by up to 1.5°C (2.7°F) during the last two weeks in September as compared to *Alternative 1*. At the end of the modeling scenario (end of September), reservoir surface temperatures are predicted to be approximately 1°C (1.8°F) warmer than those for *Alternative 1*., but these temperatures are within the normal temperature range for the reservoir (PSU, 2017b).

During periods of drawdown turbidity in Kachess Reservoir could occur (from wave action and overland runoff). However, no year-to-year effects would be expected because suspended material would be localized in distribution and would settle out as the reservoir slopes naturally regrade.

During droughts, flows in the Kachess River are predicted to increase to provide downstream drought relief compared to *Alternative 1*. Water temperatures in the pumping plant outflow are predicted to be cool (because water is being drawn from below the thermocline instead of off the surface of the reservoir), and to range between 5 and 6°C (41.0 to 42.8°F) compared to maximum water temperatures ranging from approximately 13 to 19°C (55.4 to 66.2°F) for *Alternative 1* reservoir outflows (PSU 2017b).

**Alternative 4 (Preferred Alternative).** Water quality modeling completed by PSU (2017b) (based on conditions during a recent drought year [2015]), predicts the reservoir surface temperatures to be 1 to 2°C (1.8 to 3.6°F) cooler as result of drought relief pumping (from August through September) as compared to *Alternative 1*. This reduction in reservoir surface temperature (relative to *Alternative 1*) is due to the reduction of nearshore shallow water and the difference in surface elevations between No Action and floating pumping plant operations.

The occurrence and impacts of turbidity would be similar to those described for *Alternatives 2 and 3*.

In the Kachess River, based on water quality modeling results completed by PSU (2017b), temperatures of the pumping plant outflow are predicted to be up to 1 to 2 °C (1.8 to 3.6°F) cooler than with *Alternative 1* (based on modeling of 2015, a drought year).

**Alternatives 5A, 5B, and 5C.** For *Alternatives 5A, 5B,* and *5C*, operations of KKC and pumping plant alternatives would change Kachess Reservoir surface temperatures similar to Alternative 2, 3, and 4. The temperature differences would be similar or less because of higher reservoir levels and inflow of cool water from Keechelus Reservoir with *Alternatives 5A, 5B,* and *5C* compared to *Alternatives 2, 3,* and *4*.

With KKC, water would be transferred from Keechelus Reservoir to Kachess Reservoir. Operations under *Alternatives 5A, 5B,* and *5C* would not increase contaminants.

For *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* and *Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment*, impacts on the Kachess River would be the similar to those described for *Alternatives 2* and *3*. For *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment*, impacts on the Kachess River would be similar to those described for *Alternative 4 (Preferred Alternative)* because the system would be operated much the same way.

*Keechelus Reservoir*

Water quality impacts on Keechelus Reservoir from operation of all action alternatives 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*. This may occur because the reservoir would be shallow allowing greater heating to occur. Keechelus Reservoir was not included in the drought operations surface temperature modeling completed by PSU (2017b). Releases from the reservoir would increase during drought recovery years to allow Kachess Reservoir to refill more quickly. This has the potential to occur during a period of 2 to 3 years after a drought during recovery (refill), where water surface elevations in the reservoir are predicted to be 18 feet lower than similar conditions under *Alternative 1* as a result of Keechelus Reservoir operations. Increased surface heating has the potential to increase water temperatures throughout the reservoir above the reservoir’s thermocline. Reservoir management operations would continue similar to conditions under *Alternative 1*. KDRPP would not alter the quantity or quality of reservoir inflows, resulting in no changes to water quality.

*Yakima River*

Keechelus Reservoir is upgradient of Lake Easton, and reservoir operations would remain similar to those of *Alternative 1* under all action alternatives, resulting in no water quality impacts. Downstream in the Yakima River, in the Keechelus reach, flows would be lower during the summer months (July and August). Lower flows in the river would create shallower water depths that may heat water more easily by solar radiation; however, the water would be moving through the channel with few locations to pool and warm. Additional exceedance of State temperature standards is not expected.

*Construction*

During construction, dredging of Kachess Reservoir substrate would be necessary for all alternatives. For dredging, inwater work areas would be isolated from the reservoir pool using such BMPs as silt curtains (or similar) that effectively isolate the dredging and dredged material placement areas from the main reservoir pool. Erosion and sediment control measures would minimize turbidity effects in construction areas.

*Extended Drought Conditions*

A drought is defined as conditions where water supply is expected to be 75 percent or less of the normal supply (as stated in RCW 43.83B.400 [established by the Washington State Legislature in 1989]). If a severe long-term drought occurs where water supply conditions are expected to be 75 percent or less of the normal supply for multiple years, water levels in the reservoirs could substantially drop. As Kachess Reservoir's water levels drop the amount of nearshore shallow water subject to heating would be reduced. This conclusion was supported by the results of the water temperature model completed by PSU (2017b) that showed reductions in reservoir surface temperatures (compared to *Alternative 1*) associated with lower reservoir water surface elevations that reduced nearshore shallow water. , Neither extended or multi-year drought, nor refill conditions were included in the PSU water temperature model and potential effects of these conditions are not quantified (PSU, 2017b).

### 4.4.3 Alternative 1 – No Action

#### *4.4.3.1 Kachess Reservoir*

Under *Alternative 1*, the reservoirs and their outflows would be managed the same as 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 the same as existing conditions (see Section 3.4) except that during long-term droughts, or if conditions worsen because of climate change, water levels in the reservoirs could drop substantially, potentially with effects on long-term water quality conditions for such parameters as DO and water temperature. Droughts and drought conditions have occurred in the past, with the most recent drought in 2015.

Kachess Reservoir would remain oligotrophic (nutrient-poor). Reservoir waters are cool and clear, with warmer water temperatures in the surface layer during the summer months when a thermocline is present.

#### *4.4.3.2 Kachess River*

With current operations, the mean daily temperature exceeds the State water quality temperature criterion of 16°C (60.8°F) during non-drought, drought, and drought recovery conditions (Section 3.4.4). For drought based on 2005 conditions, the river exceeded the State criterion of 16°C (60.8°F) for 70 days (19 percent of the calendar year). During drought recovery (based on 2006 conditions), the mean daily temperature exceeded the State water quality temperature criterion of 16°C (60.8°F) for 26 days (7 percent of the calendar year). The maximum mean daily temperature in the river was 20.3°C (68.5°F) during a drought year (based on 2005 conditions) and 19.1°C (66.4°F) during drought recovery. Under the No Action Alternative, it is expected that these conditions will continue.

#### *4.4.3.3 Yakima River*

In the Yakima River, immediately downstream from Easton, the river's waters exceeded the State surface water quality standard of 16°C (60.8°F) during non-drought, drought, and drought recovery conditions (Section 3.4.7). For drought conditions, the river exceeded the State criterion of 16°C (60.8°F) for 51 days (14 percent of the calendar year) (based on 2005 conditions). During drought recovery (based on 2006 conditions), the mean daily temperature exceeded the State water quality temperature criterion of 16°C (60.8°F) for 62 days (17 percent of the calendar year). The maximum mean daily temperature in the river was 18.3°C (65°F) during a drought year (based on 2005 conditions) and 18.9°C (66°F) during drought recovery.

Downstream in the Yakima River, implementation of the existing and proposed TMDLs would improve water quality for temperature and turbidity (as well as organochlorine pesticides).

### 4.4.4 Alternative 2 – KDRPP East Shore Pumping Plant

#### *4.4.4.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**

During construction, potential releases of hazardous substances, petroleum products and sediment would be avoided and minimized through applicable BMPs which are part of each alternative

*Construction Wastewater*

Construction wastewater is derived from sources such as rainfall and wash water on a construction site and for the KDRPP project would likely be generated in isolated or enclosed work areas, such as the Kachess Reservoir pool. Runoff or water that comes into contact with cement while it is curing is considered to be construction wastewater, which would be collected and conveyed to an appropriate location for treatment and disposal or discharge.

*Alternative 2* would include construction of the following main facilities near or in Kachess Reservoir or the 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

*Intake 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, *de minimis* amounts of construction wastewater could enter the receiving water. It is expected that impacts on water quality will be minimal because in water work areas would be isolated from the Kachess Reservoir pool thus, minimizing the risk of significant discharge of wastewater.

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 Kachess Reservoir.

During construction, barges would move equipment and materials to and from open-water work areas and would be used during 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 localized disturbance and removal of the reservoir bed. Appropriate inwater BMPs would be implemented in accordance with permit requirements to minimize any potential turbidity impacts on 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.

Dredging to prepare the intake location has the potential to create turbid conditions within the reservoir. However, the work area would be isolated from the reservoir pool using a turbidity curtain that floats from moored buoys. With the use of the turbidity curtain, potential impacts on the reservoir would be short-term and localized to the work area.

*Spoils Disposal Area*

Approximately 117,000 cy of excavated soil and rock would be generated during the construction phase of Alternative 2. Is it expected that the spoils will be disposed of at a certified disposal site, upland area, or in the historic spillway.

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 water quality impacts by preventing stormwater and untreated effluent from entering any receiving water. The historical channel spillway would be isolated from the Kachess Reservoir pool by a cofferdam. By implementing BMPs, no significant water quality impacts are expected.

*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.

**Volitional Bull Trout Passage Improvements**

The Volitional Bull Trout Passage Improvements could cause increased localized sediment disruption in Kachess Reservoir during construction, with the potential for increased turbidity. BMPs would minimize potential for turbidity entering the reservoir.

### *4.4.4.2 Operation*

**KDRPP East Shore Pumping Plant Facilities**

*Alternative 2* operations would have the potential to directly affect Kachess Reservoir and Kachess River water quality. Under this alternative, the management of Kachess Reservoir would change from current conditions during drought and drought recovery (refill). During drought and drought recovery, changes in Kachess Reservoir operations (e.g., reservoir volumes and surface water elevations) could affect reservoir and downstream water quality. Changes in stream flow could indirectly affect downstream water quality, with increased stream flow generally improving downstream water quality. However, during a severe or long-term drought, water levels in the reservoir could drop substantially, affecting water quality conditions (e.g., water temperature).

*Kachess Reservoir*

Reservoir operations during non-drought years would be similar to those of *Alternative 1*. 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 with respect to DO and temperature depends 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 are volume and pool elevation. The amount of reservoir surface heating is influenced by solar radiation, air temperatures, and wind conditions (O'Reilly et al., 2005). PSU completed a water temperature model (CE-QUAL-W2) of the Kachess Reservoir pumping operations based on the conditions of a recent drought year (2015) (PSU, 2017b). The modeled results were compared to those for *Alternative 1* to determine the potential impacts as a result of drought operations. The results of the water temperature modeling are described below in the temperature impacts discussion for a drought year (PSU, 2017b). However, extended or multi year drought or refill conditions were not included in the PSU water temperature model, and potential effects of those conditions are not quantified (PSU, 2017b).

During drought years and refill years, Kachess Reservoir operations would result in pool elevations substantially lower than would be the case under *Alternative 1*. Reservoir modeling predicts that the mean reservoir pool elevation would decrease by 15.9 feet from 2,236.3 to 2,220.4 (Section 4.3.4). Under *Alternative 2*, the mean residence time would fall from 659 to 580 days, a decrease of 79 days (Section 4.6.4). Effects on water quality are discussed below, based on the turbidity and temperature State surface water quality standards (Table 4-73).

**Turbidity.** As the reservoir pool levels lower, the area of exposed reservoir bed increases. This increased exposure of unvegetated areas could be a source of sediment input to the lowered reservoir pool (Dirnberger and Weinberger, 2005). The reservoir bed would continue to be exposed as the reservoir refills. If the bed is exposed during storms, particles on the bed may be carried by surface runoff as suspended sediment, enter the reservoir, and cause turbid conditions (Dirnberger and Weinberger, 2005). 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 would end when the reservoir bed stabilizes. No long-term impacts would be expected because suspended material would be localized in distribution and settle out as the reservoir bed stabilizes.

**Water Temperature.** PSU performed water temperature modeling (CE-QUAL-W2) of Kachess Reservoir and predicted results for *Alternative 2* pumping operations based on conditions of a recent drought year (2015) (PSU, 2017b). Reservoir surface temperatures are expected to vary by approximately 1.5°C (2.7°F) as a result of drought pumping for a one year period compared to *Alternative 1* for a model duration of August through September (PSU, 2017b). Based on the 2015 model results, reservoir surface temperatures in the epiliminion exceeded *Alternative 1* scenario by 1°C (1.8°F) as a result of pumping (at the end of the first year of drought recovery pumping). Modeling results further concluded that pumping would not significantly change the depth of the thermocline or water temperatures in the reservoir's hypolimnion (PSU, 2017b).

As the reservoir's water level drops, a deep storage pool would be maintained with minimal nearshore shallow water areas. This reduction of nearshore shallow water would limit the amount of reservoir heating. This conclusion was supported by the results of the water temperature model for the first year of drought completed by PSU (2017b) that showed reductions in reservoir surface temperatures when nearshore shallow water was reduced. Extended or multi-year drought or refill conditions were not included in the PSU drought conditions water temperature model and potential effects are not quantified (PSU, 2017b).

Based on predicted operations for *Alternative 2,* the mean hydraulic residence time during drought years (241 to 328 days) would be less than that during non-drought years (580 days) (see Section 4.6.4). This decreased residence time during droughts would help limit solar heating as well.

*Kachess River*

Reservoir operations during non-drought years would remain similar to those under *Alternative 1*. 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 2*.

During drought years, summer stream flow in the Kachess River downstream of the dam is predicted to increase substantially (Section 4.3.4). Changes in river flow attributable 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. Other parameters (e.g., 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 modeled flows fall within the existing flow regime.

**Turbidity.** Although summer stream flow during drought years would be higher than under *Alternative 1*, it would remain within the river's existing range for that time of year. Resultant adjustments to the bed and banks, if any, would be minimal. No increase in channel erosion, bank erosion, sediment load, or turbidity would occur.

Short-lived turbidity increases in 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 operation of *Alternative 2.*

**Water Temperature**. KDRRP would pump water from a lower level in the reservoir during droughts. This level would be below the thermocline of the reservoir that seasonally separates warmer surface water from cooler water at depth. Based on PSU (2017b) modeling results, the predicted pumping plant outflow temperature for the East Shore Pumping Plant is 5°C (41°F), which is notably cooler than temperatures predicted for *Alternative 1 – No Action* that are predicted to be as high as 19°C (66.2°F) during operations. No adverse impacts on water temperature in the Kachess River would occur as a result of *Alternative 2* drought pumping operations.

During extended droughts, as the reservoir's water levels continue to drop, a further reduction in the amount of nearshore shallow areas would occur limiting the amount of surface heating. Reservoir withdrawals have the potential to remain cooler (relative to *Alternative 1*) similar to a 1-year drought. However, extended or multi-year drought or refill conditions were not included in the PSU drought conditions water temperature model and potential effects are not quantified (PSU, 2017b).

*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's water temperatures would likely be cooler than those of Lake Easton because Lake Easton would 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 the river's cooler water. Cooler water is denser, and therefore inflow would likely sink to the hypolimnion until enough mixing has occurred and equilibrium is reached. However, temperature in Lake Easton is controlled primarily by the lake's physical characteristics (such as depth, surface area, and volume) and residence time, and not by Kachess River inflow. But, with the much cooler water temperatures predicted in the Kachess River (5°C) during a drought, a slight cooling effect may occur in the lake as a result of *Alternative 2* pumping operations.

*Keechelus Reservoir*

Water quality impacts on Keechelus Reservoir from operation of *Alternative 2* would not occur, with the exception of a potential increase in surface heating during drought recovery years when reservoir pool elevations are modeled to be lower than those under *Alternative 1*. These conditions have the potential to occur during a period of 2 to 3 years after a drought during recovery (refill), where the lowest water surface elevations in the reservoir are modeled to be 18 feet lower than similar conditions under *Alternative 1* (see Section 4.3.4.2). Increased surface heating has the potential to increase water temperatures throughout the reservoir above the reservoir's thermocline. Reservoir management operations would continue similar to conditions under *Alternative 1,* with minimal changes to surface water elevations and residence times. *Alternative 2* would not alter the quantity or quality of reservoir inflows, resulting in no changes to water quality. As part of mitigation (Section 4.4.10.2), a water quality monitoring program would be implemented to document changes in water quality, including the potential for surface heating as a result of lower surface water elevations modeled during drought recovery years.

*Yakima River*

**Keechelus reach**. Water quality in the Keechelus reach would be similar to conditions under *Alternative 1*. Water quality impacts on the Yakima River would not result from operation of *Alternative 2*. Flow regimes within the river would be similar to those under *Alternative 1* because upstream Keechelus Reservoir operations would not change. During drought years, flows in 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 2.*

**Easton reach.** During drought years, stream flow through the Easton reach would increase because of higher stream flow 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 46.7 and 32.3 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 2*.

**Parker reach.** A slight change in seasonal flows (maximum 1.3 percent) is predicted for flows in the Parker reach of the Yakima River relative to *Alternative 1* (Table 4-32 and Table 4-33 in Section 4.3.4). Water quality impacts on Parker reach would not occur as result of *Alternative 2*. Mean flow regimes within this reach of river would be similar to those of *Alternative 1*.

*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, and 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 the receiving water. These measures would reduce pollutant concentrations and minimize water quality impacts.

**Volitional Bull Trout Passage Improvements**

The Volitional Bull Trout Passage Improvements could cause increased localized sediment disruption in Kachess Reservoir during construction, with the potential for increased turbidity. BMPs would minimize potential for turbidity entering the reservoir.

No long-term water quality impacts are expected from operation of the Volitional Bull Trout Passage Improvements following construction.

### 4.4.5 Alternative 3 – KDRPP South Pumping Plant

#### *4.4.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

Construction impacts under *Alternative 3* would be similar to those described for *Alternative 2*, 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 2* 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 2*:

- 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 3* 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 required for *Alternative 2*. *Alternative 3* 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 would occur to a lesser extent than, those described for *Alternative 2*. BMPs similar to those described for *Alternative 2* (Section 4.4.4) would be implemented. *Alternative 3* would use jet grouting during intake construction. Appropriate construction BMPs would be developed to mitigate any potential water quality impacts related to the use of jet grouting during construction.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.4.4.1).

#### *4.4.5.2 Operation*

**KDRPP South Pumping Plant Facilities**

Water quality impacts attributable to operation of the alternative would be similar to those described for *Alternative 2* because Reclamation would operate KDRPP the same regardless of the pumping plant's location. The shorter overall length of access road required (690 versus 2,425 feet for *Alternative 2*) would generate a lesser degree of impact associated with the potential for suspended solids and accompanying turbidity from impervious surfaces. Based on PSU (2017b) water temperature modeling results for the south pumping plant during drought operations, the predicted pumping plant outflow temperature is approximately 5°C (41°F) to 6°C (42.8°F), which is notably cooler than temperatures predicted for *Alternative 1 – No Action* that are predicted to be as high as 19°C (66.2°F) during operations. No adverse impacts on water temperature in the Kachess River would occur as a result of *Alternative 2* drought pumping operations.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.4.4.2).

### 4.4.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

#### *4.4.6.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

Construction impacts under *Alternative 4 (Preferred Alternative)* would be similar in location to those described for *Alternative 3*; however, construction of *Alternative 4* would involve less land-based construction and no reservoir-bed intake. Instead, construction would involve construction of inwater elements such as anchor catenaries and piers to support the rigid pipe bridge that would support the conveyance from the floating pumping plant to the reservoir outlet works. However, the construction footprint for *Alternative 4 (Preferred*

*Alternative)* would be smaller than that of *Alternative 3* because it would not include a permanent on-shore pumping facility, resulting in less disturbance along the shoreline.

During construction, oil, grease, TPH, suspended sediment, nutrients, and construction wastewater could enter the 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*

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 Kachess Reservoir. BMPs would be implemented to minimize potential water quality risks.

*Turbidity*

Proposed dredging has the potential to create local, short-term turbidity impacts in the reservoir pool. To control turbidity from these activities, the dredging and dredged material placement areas would be isolated from the reservoir pool with a silt curtain. With the employment of the silt curtain, potential impacts on the reservoir would be short-term and localized to the work area.

Surface runoff that moves across disturbed soils during construction could pick up sediment and create turbid conditions (Kayhanian et al., 2001; Bruijin and Clark, 2003). Unpaved roadways used by construction vehicles and heavy equipment can generate runoff with high levels of sediment generated by ground disturbance. BMPs would be implemented to reduce the creation of sediment-laden runoff and prevent its discharge to receiving water.

*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 then disposal or discharge.

*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.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.4.4.1).

### *4.4.6.2 Operation*

**KDRPP Floating Pumping Plant Facilities**

*Alternative 4 (Preferred Alternative)* operations would have the potential to directly affect Kachess Reservoir and the Kachess and Yakima rivers' water quality. Under this alternative, the management of these resources would change from current conditions and would be different from the other action alternatives in that water would be withdrawn closer to the reservoir's surface, where water temperatures would be warmer than for the deeper withdrawal points for *Alternatives 2* and *3*.

*Kachess Reservoir*

Water quality modeling completed by PSU (2017b) (based on conditions during a recent drought year [2015]), predict the reservoir surface temperatures in the reservoir to be 1 to 2°C (1.8 to 3.6°F) lower as result of Alternative 4 (Preferred Alternative) (from August through September) as compared to *Alternative 1*. In September (at the end of the modeling period for the first year of drought recovery pumping September 29, 2015), reservoir surface temperatures are predicted to be approximately 1°C (1.8°F) cooler than for *Alternative 1*. This reduction in reservoir surface temperature (relative to *Alternative 1*) is due to the reduction of nearshore shallow water and difference in surface elevations between existing conditions and floating pumping plant operations.

If a severe long-term drought and drought recovery occurs, water levels in the reservoir would drop. As the reservoir's water levels drop, a reduction in the amount of nearshore shallow areas would occur limiting the amount of surface heating of remaining deep storage pool. Extended or multi-year drought or refill conditions were not included in the PSU drought conditions water temperature model and potential effects are not quantified (PSU, 2017b).

*Kachess River*

Reservoir operations would remain similar to those under *Alternative 1* except during drought and drought recovery. During drought years, summer stream flow in the Kachess River is predicted to increase substantially (Section 4.3.4). Changes in river flow attributable to project operations may alter physical conditions that affect water quality. Turbidity could be generated during periods of channel expansion (widening or down-cutting) from the erosive action of the water; however, this condition is not expected in the Kachess River because predicted flows fall within the existing flow regime for non-drought years.

**Turbidity.** Although summer stream flow during drought years would be higher than under *Alternative 1*, it would remain within the river's existing range. Resultant adjustments to the bed and banks, if any, would be minimal. No increase in channel erosion, bank erosion, sediment load, or turbidity would occur.

Short-lived turbidity increases in 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 operation of *Alternative 4 (Preferred Alternative).*

**Water Temperature**. During droughts, *Alternative 4 (Preferred Alternative)* would pump water from near the surface of the reservoir (the intake would be 18 feet below the water surface). Based on water quality modeling completed by PSU (2017b) for conditions during a recent drought year (2015), surface water temperatures in the epiliminion, and in the outflow from the pump station are predicted to decrease by 1 to 2°C (1.8 to 3.6°F) as a result of pumping compared to *Alternative 1* (PSU, 2017b). This condition would be the result of the reduction of the nearshore shallow water as the reservoir is drawdown, and would result in cooler water temperatures in the Kachess River compared to *Alternative 1*.

For *Alternative 4 (Preferred Alternative),* during extended droughts, water would continue to be withdrawn from the reservoir's surface layer (epilimnion) and pumped into the Kachess River. As the reservoir's water levels continue to drop, a further reduction in the amount of nearshore shallow areas would occur limiting the amount of surface heating. Reservoir withdrawals have the potential to remain cooler (relative to *Alternative 1*) similar to a 1-year drought. Extended or multi-year drought or refill conditions were not included in the PSU drought conditions water temperature model and potential effects are not quantified (PSU, 2017b).

*Lake Easton*

The Kachess River is a major tributary inflow into Lake Easton in addition to the Yakima River. During drought years, more inflow to Lake Easton from the Kachess River would result from pumping from Kachess Reservoir. Kachess River inflow during an extended drought and drought recovery has the potential to be cooler (1 to 2 °C [1.8 to 3.6°F]) than it would be under *Alternative 1* (see Water Temperature discussion above for the Kachess River).

*Keechelus Reservoir*

Results of operations of *Alternative 4 (Preferred Alternative)* would be the same as those described for *Alternative 2*.

*Yakima River*

**Keechelus reach**. No changes to water quality would occur upstream of Lake Easton in the Yakima River as a result of *Alternative 4 (Preferred Alternative)* operations.

**Easton reach**. During drought years, stream flow through the Easton reach would increase because of higher stream flow in the Kachess River. Based on modeling results using data from two recent drought years, 1994 and 2001, the mean July-to-August increase in flow would be 46.7 and 32.3 percent , respectively (Section 4.3.4, Surface Water Resources). The existing range of flow would not be changed by this flow increase.

A decrease in water temperatures is predicted to occur during drought and potentially for drought recovery (refill) years for *Alternative 4 (Preferred Alternative)* when compared with *Alternative 1*.

**Parker reach**. A slight change in seasonal flows (maximum 1.3 percent) is predicted for flows in the Parker reach of the Yakima River relative to *Alternative 1* (Section 4.3.4). Water quality impacts on Parker reach would not occur as result of *Alternative 4 (Preferred Alternative)*. Mean flow regimes in this reach of river would be similar to those of *Alternative 1*. With operations of *Alternative 4 (Preferred Alternative)*, additional water would be supplied downstream to Lake Easton for the KRD, Roza Dam, and Wapato Dam for the WIP.

*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, and 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 the receiving water. These measures would reduce pollutant concentrations and minimize water quality impacts.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.4.4.2).

## 4.4.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

### *4.4.7.1 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 the receiving water was provided previously for *Alternative 2* facilities (KDRPP East Shore Pumping Plant), which are also part of *Alternative 5A*. BMPs would limit the potential construction water quality impacts on Kachess Reservoir and the Kachess River. Water quality monitoring would be conducted during construction to ensure that the receiving water meets applicable permit provisions and applicable State surface water quality standards.

*Alternative 5A* would also include construction of the following main facilities necessary for construction of the KKC 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 and portals

*Yakima River Diversion, Intake, and Fish Screens*

The Yakima River diversion and intake structure would require work below the river's ordinary high water mark. 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, 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 sheet pile 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 with 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 used 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. Surface disturbance would occur at the ventilation shaft construction locations; however, this area would be small. With implementation of work area isolation BMP measures, impacts would be minimized.

Surface disturbance would be limited to construction of the tunnel portals. With implementation of work area isolation BMP measures, impacts would be minimized.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.4.4.2).

### *4.4.7.2 Operation*

**KKC North Tunnel Alignment Facilities**

*Alternative 5A* operations of KDRPP would be the same as *Alternative 2;* operations of KKC could affect 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*. For the downstream water resources in the study area, potential indirect water quality impacts would result from these upstream operational changes. However, these changes are not expected to increase violations of State surface water criteria.

*Kachess Reservoir*

Piping water from Keechelus Reservoir to Kachess Reservoir could change water quality in Kachess Reservoir. Reservoir modeling indicates that, relative to *Alternative 1*, the annual daily mean Kachess Reservoir pool elevation would decrease by 10.4 feet (Table 4-38). Reservoir modeling results predict an increase in the maximum reservoir pool elevation by 0.8 foot during a single-year drought (2001) and a decrease in the maximum reservoir pool elevation by 48.9 feet during the third year of a multi-year drought (1994) (Section 4.3.7). If a severe long-term drought occurs, or conditions worsen because of climate change, long-term conditions for water temperature would be affected.

Both reservoirs are currently 303(d) Category 5-listed for PCBs in fish tissue (see Section 3.4.1.1). Because both water bodies are listed, the transfer of water would likely not affect the PCB concentrations in fish tissue in Kachess Reservoir.

**Turbidity.** Under *Alternative 5A*, the source and impacts from turbidity would be similar as for *Alternatives 2, 3,* and 4.

**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, reservoir surface water temperatures can exceed the State surface water criterion of 16°C (61°F).

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 5A*, Kachess Reservoir would be less full than under *Alternative 1* but be fuller (from the Keechelus Reservoir inflow) than under *Alternative 2*. Water temperature modeling performed by PSU predicted results for *Alternative 2* pumping operations based on conditions of a recent drought year (2015) (PSU, 2017b). Reservoir surface temperatures are expected to vary by approximately 1.5°C (2.7°F) as a result of drought pumping compared to *Alternative 1* for a model duration of August through September (PSU, 2017b). Based on the 2015 model results, reservoir surface temperatures in the epiliminion exceeded the *Alternative 1* scenario by 1°C (1.8°F) as a result of pumping (at the end of the first year of drought recovery pumping). Modeling results further concluded that pumping did not significantly change the depth of the thermocline or water temperatures in the reservoir's hypolimnion (PSU, 2017b). PSU did not model *Alternative 5A;* however, the temperature differences would be similar or less because of a higher reservoir level and inflow of cool water from Keechelus Reservoir with *Alternative 5A* compared to *Alternative 2*.

During drought recovery after an extended drought, as Kachess Reservoir fills, the reservoir would begin to back up into the Little Kachess basin. The inflow from Keechelus Reservoir 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]); however, the extent or impact of this occurrence is not known.

*Kachess River*

Kachess River water quality impacts during operations would be similar for those of *Alternative 2.*

*Keechelus Reservoir*

Keechelus Reservoir management operations would resemble those under *Alternative 1*. KKC would not alter water quantity or quality of the reservoir's inflow tributaries. Hydraulic modeling predicts a decrease of 2.4 feet in the annual mean reservoir pool elevation, and the mean annual hydraulic residence time is predicted to decrease slightly (by 8 days) to 115 days (Table 4-82,Section 4.6.4.2). These changes would not result in long-term water quality impacts on Keechelus Reservoir.

**Water Temperature**. During single year drought conditions (2001), mean annual pool elevations are expected to increase by 6.9 feet (Table 4-43, Section 4.3.7) while minimum pool levels are expected to decrease by 1.7 feet. For multiyear drought conditions (1992 to 1994), a slight reduction (0.6 to 2.7 feet) in mean to minimum annual reservoir levels would occur. Modeled reservoir levels for *Alternative 5A* would fall within the range that would occur under *Alternative 1*. For this reason, impacts on water temperature are not expected from operation of *Alternative 5A*.

**Sediment and Turbidity**. Sources of sediment would not increase with *Alternative 5A*. The mean annual reservoir pool elevations would remain similar to those under *Alternative 1*, and large reservoir drawdowns would not occur (Section 4.3.7). 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 by 4.3 to 4.6 feet, increasing the area of reservoir bed exposed. This increase would occur during summer and during drought conditions, when the potential for surface runoff from a rain event would be at a minimum. Turbidity increases attributable to a runoff event during drought conditions, if any, would be short-lived. Operation of A*lternative 5A* would not cause turbidity impacts on Keechelus Reservoir.

*Yakima River*

**Keechelus reach**. Under *Alternative 5A*, the hydraulic model predicts that the river's mean annual flow (337 to 225 cfs) would decrease from existing conditions (Table 4-58, Section 4.3.7). Below the diversion, flows in Keechelus reach would be lower during the summer months (July and August). Lower flows in 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 stream flow. Additional exceedances of State temperature standards are not expected.

**Easton reach**. Water quality impacts on the Easton reach from operation of *Alternative 5A* would not occur. Water quality in this reach would remain similar to that of *Alternative 1*. 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 5A* would not occur. Flow regimes within the Parker reach would be similar to those of *Alternative 1*. A nominal decrease (0.5 percent) is predicted for flow in the main reach of the Yakima River annually (Table 4-68, Section 4.3.7). Therefore, no water quality impacts are expected downstream in this reach.

*Lake Easton*

Water quality impacts on Lake Easton from operation of *Alternative 5A* would be similar for those described for *Alternative 2.*

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.4.4.2).

### 4.4.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation of *Alternative 5B* would be the same as described in Section 4.4.7 (*Alternative 5A*) for the North Tunnel; however, KDRPP would be constructed at the south shore location as described in Section 4.4.5 (*Alternative 3*) rather than at the east shore location (*Alternative 2*). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.4.7 (*Alternative 5A*).

### 4.4.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation (with the exception of Kachess River and downstream) of *Alternative 5C* would be the same as described in Section 4.4.7 (*Alternative 5A*) for the North Tunnel; however, the KDRPP floating pumping plant would be constructed as described in Section 4.4.6 (*Alternative 4 [Preferred Alternative]*) rather than at the east shore location. Downstream in the Kachess River and Lake Easton, impacts from floating pumping plant operations would be similar to those described for *Alternative 4 (Preferred Alternative).* The cool water inflow from Keechelus Reservoir may have a cooling effect on surface water temperatures (above the thermocline), resulting in cooler water discharges to the Kachess River when operational relative to *Alternative 4 (Preferred Alternative)*. Impacts of construction and operation the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.4.7 (*Alternative 5A*).

### 4.4.10 Avoidance, Minimization, and Mitigation Measures

#### *4.4.10.1 Construction*

Construction activities associated with the action alternatives have the potential to adversely affect water quality. During construction of KDRPP and bull trout passage improvements at the Narrows, project proponents 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. For work in Kachess Reservoir, project proponents 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.

Project proponents would use 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 Stormwater 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
  - Temporary covering of stockpiled materials
  - Temporary use of silt curtains during dredging and dredged material placement
- 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 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.
- 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 Kachess Reservoir.
- Jet grouting would be used for *Alternatives 3 and 5B*; water quality BMPs would be developed to minimize water quality impacts associated with jet grouting.
- Procurement of equipment would preclude components containing any toxic substances listed under the Toxic Substance Control Act.

#### *4.4.10.2 Operation*

Reclamation would coordinate with Ecology to continue a surface water quality monitoring program. Based on the preferred alternative, Reclamation and Ecology would continue to evaluate monitoring data and conduct further analysis, as warranted, during final design to refine estimates of water quality impacts and evaluate design modifications that would minimize or avoid those impacts. As warranted, Reclamation and Ecology, in coordination with Roza, would develop appropriate mitigation to address water quality impacts.

As noted in Section 4.4.10.1, once the project is constructed, continued monitoring of site conditions and erosion potential would be conducted to provide adaptive management of any identified long-term erosion problems that affect surface water quality. Reclamation would continue its existing shoreline monitoring program for Kachess and Keechelus reservoirs. If water quality or 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. The measures would be implemented to minimize effects include the following:

- Limit drawdown rates to not more than approximately 1 foot per day, to allow for drainage and pore pressure relief in saturated soil along the shoreline (from Section 4.2.10.2)
- Perform an annual survey of the reservoir rim to identify emerging erosion or slope stability issues and plan mitigation corrective measures, if necessary (from Section 4.2.10.2)
- 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 (from Section 4.2.10.2)
- WDFW and Ecology would review and approve any corrective erosion control measures prior to implementation (from Section 4.2.10.2)

Implementation of BMPs such as those described above would be effective in minimizing erosion and soil loss during operation of the project. Additionally, continuation of the water quality monitoring program will support design efforts to minimize or avoid 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. Impacts were evaluated using available hydrogeologic data, from investigations developed for the project feasibility design reports, and from groundwater monitoring conducted by Ecology (see Section 3.5 for additional information).

**Impact Indicators.** Two potential impact indicators are associated with the alternatives: changes to groundwater supply due to changes in Kachess Reservoir pool levels and KKC construction (Table 4-75). Impacts would be expected if lower groundwater levels resulted in decreased groundwater levels and supply.

**Table 4-75. Impact Indicators for Groundwater**

| Issues | Impact Indicators |
|---|---|
| Potential reduced access to groundwater supply due to change in water table impacted by Kachess pool level | Loss of groundwater supply at a level compromising property use due to a change in Kachess Reservoir pool level below elevation 2,192.75 at potentially affected wells |
| KKC construction activities lowering groundwater elevation levels | Groundwater elevations not returning to preconstruction groundwater levels |

## 4.5.2 Summary of Impacts

*Alternative 1 – No Action* would not affect groundwater because no construction or changes to reservoir operations would occur. In addition, no known adverse impacts on groundwater resources are 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.

*Alternative 2 – KDRPP East Shore Pumping Plant* and *Alternative 3 – KDRPP South Pumping Plant* will require minor dewatering during construction and are not expected to decrease groundwater contributions to streams, springs, wetlands, and water wells. *Alternative 4 (Preferred Alternative)* construction is not expected to require dewatering or to affect groundwater contributions to streams, springs, wetlands, or nearby wells. *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment, Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment,* and *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment* would likely require substantial dewatering during construction and could result in temporary impacts on groundwater levels. In turn, these effects on groundwater levels could cause temporary impacts on groundwater contributions to streams, springs, and wetlands and impacts on water levels in nearby wells. Construction activities for any alternative could affect groundwater quality through inadvertent spills; however, these potential impacts would be minimized through the use of construction BMPs.

Operation of *Alternatives 2, 3, 4, 5A, 5B,* and *5C* may lower groundwater levels in adjacent aquifers and potentially interrupt well operations.

Volitional Bull Trout Passage Improvements at the Narrows would not be anticipated to affect groundwater.

Table 4-76 summarizes impacts on groundwater.

**Table 4-76. Summary of Impacts for Groundwater**

| Impact Indicator | Summary of Impact |
|---|---|
| Loss of groundwater supply at a level compromising property use due to a change in Kachess Reservoir pool level below elevation 2,192.75 at potentially affected wells | *Alternative 1* would not affect groundwater contributions to wells.<br>Construction of *Alternatives 2* and *3* may require minor dewatering and is not expected to decrease the water supply to wells.<br>Construction of *Alternative 4 (Preferred Alternative)* is not expected to require dewatering or negatively affect groundwater contributions to wells.<br>Operation of *Alternatives 2, 3, 4, 5A, 5B,* and *5C* may result in temporary decreased groundwater levels in shallow aquifers adjacent to the reservoir, potentially decreasing the groundwater supply to some wetlands, springs, streams, or wells. |
| Groundwater elevations not returning to preconstruction groundwater levels | Construction of *Alternatives 5A, 5B,* and *5C* would require substantial dewatering and could result in temporary impacts on groundwater levels. |

## 4.5.3 Alternative 1 – No Action

Under *Alternative 1*, 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 described in Section 3.12, climate change could affect future water availability in the Yakima River basin. Under *Alternative 1*, current trends in water supply for the proratable irrigation districts would continue. Climate change could result in reduced groundwater recharge because reduced water supply could lead to less water delivered for crops, thus reducing conveyance losses that recharge aquifers. Groundwater pumping during droughts would continue, requiring continued and potentially increased use of drought relief wells, most of which are downstream from the Parker stream gage and serve proratable water users. Additionally, climate change would likely affect the occurrence and extent of wetlands and springs through 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 2 – KDRPP East Shore Pumping Plant

### *4.5.4.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**

Excavation of the pumping plant shaft would use a combination of hydro-mill and slurry wall techniques in the upper (soil) area and drill-and-blast methods in the lower (bedrock) area. These methods may require minor dewatering of ground water to control seepage, but use of a slurry wall would not require large-scale dewatering to lower groundwater levels to the base of the shaft. Seepage water that does enter the excavation would be collected in sumps, pumped to the surface, treated with a sediment removal BMP, and returned to Kachess Reservoir. The intake tunnel would be constructed using drill-and-blast methods. The tunnel would be sealed as it is constructed, and major dewatering that would influence groundwater levels would not be required. Construction of the power transmission line would also not require any dewatering.

The pipeline from the pumping plant to the Kachess Dam discharge pool would be constructed on the reservoir floor and might require dewatering depending on the reservoir elevation during construction. The dewatering system would likely involve installation of temporary well points in the area where active excavation, installation, welding, backfilling, and compaction would occur. The dewatered area would move along slightly in advance of the area being constructed and would terminate soon after completion of compaction. Dewatering discharge would be routed to a sediment removal BMP prior to final discharge back to Kachess Reservoir. During final design, project proponents would develop a Kachess Reservoir operation and management plan for the construction period. This plan would consider the operational constraints that may affect the construction schedule.

Portions of the associated discharge structures including the stilling basin and channel would be constructed below the water table and some shallow (estimated less than 5 feet) dewatering may be required. If dewatering is required, it is anticipated that groundwater seeping into the open excavation would be collected in sumps and pumped to a sediment removal BMP, such as a sediment trap or filter box, positioned near the construction area, and the treated water would be discharged to the Kachess River.

Dewatering systems would include a water treatment method to remove suspended solids before discharge, so that the quality of discharge would meet acceptable water quality standards. Dispersal of the discharge into the adjacent wooded areas at the project site is likely permissible with the use of appropriate erosion control BMPs. The *Alternative 2* elements that require dewatering would not substantially affect groundwater levels and would be temporary. Therefore, no changes to groundwater contributions to streams, springs, wetlands, or nearby wells are anticipated. Groundwater rights held by local residents and other entities are similarly not expected to be affected by KDRPP construction.

Construction activities could affect groundwater quality through 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. A domestic well is near the primary construction staging area and would be protected. WSDOH requires a 100-foot radius well protection zone, centered on the wellhead, wherein hazardous materials cannot be stored or used. However, the well protection zone can be driven on and have non-hazardous materials stored within its radius. BMPs would be implemented to prevent and minimize the potential for spills, as described in Section 4.4; therefore, groundwater quality impacts are unlikely.

**Volitional Bull Trout Passage Improvements**

Construction of the Volitional Bull Trout Passage Improvements at the Narrows, including the roughened channel, flow bifurcation weir, and flow isolation berm, would be completed during low pool levels and is not expected to require dewatering of groundwater. No changes to groundwater contributions to streams, springs, wetlands, or nearby wells are anticipated.

### *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, to a proposed minimum elevation of 2,112.75. The drawdown could last from 2 to 5 years, though during most of that time the pool elevation would be well above the minimum elevation and at many times it would be within the current range of elevations under existing conditions (see Section 4.3.4.2). 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 shallow groundwater supply to nearby wetlands, springs, streams, or wells.

As described in Section 3.5, Ecology performed groundwater level monitoring in six wells in the primary study area to better understand the potential impact of KDRPP operation. Because groundwater levels generally mimic topography, and are about 60 feet below land surface in the affected area, only areas topographically close to the reservoir are likely to exhibit groundwater elevations in the inundated zone that could be affected by lowered reservoir elevations. Three 100-foot topographic zones are shown in Figure 4-12, along with the six wells monitored by Ecology and the general locations of other wells. The red zone shown in Figure 4-12 represents the area where the surface elevation is up to 100 feet above the maximum elevation of the reservoir. The five monitoring wells shown to be influenced by reservoir elevations as described in Section 3.5 are all located in the red zone. The sixth monitoring well (Carlson well) is outside the red zone and apparently not in an area that is influenced by reservoir operations. The wells in the red zone located in the Yakima River valley southeast of the Keechelus Reservoir are not expected to be affected by Kachess Reservoir operations given the topographic flow divide that separates them from Kachess Reservoir. It is estimated that, of the approximately 107 wells in the primary study area, only about 15 wells are located in areas that could be affected by KDRPP (Ecology, 2016d). KDRPP reservoir drawdown may reduce water levels by as much as 80 feet in these wells, including the well at the USFS Kachess Campground, during a 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.

Static groundwater elevations are not expected to drop below the reservoir elevation because the reservoir is the discharge location for groundwater in the valley.

Wells located below Kachess Reservoir near Lake Easton and the town of Easton are not anticipated to be negatively affected by KDRPP operations. These wells are located outside the red zone shown in Figure 4-12. Wells near Lake Easton and the town of Easton that are hydraulically connected to the Kachess River or Lake Easton are not expected to be affected by Kachess Reservoir operations during maximum reservoir drawdown since water levels in the Kachess River and Lake Easton would be maintained by KDRPP operations.

Springs located above the reservoir, including the spring-fed infiltration gallery that serves Kachess Community Association, are supplied from upslope groundwater contained in bedrock fractures that are separated from the reservoir by impermeable bedrock and are, therefore, not anticipated to be affected by reservoir operations. Below the dam, wetlands and springs that potentially feed the wetlands may be affected by KDRPP reservoir drawdown. This could result in periodic shifts in wetland vegetation below the dam, as indicated in Section 4.7, Vegetation and Wetlands. Minor shifts or changes in wetland extent would be mitigated using the methods described in Section 4.7.10, Vegetation and Wetlands.

At the proposed minimum elevation of 2,112.75 during KDRPP operation, the groundwater seepage through the Narrows is expected to be 0.3 to 2.6 acre-feet per day greater than at current low pool conditions, depending on the hydraulic conductivity of the materials. Groundwater seepage through the Narrows would be less while the reservoir is being drawn down and during refill operations. The increased groundwater seepage through the Narrows while Big Kachess is drawn down is expected to result in drainage from Little Kachess Reservoir, but the impact would be minimal relative to the amount of water stored in Little Kachess. No adverse impacts on Little Kachess are anticipated because of increased groundwater seepage through the Narrows resulting from KDRPP operation.

Implementation of KDRPP would increase streamflow during the irrigation season (April to October) in the Yakima River from Easton to Wapato Dam during drought years. In addition, proratable irrigation districts (KRD, RID, and WIP) would have an increased water supply during drought years (see Section 4.3). The increased streamflow could potentially cause a small increase in 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 via conveyance losses. These beneficial effects related to increases in groundwater recharge in drought years 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 downstream from the Parker stream gage and serve proratable water users.

Operational activities could affect groundwater quality through inadvertent spills from fuel storage tanks resulting in groundwater contamination. Spills could occur at the storage tanks or during fuel tank refilling. BMPs would be implemented to prevent and minimize the potential for spills; therefore, groundwater quality impacts are unlikely.

### Volitional Bull Trout Passage Improvements

Operation of the roughened channel and flow splitter at the Narrows is not expected to affect groundwater resources. These project elements would interact with surface water and would be separate from groundwater. No changes to groundwater contributions to streams, springs, wetlands, or nearby wells would occur.

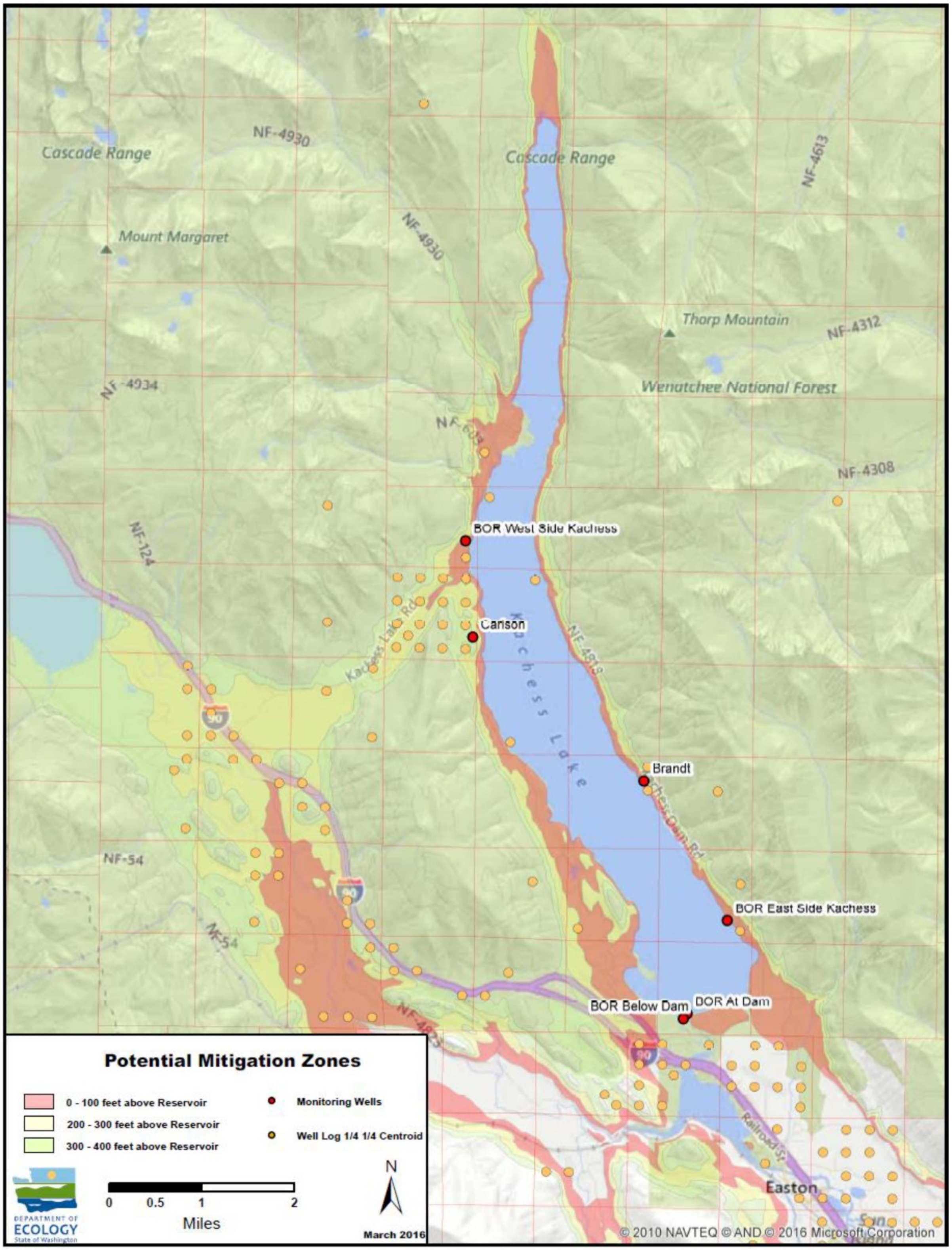



**Figure 4-12. 100-foot Topographic Elevation Zones around Kachess Reservoir**

## 4.5.5 Alternative 3 – KDRPP South Pumping Plant

### *4.5.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

The pumping plant shaft would be constructed using hydro-mill and slurry wall techniques. These methods may require minor dewatering to control seepage, but use of the slurry wall would not require large-scale dewatering to lower groundwater levels to the base of the shaft. Similar methods would be used to construct the surge tank shaft. Seepage water that does enter the excavations would be collected in sumps, pumped to the surface, treated with a sediment removal BMP, and returned to Kachess Reservoir. The intake tunnel would be constructed using a TBM. The intake tunnel would be sealed as it is constructed, and major dewatering that would influence groundwater levels would not be required.

Dewatering systems would include a water treatment method to remove suspended solids before discharge, so that the quality of discharge would meet acceptable water quality standards. If the release of sump water to Kachess Reservoir is problematic, then dispersal of the discharge into adjacent wooded areas at the project site is likely permissible with the use of appropriate erosion control BMPs. The *Alternative 3* elements that require dewatering would not impact groundwater levels outside the construction zone and would be limited to the period of construction. Therefore, no changes to groundwater contributions to streams, springs, wetlands, or nearby wells are anticipated.

Construction activities that could affect groundwater quality are the same as those discussed for *Alternative 2*.

Reclamation would implement BMPs to prevent and minimize potential for spills, and groundwater quality impacts are unlikely.

**Volitional Bull Trout Passage Improvements**

Construction activities that could affect groundwater quality are the same as those discussed for *Alternative 2* (Section 4.5.4.1).

### *4.5.5.2 Operation*

**KDRPP South Pumping Plant Facilities**

Operation impacts on groundwater would be similar to those described for *Alternative 2* (Section 4.5.4.2). Reclamation would operate KDRPP the same regardless of the location of facilities.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.5.4.2).

## 4.5.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.5.6.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

Construction of the floating pumping plant facilities would not require substantial dewatering of groundwater. The flow control structure would be constructed using cellular sheet piles that would serve as both a cofferdam during construction dewatering and as a permanent structure. Dewatering behind the cofferdam would involve reservoir water, and no groundwater impacts would occur. The control building, storage building, switchyard, and transmission line would be land-based structures using standard construction techniques with concrete slabs on grade or footings and would require little or no dewatering. Construction of *Alternative 4 (Preferred Alternative)* is not expected to affect groundwater levels. No changes to groundwater contributions to streams, springs, wetlands, or nearby wells are anticipated.

Construction activities that could affect groundwater quality are the same as those discussed for *Alternative 2* (Section 4.5.4.1).

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.5.4.1).

### *4.5.6.2 Operation*

**KDRPP Floating Pumping Plant Facilities**

Impacts under *Alternative 4 (Preferred Alternative)* would be the same as those under *Alternative 2* (Section 4.5.4.2). Reclamation would operate KDRPP the same regardless of the location of the facilities.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.5.4.2).

## 4.5.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

### *4.5.7.1 Construction*

*Alternative 5A* would include construction of the KDRPP East Shore Pumping Plant (*Alternative 2*) and the KKC North Tunnel Alignment. The impacts from construction and operation of these components of the KDRPP east shore portion of this alternative would be the same as described for *Alternative 2* (Section 4.5.4). Impacts of the KKC North Tunnel are described below.

**KKC North Tunnel Alignment Facilities**

Construction of *the KKC North Tunnel Alignment* would involve substantial dewatering to lower groundwater levels for the portion of the pipeline constructed in the Yakima River valley west 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 contracted the development of a groundwater flow model to evaluate the decrease in groundwater levels and pumping rates needed for construction (Reclamation and Ecology, 2014c). Groundwater levels would need to be decreased up to 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 approximately 1,000 feet to the southeast to a settling basin to remove suspended solids and then returned to the aquifer using several 3-acre rapid infiltration basins. These basins would be constructed downgradient from the dewatering system in the existing glacial outwash deposits. Reclamation would develop a dewatering plan and complete a hydrogeologic study to design the dewatering system and determine the effects on groundwater levels, groundwater wells, and river flow. 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.

Lowering of the water table in the immediate vicinity of the pipeline due to drought relief pumping would result in reduced groundwater discharge to the wetland mitigation area located east of Keechelus Dam for a 1-year period. Impacts on this wetland (described in Section 4.7.7) or springs in the immediate vicinity would be temporary. Any reduction in groundwater levels downgradient from or outside the immediate area of dewatering are expected to be minor, 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 would likely be no decrease in groundwater levels in the two groundwater wells located at the permanently closed Crystal Springs campground (see well numbers15 and 157 in Figure 3-15) southeast of the construction dewatering area. These wells are nearly 1 mile from the dewatering area and close to the Yakima River, and the level of the river would determine the groundwater levels in the wells. Groundwater levels would reestablish to natural conditions when construction-related dewatering is completed.

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 2* (Section 4.5.4.1). Reclamation would implement BMPs to prevent and minimize the potential for spills, and groundwater quality impacts are unlikely.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.5.4.1).

### *4.5.7.2 Operation*

**KDRPP East Shore and KKC North Tunnel Alignment Facilities**

Operation of KKC is not anticipated to negatively affect groundwater. No dewatering would be required during operations, and the proposed tunnel would not interact with groundwater or change groundwater migration patterns. 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.

Operating KKC would have a positive effect on the Kachess Reservoir pool level during KDRPP operation. As described in Section 4.3.7, the combined KDRPP and KKC would lower the Kachess Reservoir pool below elevation 2,220 for 14 fewer days per year than with KDRPP operation alone. This means that *Alternative 5A* could reduce the duration of operation effects on groundwater levels compared with *Alternative 2*. However, *Alternative 5A* would still have the potential to lower groundwater levels around Kachess Reservoir and thus decrease the groundwater supply to nearby wetlands, springs, streams, and wells. The potential impacts on wells would be mitigated using the methods described in Section 4.5.10.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.5.4.2).

## 4.5.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 3* (Section 4.5.5.1). Impacts associated with the North Tunnel would be the same as those discussed in *Alternative 5A* (Section 4.5.7.1). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.5.7 (*Alternative 5A*).

## 4.5.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 4 (Preferred Alternative)* (Section 4.5.6.1). Impacts associated with the North Tunnel would be the same as those discussed for *Alternative 5A* (Section 4.5.7.1). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.5.7 (*Alternative 5A*).

### 4.5.10 Avoidance, Minimization, and Mitigation Measures

Project proponents would implement the following measures to minimize or mitigate potential impacts on groundwater associated with the action alternatives:

- During construction project proponents would prevent or minimize potential adverse effects on groundwater quality from inadvertent spills through compliance with regulatory requirements and use of construction BMPs. Storage of hazardous materials would not be allowed within 100 feet of water supply wells. These BMPs are described further in Section 4.4 and Chapter 2.
- Project proponents will continue to monitor a representative group of wells near Kachess Reservoir to determine whether groundwater levels are lowered by additional reservoir drawdown attributable to the action alternatives and will coordinate with affected parties on a case-by-case basis. Although a majority of these uses are junior in priority to Reclamation's water rights, which have a May 10, 1905 priority date, if well water levels fall and water yields in specific wells are adversely affected to the point that property uses are compromised, then mitigation will be applied even though such mitigation is not required under the priority system for water rights under Washington State law. Mitigation options may include but are not limited to: changing the intake elevation of a pump, deepening the well, or drilling a new well. Mitigation measures would be compliant with applicable laws. In a worst-case scenario, project proponents might have to drill up to 15 new wells in the red zone shown in Figure 4-12. In the event this occurs, interim deliveries of potable water would be made while the original well is out of service to ensure that the property use can be maintained consistent with prior use. Once mitigation is completed, future maintenance of the well and associated works is the responsibility of the property owner. Mitigation would not apply to wells installed following publication of the ROD approving the project. (Note: Drilling a new well likely would not require additional NEPA review because it is categorically excluded from NEPA review once it is ensured there are no extraordinary circumstances present. If required, additional NEPA and other environmental compliance will be conducted, as needed.)

Wetlands that may be adversely affected by changes in groundwater levels would be monitored and mitigated as described in Section 4.7.10.

## 4.6 Fish

### 4.6.1 Methods and Impact Indicators

**Methods**. The assessment of impacts on fish was based on a review of previous studies and planning efforts in the upper Yakima River 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 (Table 4-77). Quantitative changes in flow and pool elevations were based on hydrologic modeling using data from 1926 to 2009, as described in Section 4.3. Quantitative changes in water temperature in response to each pumping strategy were modeled to estimate effects on Kachess Reservoir and the outflow to the Kachess and Yakima rivers (PSU, 2017b). In addition, potential associated changes in salmonid growth were estimated based on potential changes in temperature and zooplankton abundance in Kachess Reservoir (PSU, 2017b). Food web interactions between predators and prey were directly measured and modeled under varying conditions Kachess Reservoir to support evaluation of impacts on kokanee that may result from KDRPP (Hansen, 2017).

The severity of an impact is influenced by its duration. Short-term impacts are not expected to persist once construction activities have been completed. Long-term impacts would occur after construction has been completed and are associated with operation of the pump station and drawdown of Kachess Reservoir. Discussions of impacts on Middle Columbia River (MCR) steelhead and bull trout are not included in this section (see Section 4.9). Impacts on nonnative sport fish are not considered because these fish are stocked. This section therefore focuses on native fish that are not threatened or endangered.

**Table 4-77. Impact Indicators for Fish**

| Issues | Impact Indicators |
|---|---|
| Water temperature | Increase in Kachess Reservoir and Kachess River water temperatures |
| River flow in Keechelus reach | Seasonal decrease in Keechelus reach flow (spring 50% exceedance) |
| River flow in Easton reach | Seasonal increase in Easton reach flow (summer 50% exceedance) |
| Increase in turbidity | Turbidity over State water quality standard (5 NTUs) |
| Decrease in hydraulic residence time | Reduction in food-base |
| Reduction in reservoir volume | Concentration of predatory fish and their prey in a smaller space causing predation rate and competition between predators to increase |
| Reduction in habitat complexity | Reduction in habitat complexity that substantially limits or eliminates habitat features used by native fish species at different life history stages (e.g., incubation, rearing, or spawning). Habitat features can be lost due to removing riparian vegetation, removing inwater structures, or preventing natural habitat-forming processes |
| Disturbance from construction or operations | Increases in noise levels or vibrations that cause injury or displace fish from rearing, spawning, foraging, or using migratory corridor habitats |
| Entrainment of fish during operations | Increased rate of entrainment of resident fishes from reservoir habitats into downstream habitats |

## 4.6.2 Summary of Impacts

The effects of each alternative on the specified impact indicators is described below and summarized in Table 4-78.

**Table 4-78. Summary of Impacts for Fish**

| Impact Indicator | Summary of Impact |
|---|---|
| Increase in Kachess Reservoir and Kachess River water temperatures | *Alternative 1*– No change<br>*Alternatives 2*, *3*, , *5A,* and *5B,*– Decrease Kachess Reservoir surface temperatures 1 to2°C (2 to 4°F) in mid-August, increase surface temperatures up to 1.5°C (3°F) in late September<br>Alternatives 4 and 5C – Decrease Kachess Reservoir surface temperatures 1 to 2 °C (2 to 4 °F) in August-September<br>*Alternatives 2*, *3*, 4, *5A, 5B,* and *5C* – Decrease Kachess River water temperature |

| Impact Indicator | Summary of Impact |
|---|---|
| Seasonal decrease in Keechelus reach flow (spring 50% exceedance) | *Alternative 1* – 350 cfs<br>*Alternatives 2, 3,* and *4* – 357 cfs<br>*Alternatives 5A*, *5B,* and *5C* – 288 cfs |
| Seasonal increase in Easton reach flow (summer 50% exceedance) | *Alternative 1* – 534 and 694 cfs in drought years (1994 and 2001)<br>*Alternatives 2*, *3* and *4* – 784 and 918 cfs in drought years<br>*Alternatives 5A*, *5B* and *5C* – 794 and 984 cfs in drought years |
| Change in turbidity over State water quality standard (5 NTUs) | State turbidity criterion: State standard is maximum of 5 NTUs over background<br>*Alternative 1*: No change<br>All action alternatives: Localized, short-term exceedance of the standard |
| Reduction in food-base | *Alternative 1* – Baseline<br>*Alternatives 2*, *3, 4, 5A, 5B* and *5C* – Decreased hydraulic residence time and lower minimum reservoir levels would reduce available prey in Kachess Reservoir |
| Concentration of predatory fish and their prey in a smaller space causing predation rate and competition between predators to increase | *Alternative 1* – Baseline<br>*Alternatives 2*, *3, 4, 5A, 5B* and *5C* – lower minimum reservoir levels would cause more overlap between predator and prey species |
| Reduction in habitat complexity that substantially limits or eliminates habitat features used by native fish species at different life history stages (e.g., incubation, rearing, or spawning). Habitat features can be lost due to removal of riparian vegetation, inwater structures, or preventing natural habitat-forming processes | *Alternative 1* – Baseline<br>*Alternatives 2*, *3, 4, 5A, 5B* and *5C* – Construction of new facilities, staging areas and roads would reduce shoreline vegetation adjacent to Kachess Reservoir.<br>Lower minimum reservoir levels 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 measures to ensure no net loss of wetlands. |
| Increases in noise levels or vibrations that cause injury or displace fish from rearing, spawning, foraging, or using migratory corridor habitats | *Alternative 1* – Baseline<br>*Alternatives 2, 3, 4, 5A, 5B,* and 5C – during project construction increased noise levels may affect fish in Kachess Reservoir<br>*Alternatives 4* and *5C* – Operations of pumps may disturb fish near the floating pumping plant barge |
| Increased rate of entrainment of resident fishes from reservoir habitats into downstream habitats | *Alternative 1* – Baseline<br>*Alternatives 2, 3, 4, 5A, 5B,* and *5C* – increase risk of entrainment of juvenile or small resident fish (other than salmon and trout) |

**Water Temperature**. Under *Alternative 1 – No Action*, current operations would continue and water temperatures would remain the same as existing conditions except if conditions worsen because of climate change. Under *Alternative 2 – KDRPP East Shore Pumping Plant*, *Alternative 3 – KDRPP South Pumping Plant*, *Alternative 5A – KDRPP East Shore*

*Pumping Plant with KKC North Tunnel Alignment, and Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment* the reduced Kachess Reservoir minimum pool elevation would reduce surface water heating in the upper 20 meters of the water column during the summer months by reducing the amount of inundated shallow near shore area around the edge of the natural Lake Kachess basin (PSU, 2017b). The natural Lake Kachess basin is deep and steeply sloped and less vulnerable to solar heating. All pumping scenarios would cause reservoir surface temperatures to be 1 to 2°C cooler than under *Alternative 1* in late August. By the end of the pumping season (end of September) surface temperatures would be approximately 1°C warmer than under *Alternative 1*.Temperatures would remain below the state water quality criteria for salmon of 16°C (60.8°F) throughout the pumping season.

Under *Alternative 4 (Preferred Alternative)* and *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment*, Kachess Reservoir surface temperatures are predicted to be 1 to 2°C (1.8 to 3.6°F) cooler as result of drought relief pumping (from August through September) as compared to *Alternative 1* (PSU, 2017b). This reduction in reservoir surface temperature (relative to *Alternative 1*) is due to the reduction of nearshore shallow water and the difference in surface elevations between No Action and floating pumping plant operations.

Under *Alternatives 2, 3, 5A,* and *5B,* cooler water would be pumped from a greater depth than currently withdrawn from under *Alternative 1*. This cool water would be conveyed to the Kachess River and would result in lower temperatures downstream in the Kachess River (see Section 4.4.2). In drought and refill years, decreased water temperatures would benefit salmonids in the Kachess River. In addition, under *Alternatives 2* and *3,* cool water withdrawn from greater depths than under *Alternative 1* may reduce the amount of cold water habitat in the reservoir, resulting in decreased productivity of zooplankton, degraded thermal refugia for predator and prey species, and the creation of direct competitive interactions between predators on shared prey resources. Deep water withdrawals are predicted to reduce salmonid growth in August and September compared to *Alternative* 1 (PSU, 2017a).

Under *Alternatives 4* and *5C,* water pumped from closer to the surface of Kachess Reservoir (18-foot depth) would reduce water temperatures in the Kachess River slightly during drought relief pumping in summer months compared with *Alternative 1.* Under *Alternatives 4* and *5C*, pumping water from the epilimnion of Kachess Reservoir may degrade the productivity of zooplankton that inhabit the lake's warmer surface waters. The effects of surface withdrawal on salmonid growth are predicted to be small compared to *Alternative 1* (PSU, 2017a).

**River Flow**. Under *Alternative 1,* snowmelt and runoff patterns associated with climate change may reduce Reclamation's operational flexibility to meet instream flow requirements.

Under *Alternatives 2, 3,* and *4,* streamflow in the Kachess River would be higher than under *Alternative 1* during summer in drought years.

Under *Alternatives 2, 3*, and *4,* decreased flows during July to August of drought years during summer (June 16 to October 31) in the Keechelus reach would reduce water velocities that are currently too high for rearing fish, closer to the flow target of 500 cfs.

Under *Alternatives 2, 3*, and *4,* increases in annual instream flows, and in July to August instream flows during drought years in the Easton reach, would decrease the quantity of rearing habitat available to spring Chinook and rainbow trout subyearlings, resulting in a negative impact on these species during drought years.

Under *Alternatives 2, 3,* and *4,* increased spring flows would benefit outmigrating smolts of anadromous species, which would address an instream flow objective for the Easton reach and would provide a benefit to salmon.

Under *Alternatives 5A*, *5B*, and *5C*, KKC reduced spring flows in the Keechelus reach would result in an adverse impact on outmigrating smolts of anadromous species. Overall, mean summer flows would be reduced by over 50 percent and would provide a benefit to instream flow conditions in the Keechelus reach in summer. In addition, *Alternatives 5A, 5B, and 5C* would 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; *Alternatives 5A, 5B*, and *5C* would maintain the current fall and winter base flow of 100 cfs.

**Turbidity**. *Alternative 1* would not cause turbidity impacts. Under *Alternatives 2, 3, 4, 5A, 5B,* and *5C,* construction activities associated with upland and inwater work would temporarily increase turbidity levels, resulting in negative impacts on fish. 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 or other surface water bodies. Collected water would be conveyed to an appropriate location for necessary treatment and disposal or discharge.

Under *Alternatives 2, 3, 4, 5A*, *5B,* and *5C,* the reduction in Kachess Reservoir minimum pool elevation would expose the lower reservoir bed to wave action and increase turbidity along the reservoir's perimeter during and immediately following runoff events (no more than a few days) but would end when the reservoir bed stabilized. This impact is expected to reduce the feeding efficiency of predators that visually locate prey during this time, however no long-term impacts would be expected because suspended material would be localized in distribution and settle out as the reservoir bed stabilizes.

**Nutrients**. Under *Alternative 1*, nutrient levels in the primary study area are not expected to change. Under *Alternatives 5A, 5B*, and *5C*, the addition of nutrients through the conveyance of water from Keechelus Reservoir to Kachess Reservoir would cause a small increase in the productivity of Kachess Reservoir.

**Hydraulic Residence Time**. Under *Alternatives 2, 3, 4, 5A, 5B,* and *5C,* decreased hydraulic residence time, slight cooling of surface temperatures, and lower minimum reservoir elevation in Kachess Reservoir would decrease prey availability. The largest decrease in hydraulic residence time is expected under *Alternatives 5A, 5B,* and *5C.* Under *Alternatives 2, 3,* and *4*, the decrease in hydraulic residence time in Keechelus Reservoir during and after droughts would reduce the food-base for fish

**Habitat Compression.** Under *Alternative 1*, habitat compression is not expected to occur. Under *Alternatives 2, 3, 4, 5A, 5B,* and *5C*, reductions in water surface elevation, slight reductions in surface temperature, and the smaller volume of Kachess Reservoir would put large predator fish such as burbot and northern pikeminnow in closer proximity to potential prey species such as kokanee and pygmy whitefish, resulting in greater overlap among species. However, habitat compression is not expected to result in unsustainably high predation rates that would cause declines in the abundance of prey species. Under *Alternative 1*, climate change is expected to increase water temperatures and demand on the food-base by fish present in Kachess and Keechelus reservoirs. However, the food-base is expected to be sufficient to support increased prey consumption rates (Hanson et al., 2017). Under *Alternatives 4* and *5C*, pumping water from the epilimnion of Kachess Reservoir may degrade the productivity of zooplankton that inhabit the lake's warmer surface waters.

**Habitat Complexity**. Under *Alternative 1*, habitat complexity is expected to remain similar to historic conditions. Under *Alternatives 2, 3, 4, 5A, 5B,* and *5C*, shoreline vegetation would be reduced by construction of new pumping facilities and roads adjacent to Kachess Reservoir. Habitat complexity would be reduced due to greater fluctuations in Kachess Reservoir levels, reductions in Kachess Reservoir minimum elevation, and lower reservoir levels in Keechelus Reservoir following drought years.

**Change in Reservoir Levels**. Under *Alternative 1*, lower reservoir levels attributable to climate change could have a negative impact on connectivity between the two historical lake basins of Kachess Reservoir. Under *Alternatives 2, 3, 4, 5A, 5B,* and *5C*, the reduction in Kachess Reservoir operating level (at times up to 80 feet below existing low pool conditions [elevation 2,192.75]) would also have a negative impact on within-reservoir habitat connectivity and could result in stranding or isolation of fish between Little and Big Kachess basins. The construction of a roughened channel to facilitate volitional passage between the basins would reduce the impact of lower reservoir elevations and provide a benefit to connectivity within Kachess Reservoir habitats during drought relief pumping. In addition, during periods when the Big and Little Kachess basins already separate under existing conditions (occurring in 83 out of 91 years modeled, for 111 days average per year), the roughened channel would provide passage opportunities that are not currently available to fish.

Under *Alternative 1*, climate change may reduce reservoir levels and decrease access between reservoir and tributary fish habitats, particularly in Big Kachess. Under *Alternatives 2, 3, 4, 5A, 5B,* and *5C*, the reduction in Kachess Reservoir operating level (up to 80 feet below existing low pool conditions) would have a negative impact on fish passage and connectivity between reservoir and tributary habitats compared with *Alternative 1*, particularly in Big Kachess where tributaries such as are currently connected.

**Disturbance**. Under *Alternative 1*, no noise-based disturbance is anticipated. Under *Alternatives 2, 3, 4, 5A, 5B,* and *5C*, increased noise levels during construction would have a temporary negative impact on fish. Under *Alternatives 4* and *5C*, operation of the floating pumping plant would cause noise and vibration that would likely disturb fish in close proximity.

**Entrainment**. Under *Alternative 1*, the entrainment risk to fish is not expected to change from current conditions. Under *Alternatives 2, 3, 4, 5A, 5B,* and *5C*, there is an increased risk of entraining resident fishes (other than salmon and trout) with small larval or juvenile stages in the new intake in Kachess Reservoir. Entrainment would increase when larger volumes of water are withdrawn from the reservoir and for *Alternatives 3, 4,5B, and 5C*, when pumping water from relatively shallow areas (less than 50 feet) where larval and juvenile fish are more likely to occur

**Disease and Invasive Species.** Under *Alternative 1*, there is a risk of new fish diseases being introduced to Kachess and Keechelus reservoirs through the proposed and ongoing efforts to reintroduce anadromous species above the reservoir dams. Under *Alternatives 5A, 5B,* and *5C*, the KKC poses an additional risk of fish disease and invasive species introductions from Keechelus Reservoir to Kachess Reservoir through the conveyance of water. Construction activities that introduce large equipment or boats into the water that have been used in other aquatic areas create a risk of introducing invasive aquatic species, such as zebra mussels and quagga mussels that can alter native ecosystems.

## 4.6.3 Alternative 1 – No Action

### *4.6.3.1 Kachess Reservoir*

Under *Alternative 1*, 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 River basin. Reservoir elevations would fluctuate within the existing range as 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*, reservoir operations would continue to cause seasonal passage problems at tributaries such as Box Canyon Creek and the Kachess River, and passage problems into tributaries of the lower Kachess Reservoir may become exacerbated. 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 become braided and too shallow for fish to pass (e.g., Reiss et al., 2012).

Kachess Reservoir would remain relatively unproductive (oligotrophic), 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).

Under *Alternative 1*, climate change is expected to change the periodicity of runoff and reduce the net amount of runoff available to refill the reservoir.

The shifts in runoff quantity and timing shown by the model results would pose a risk to the water supply, including instream flow for fish. 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 for irrigators and instream flow for during the high-demand period.

Simulated existing Keechelus and Kachess reservoir water surface elevations under the baseline (historical) and adverse climate scenarios are described in Section 3.12. 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 reduced 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; Mantua et al., 2010; Schindler, 2001). Reduced inflow and lower reservoir levels may change the reservoir's hydraulic residence time 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 abundance, diversity, or distribution of freshwater shellfish may be similarly affected. 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*, passage barriers would continue to be a problem for resident fish and would worsen with climate change.

Potential changes in 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 negative impacts.

**Kachess River**

Under *Alternative 1*, 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, representing an adverse impact on fish. 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). The reach's flow regime and short length reduce its habitat value relative to other reaches in the basin. The Kachess River is a "Lower Priority" instream flow reach, with no flow objectives identified in the Integrated Plan (Reclamation and Ecology, 2012). Because habitat functions in the reach are already substantially impaired by baseline operations, changes occurring under *Alternative 1* are unlikely to improve conditions for fish and increases in Kachess Reservoir temperatures with climate change would negatively impact fish downstream in the Kachess River.

**Keechelus Reservoir**

Under *Alternative 1*, 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 River basin. Operations under *Alternative 1* would be similar to those of existing conditions, affecting spring Chinook and coho salmon. 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 and Cold creeks. When the reservoir is at lower elevations, seasonal fish barriers form where the creeks cross the reservoir bed's dewatered portion. 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 Figure 3-38 through Figure 3-39 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 in 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 above.

Under *Alternative 1*, no actions to improve tributary passage, reduce tributary dewatering events, expand available tributary habitat, or improve the reservoir prey base would occur (Section 4.6.10). 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 in the reservoir.

### Yakima River

Under *Alternative 1*, 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 River 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 Yakima River flow would be closer to flow objectives because less water would be available in, and delivered from, Keechelus Reservoir.

Under *Alternative 1*, flows within the Keechelus reach would remain at undesirably high levels from July through early September, when juvenile Chinook (and potentially coho if reestablished) are rearing in this reach (Table 4-79). 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 notable 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 1*, this target is attained only 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 4-79. Percentage Attainment of Seasonal Instream Flow Targets, Keechelus Reach of the Yakima River**

| Flow Criterion | Winter | Spring | Summer (July) | Summer (August) | Fall |
|---|---|---|---|---|---|
| Target (cfs) | ≥100.0 | ≥100.0 | Reduce to 500 | Reduce to 120 | ≥100.0 |
| ***Alternative 1*** | | | | | |
| Attainment[a] | 67.6 | 82.8 | 1.0 | 11.8 | 68.2 |
| ***Alternatives 2, 3,* and *4*** | | | | | |
| Attainment[a] | 71.3 | 85.0 | 3.7 | 12.7 | 72.3 |
| Change[b] (%) | 3.7 | 2.2 | 2.7 | 0.9 | 4.1 |
| ***Alternatives 5A, 5B,* and *5C*** | | | | | |
| Attainment[a] | 69.1 | 81.3 | 93.8 | 96.1 | 70.1 |
| Change[b] (%) | 1.5 | –1.5 | 92.8 | 84.3 | 1.9 |

Note: Data are based on 1925 to 2009 period of record.
[a] Percentage of years when instream flow target would be met for period of record.
[b] Change relative to *Alternative 1.*

Under *Alternative 1*, flows during winter would remain lower than recommended (Reclamation and Ecology, 2011c). Lower flows would 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*, 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 by adding flow during the fall and winter (Reclamation and Ecology, 2011c). Currently, instream flow targets are not always met (Table 4-80). In addition, the adverse climate change scenario shows that the winter and spring target flows in the Easton reach would be met 7 to 22 percent less frequently, and the fall flows would be 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 Keechelus and Kachess reservoirs 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 4-80. Percentage Attainment of Seasonal Instream Flow Targets, Easton Reach of the Yakima River**

| Flow Criterion | Winter | Spring | Summer | Fall |
|---|---|---|---|---|
| Target (cfs) | ≥250.0 | ≥250.0 | ≥250.0 | ≥220.0 |
| ***Alternative 1*** | | | | |
| Attainment[a] | 64.3 | 76.3 | 72.4 | 69.5 |
| ***Alternatives 2, 3,* and *4*** | | | | |
| Attainment[a] | 64.7 | 76.3 | 66.4 | 71.0 |
| Change[b] (%) | 0.4 | 0.0 | -6.0 | 1.5 |
| ***Alternatives 5A, 5B,* and *5C*** | | | | |
| Attainment[a] | 64.3 | 75.4 | 66.8 | 70.5 |
| Change[b] (%) | 0.0 | -0.9 | -5.6 | 1.0 |

Note: Data are based on 1925 to 2009 period of record.
[a] Percentage of years when instream flow target would be met for period of record.
[b] Change relative to *Alternative 1.*

Under *Alternative 1*, the availability of water supply to provide spring flow pulses to benefit spring Chinook, coho, and sockeye outmigrants would be limited. Properly timed flow pulses are expected to improve outmigration success rates (Reclamation and Ecology, 2011c).

Snowmelt is critical for refilling reservoirs and meeting irrigation needs, so substantial 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 affect instream flow requirements for salmonids. Over time, this could cause negative impacts.

## 4.6.4 Alternative 2 – KDRPP East Shore Pumping Plant

### *4.6.4.1 Construction*

#### KDRPP East Shore Pumping Plant Facilities

*Kachess Reservoir*

Construction of the *Alternative 2* 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 2* are expected to result in the following negative impacts on fish and habitat in 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.
- 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 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. Approximately 75.5 acres would be cleared (18 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 in 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 in the reservoir. Higher turbidity can reduce the productivity of aquatic ecosystems (Henley et al., 2000), reduce prey detection for visual predators (Gregory and Levings, 1998; Hansen et al., 2013), and reduce growth and alter fish behavior (Sigler et al., 1984). Increases in turbidity would occur during and immediately after the 3-year construction window but would be limited by the use of sediment and erosion control measures at upland locations and by the deferral of construction activities in the reservoir until periods of reservoir drawdown. For inwater sediment dredging and deposition, the work area would be isolated by cofferdams or turbidity curtains used to minimize the extent of turbidity impacts on the immediate area where sediments are removed or placed. 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 or other surface water bodies. Short-term turbidity increases caused by construction would not cause long-term impacts on fish habitat. Fish species that may be disturbed by turbidity include shallow-water species listed previously and deepwater species such as burbot and pygmy whitefish.

Inwater work that uses equipment or boats that have been used in other water bodies would create the risk of introducing invasive aquatic species that can alter aquatic ecosystems, such as zebra mussels or quagga mussels. Kachess Reservoir experiences high boating activity, and the increase in the number of boat launchings, and therefore the increase in the risk of invasive species introductions, would be minimal. The risk of introductions can be minimized by washing equipment prior to transfer into water in accordance with State guidelines.

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 sound's frequency and intensity (Mitson and Knudsen, 2003). For the construction activities proposed for *Alternative 2*, blasting would generate the most notable increase in noise and vibrations that would cause avoidance behavior or injury. For salmonids, hearing occurs through the particle motion component of sound (Hawkins and Johnstone, 1978). The behavioral response threshold for salmonids is about 80 decibels referenced to 1 micrometer per second squared (80 dB/1 $\mu m/s^2$; Hawkins, 2015) which is equivalent to acceleration of 0.01 $m/s^2$. Activities that create sound and vibrations exceeding this threshold are likely to cause avoidance behavior and, at higher intensities, injuries or mortality may occur. Monitoring for high-intensity sound and vibrations associated with activities such as blasting may be performed during construction. If the behavioral threshold is exceeded, bubble curtains or other sound- and vibration-reducing BMPs would be used.

*Kachess River*

*Alternative 2* would require construction of a discharge spillway at the headwaters of the Kachess River immediately downstream from 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 near these activities. The types of impacts resulting from shoreline disturbance and turbidity on fish for KDRPP East Shore Pumping Plant facilities are described below.

*Keechelus Reservoir*

No construction activities for *Alternative 2* would occur at Keechelus Reservoir. All project facilities would be downstream from Keechelus Dam. No construction-related impacts would occur.

**Volitional Bull Trout Passage Improvements**

Volitional Bull Trout Passage Improvements would require construction of the following project elements:

- Roughened channel nature-like fishway
- Flow bifurcation weir

- Flow isolation berm
- Hill slope stabilization soldier pile wall

The construction would begin at upland locations to provide an access road to the construction site and a laydown area for staging. Activities would involve clearing, grubbing, and rough grading, followed by gravel surfacing. The lowest elevation to which the roughened channel would be constructed during this initial construction season is approximately 2,192.75 feet, the lowest pool elevation that can be attained prior to proposed operation at the lower pool elevation.

In addition to the upland work, several project elements would be constructed on the floor of Kachess Reservoir and would require vehicle access, excavation, or other activities that would disturb sediments as part of the construction process. The construction activities for the reservoir floor elements would be performed “in-the-dry,” but may contribute to temporary increases in turbidity in the reservoir during runoff events. These activities include constructing the Volitional Bull Trout Passage Improvements at the Narrows including the roughened channel, access roads, and staging areas for the west shore access route to the Narrows.

Construction at upland locations and on the floor of the reservoir would cause a temporary reduction in habitat complexity and an increase in turbidity during the construction period. These impacts are the same as those for the construction of the KDRPP East Shore Pumping Plant facilities discussed in Section 4.6.4.1.

The construction of a roughened channel to create Volitional Bull Trout Passage Improvements at the Narrows between Little Kachess and Big Kachess basins would require inwater work that may temporarily reduce fish passage between the two basins. All inwater work would adhere to Federal, State, and local regulatory requirements. The timing of all inwater work would be subject to work windows that minimize the disturbance to fish and other aquatic and terrestrial species in the project area.

During construction of the bifurcation weir and upstream end of the roughened channel, flows would be either partially or completely diverted from the existing channel that connects the two to allow construction access to bed materials and to prevent fish from encountering major construction activities. This would prevent fish passage through the existing channel, even if pool levels would otherwise permit passage during the construction period. The flow diversion would be limited to the period of construction, and the reduction in fish passage would be temporary.

Construction of the full length of the roughened channel would be tied to drought relief pumping that lowers the pool level in Big Kachess and therefore may need to occur in phases over multiple years as the reservoir is drawn down to successively lower elevations. The final and lowermost reach of the roughened channel can be constructed only when the new, minimum pool level is reached. In each of these construction phases, during pool drawdown while construction is under way, fish would not be able to access the roughened channel.

### *4.6.4.2 Operation*

**KDRPP East Shore Pumping Plant Facilities**

*Kachess Reservoir*

Under *Alternative 2*, reservoir pool elevations are predicted to decrease relative to *Alternative 1* (Section 4.3) based on RiverWare modeling of historic conditions (modeled years 1926 to 2015). The lowered Kachess Reservoir elevation in drought years would reduce connectivity between reservoir basin habitats during some periods, reduce connectivity between reservoir and tributary habitats, reduce the food-base for fish (benthic invertebrates and zooplankton), limit the productivity of freshwater shellfish, reduce habitat complexity, and reduce water temperatures 1 to 2°C (PSU, 2017a).

Under *Alternative 2*, lower reservoir levels would result in more frequent and greater separation of the historical Kachess and Little Kachess lake basins at the Narrows within Kachess Reservoir, reducing within-reservoir connectivity for fish species if no passage mitigation is provided. Based on RiverWare modeling of historic conditions (modeled years 1926 to 2015), Kachess Reservoir would be below the level at which the two basins become separated (elevation 2,220) in 76 out of 90 years modeled, an increase of 3 years from *Alternative 1* (see Table 4-39 in Section 4.3.7). The mean duration would have been 154 days per year, an increase of 76 days per year compared to *Alternative 1*. An increase in duration of separation between the upper and lower lake basins represents a negative impact for connectivity within reservoir habitats. During drought years and while reservoir elevations remain below elevation 2,220, fish passage between the basins would have been reduced, preventing access to spawning and rearing habitats necessary for reproductive success, cover, refugia, and prey.

Following drought years, the inability to refill the reservoir to normal operating levels may also contribute to existing passage issues for resident fish between tributary and reservoir habitats (Ackerman et al., 2002; Reiss et al., 2012). Under *Alternative 2*, Kachess Reservoir would be below the level at which fish passage into Kachess River tributary streams is impeded (elevation 2,226) in 85 out of 90 years modeled, an increase of 2 years from *Alternative 1*. The mean duration would be 171 days per year, an increase of 60 days per year compared to *Alternative 1*. The increased duration of reduced tributary access would represent a negative impact for connectivity between tributary and reservoir habitats.

Loss of connectivity between tributaries and Kachess Reservoir would reduce the availability of tributary and reservoir habitats for spawning, rearing, and foraging and could expose fish to stranding in tributaries or higher predation levels. Existing resident fish species, and sockeye and coho that may be introduced in the future, would be affected by passage impediments. The increased duration of low reservoir elevations would affect lower Kachess Reservoir tributaries (Gale Creek, Thetis Creek, and Lodge Creek) which were assessed as potential habitats that could support anadromous salmonids under future restoration scenarios (Reclamation, 2005b).

Food-web modeling suggests that top predators in Kachess Reservoir currently rely on a diversity of fish prey that feed on both benthic invertebrate and open-water zooplankton prey, in contrast to Keechelus Reservoir where predators rely mainly on fish that feed on open-water zooplankton prey (Hansen et al., 2017). The difference between reservoir food webs is likely due to extensive drawdowns in Keechelus Reservoir that expose the substrate for months at a time and limit benthic productivity. Reductions in Kachess Reservoir elevation and persistence of lower elevations for longer periods (2 to 5 years to refill the reservoir, occurring in 8 instances over the period of record 1926 to 2015) under *Alternative 2* would reduce the abundance of benthic invertebrate prey for fish and reduce shallow shoreline area preferred by small fishes like redside shiner (Hansen et al., 2017). Although the relationship between pool elevation and benthic invertebrate prey diversity and abundance has not been evaluated for Kachess Reservoir, fluctuations in the water level of aquatic habitats may reduce the diversity and quantity of benthic organisms (Fisher and LaVoy, 1972) that provide food for fish. Aquatic invertebrates that are intolerant of direct exposure to air cannot survive long periods out of water (Fisher and LaVoy, 1972) and would be vulnerable to prolonged exposure during drought and subsequent refill years. The benthic invertebrate community in Kachess Reservoir is already very limited and has been reduced by existing operations (Mongillo and Faulconer, 1982). Further reductions and fluctuations in operational elevations would affect those remaining invertebrate species, particularly in nearshore shallow-water habitats (Hansen et al., 2017). The benthic community includes freshwater shellfish for which distribution and abundance are currently not well documented in Kachess Reservoir but could be adversely affected by more prolonged exposure of reservoir bed materials to air. Decreased availability of benthic invertebrate prey would negatively affect fish species by increasing pressure on the open-water zooplankton prey population. Fishes potentially affected include all reservoir species: mountain whitefish, cutthroat trout, rainbow 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 abundance of the zooplankton food-base would be incrementally reduced by shorter hydraulic residence times under *Alternative 2* operations as compared with *Alternative 1*. Over the entire range of years considered in the modeling described in Section 4.3, Surface Water Resources (1926 to 2015), average hydraulic residence time drops from 659 days under *Alternative 1* to 580 days under *Alternative 2*. In drought years, larger declines in hydraulic residence time are expected. The hydraulic residence time for conditions similar to the 1994 drought would be reduced by 562 days under *Alternative 2* compared with *Alternative 1*. Under conditions similar to the 2001 drought, the hydraulic residence time under *Alternative 2* would be reduced by 420 days compared with *Alternative 1*.

Additional hydrodynamic modeling is needed to estimate reductions in zooplankton abundance (Beauchamp, 2016), but the biomass and diversity of zooplankton is typically positively correlated with hydraulic residence time (Obertegger et al., 2007). Because zooplankton is an important source of food for fish in Kachess Reservoir (Hanson et al., 2015; Mongillo and Faulconer, 1982) and because alternative prey is scarce (Mongillo and Faulconer, 1982), reduced zooplankton abundance would likely diminish the survival and productivity of fish that feed on zooplankton (Dettmers et al., 2003; Welker et al., 1994).

The reduced abundance of fish that feed on zooplankton would also reduce the amount of prey available for predatory fish species (McQueen et al., 1986), such as cutthroat trout and rainbow trout, which feed on smaller fish. All reservoir fish species would likely be affected by a loss of zooplankton prey during drought years because the existing reservoir ecosystem relies heavily on zooplankton as a food source (Mongillo and Faulconer, 1982). Future restoration of sockeye salmon would also be negatively affected because juvenile sockeye feed primarily on zooplankton in reservoir habitats.

**Table 4-81. Kachess Reservoir Mean Hydraulic Residence Times in Days**

| Modeled Year | *Alternative 1* | *Alternatives 2, 3,* and *4* | Change | *Alternatives 5A, 5B,* and *5C* | *Change* |
|---|---|---|---|---|---|
| **1926–2015** | | | | | |
| Annual | 659 | 580 | –79 | 512 | –147 |
| Annual maximum | 995[a] | 960[b] | –35 | 777[c] | –218 |
| Annual minimum | 396[d] | 214[e] | –182 | 208[f] | –188 |
| **1994 (Drought Year)** | 803 | 241 | –562 | 253 | –550 |
| **2001 (Drought Year)** | 748 | 328 | –420 | 333 | –415 |

Note: Calculations are based on the total reservoir volume, including active and inactive storage.
[a] Year of highest *Alternative 1* maximum = 2005
[b] Year of highest *Alternatives 2, 3,* and *4* maximum = 1967
[c] Year of highest *Alternatives 5A, 5B,* and *5C* maximum = 1964
[d] Year of lowest *Alternative 1* minimum = 1934
[e] Year of lowest *Alternatives 2, 3,* and *4* minimum = 1931
[f] Year of lowest *Alternative 5A, 5B,* and *5C* minimum = 1931

Under *Alternative 2*, habitat compression would result from reductions in elevation of the Kachess Reservoir, concentrating predators and prey in a smaller volume of water. In addition, lower temperatures in the epilimnion may remove a temperature barrier that prevented kokanee from foraging at the surface in summer; kokanee that spend more time at the surface may be more exposed to predation by northern pikeminnow and burbot (Hansen et al., 2017). However, based on recent hydroacoustic evaluations, food-web modeling indicated that an increase in predator density, such as conditions that could be observed with greater drawdown, would not reduce prey abundance to a point that would lead to unsustainable predator-prey interactions, as long as kokanee continue to be stocked at current levels (Hansen et al., 2017).

Under *Alternative 2*, habitat complexity would be reduced compared with *Alternative 1* by losses of shoreline vegetation and displacement of riparian habitat by new facilities, and the presence of overwater structures that shade or displace natural habitat.

Lower reservoir levels during and after drought years would reduce the duration that shallow shoreline habitat is in contact with shoreline vegetation (Busch and Smith, 1995) that provides cover and habitat complexity for fish (Braatne et al., 2007; Tabor and Wurtsbaugh, 1991). The overwater structures and displacement of vegetation associated with development of the east shore boat ramp adjacent to the reservoir would also reduce shoreline habitat complexity and the productivity of habitat for littoral resident fish species (Sass et al., 2006).

Under *Alternative 2*, lower reservoir levels after drought years would reduce water temperatures 1 to 2°C through reduced area of shallow near shore areas exposed to solar heating during the summer months (Section 4.4.4.2; PSU, 2017b). The benefit of slightly lower reservoir temperatures resulting from *Alternative 2* operations would be small compared to temperature increases caused by climate warming. Based on projections for the 2040s, the number of weeks that water temperatures exceed the thermal tolerance of salmon and trout (21°C [70°F]) may rise from less than 5 weeks in historical conditions to over 10 weeks (Section 3.12.2; Mantua et al., 2009). The combined effect of *Alternative 2* and climate change would be a decrease in the quantity, accessibility, and suitability of reservoir and tributary habitats and a decline in the survival and productivity of trout and salmon (Eaton and Scheller, 1996; Mantua et al., 2010; McCullough, 1999; Schindler, 2001). Therefore, during drought years and subsequent refill years, *Alternative 2* would slightly reduce water temperature and fish resources in Kachess Reservoir, but likely not enough to counteract the negative impact of warming due to climate change. Water temperature effects for prolonged droughts lasting multiple years are not quantified, however the reduction in nearshore shallow water due to lower reservoir water levels limits the amount of reservoir heating.

Under *Alternative 2,* water would be withdrawn from greater depths than under *Alternative 1* and may disrupt the reservoir's thermal structure, resulting in decreased productivity of zooplankton, degraded thermal refugia for predator and prey species, and the creation of direct competitive interactions between predators on shared prey resources (Hansen et al., 2017). Based on water temperature, prey availability and salmonid biomass alone, the effect of deep water withdrawals on salmonid growth are predicted to vary across the growth season (April to November) with slightly improved growth in April through June, but a noticeable reduction in growth in August and September (PSU, 2017b).

The reduction in minimum reservoir elevation under *Alternative 2* may also contribute to increased turbidity in 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 in shoreline areas of the reservoir during and immediately following runoff events when reservoir levels are below elevation 2,192.75. Short-term exceedances of State surface water quality standards for turbidity may occur during and immediately following runoff events (see Section 4.4.4.2). This short-term increased turbidity would cause negative impacts on fish that visually locate prey and may alter existing predator-prey relationships in shallow shoreline areas (Gregory and Levings, 1998; Hansen et al., 2013).

Under *Alternative 2*, entrainment risks posed by operation of the pumping plant facilities are expected to be low for salmonids because fish screens would be installed that prevent entrainment of juvenile salmonid fry of a size observed in the reservoir after they emigrate from tributaries or are stocked artificially. Entrainment is a problem for resident species such as sculpin, burbot, and northern pikeminnow whose larval stages occur in the reservoir and are small enough to pass through screens (e.g., Jensen et al., 1982; Mansfield et al., 1983; Weisberg et al., 1987) and would be injured, translocated, or killed during entrainment. Under *Alternative 2* the intake would occur at an elevation of 1,989, under at least 123.75 feet of water during years of maximum drawdown (low water years), but typically much deeper at other times. Most small fish or larval fish would not be present in deep water, however larval burbot (Jude et al., 2013) and larval Northern pikeminnow (Gadomski et al., 2001) can be present at these depths, and northern pikeminnow spawn in summer, just prior to the pumping window of late summer/early fall. The risk of entrainment is higher for *Alternative 2* than *Alternative 1* because of the larger volume of water drawn from the reservoir during drought periods and because increased concentration of fish would occur at lower reservoir levels. Entrainment risk increases as water becomes shallower, favoring more small-bodied fish. Negative entrainment impacts would be minor as they are expected to occur only for larval and small juvenile stages of non-salmonid species that could occur at depth during years when the reservoir is drawn down below the current level of maximum drawdown (elevation 2,192.75).

Noise from pumping operations may affect fish across relatively large distances from the pump station depending on frequency and intensity due to particle motion of sound waves in water and transmission of sound waves in substrate. Noise is unlikely to rise sharply to injurious levels from pumping stations; however, noise should be monitored for levels that are known to cause behavioral effects (80 decibels referenced to 1 micrometer per second squared [80 dB/1 $\mu m/s^2$]) (Hawkins, 2015).

*Kachess River*

The water released from Kachess Reservoir under *Alternative 2* 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 substantially under *Alternative 2* (Section 4.3.4). The Kachess River is a lesser priority for improving river flow because of other objectives in the Integrated Plan (Reclamation and Ecology, 2012). 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.

Under *Alternative 2*, pumped water would from a greater depth than water released downstream under *Alternative 1*. This cool water that is 5 to 6°C (41 to 43°F) would be conveyed to the Kachess River compared to maximum surface temperatures of 13 to 19°C (55 to 62°F) conveyed downstream under *Alternative 1*, and would result in lower temperatures downstream in the Kachess River (Section 4.4.4.2). In non-drought years, decreased water temperatures would benefit salmonids in the Kachess River.

During extended droughts, as the reservoir's water levels continue to drop, a further reduction in the amount of nearshore shallow areas would occur limiting the amount of surface heating. Reservoir withdrawals have the potential to remain cooler (relative to *Alternative 1*) similar to a 1-year drought. However, extended or multi-year drought or refill conditions were not included in the PSU drought conditions water temperature model and potential effects are not quantified (PSU, 2017b).

*Keechelus Reservoir*

The operational impacts on Keechelus Reservoir elevation and hydraulic residence time under *Alternative 2* are similar but smaller than those expected at Kachess Reservoir under *Alternative 2*. Keechelus Reservoir operations would change slightly from *Alternative 1* because Reclamation would withdraw more water from Keechelus Reservoir after a drought to allow Kachess Reservoir to refill as quickly as possible.

Under *Alternative 2*, Keechelus Reservoir would be below the level at which fish access to tributary streams is impeded (elevation 2,466) in 81 of 90 modeled years, an increase of 1 year from *Alternative 1* (based on RiverWare modeling years 1926 to 2015). The duration of impeded access would also increase by 2 days to a mean of 131 days under *Alternative 2* compared with *Alternative 1*. These minimal changes would not adversely affect connectivity between reservoir and tributary habitats.

Under *Alternative 2*, mean annual minimum and maximum reservoir elevations would decrease slightly (all less than 4 feet) compared with *Alternative 1*. The small reduction in reservoir elevation is not expected to have a notable impact on habitat complexity, water temperature, or the food-base. The benthic community includes freshwater shellfish for which species, distribution and abundance are currently not well documented in Lake Keechelus but could be adversely affected by more prolonged exposure of reservoir bed materials to air.

Under *Alternative 2*, 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 in Keechelus Reservoir. Over all the years considered (RiverWare modeling years 1926 to 2015), the hydraulic residence time under *Alternative 2* decreased by 2 days (2 percent) compared with *Alternative 1*. Larger expected reductions in hydraulic residence time were observed for drought years. Under conditions similar to the 1994 drought, the hydraulic residence time would be reduced by 7 days (8 percent) under *Alternative 2* compared with *Alternative 1* (based on RiverWare modeling years 1926 to 2015). Under conditions similar to the 2001 drought, the hydraulic residence time under *Alternative 2* would be reduced by 12 days (13 percent) compared with *Alternative 1* (Table 4-82). Negative impacts on the food-base resulting from decreased hydraulic residence times are expected to be greater only during drought years. The general interactions between reservoir level, hydraulic residence time, and prey abundance are the same as those described for Kachess Reservoir in *Alternative 2*.

**Table 4-82. Keechelus Reservoir Mean Hydraulic Residence Times in Days**

| Modeled Year | *Alternative 1* | *Alternatives 2, 3,* and *4* | Change | *Alternatives 5A, 5B,* and *5C* | Change |
|---|---|---|---|---|---|
| **1926–2015** | | | | | |
| Annual | 123 | 121 | –2 | 115 | –8 |
| Annual maximum | 157[a] | 156[b] | –1 | 165[c] | 8 |
| Annual minimum | 67[d] | 61[e] | –6 | 62[f] | –5 |
| **1994 (Drought Year)** | 85 | 78 | –7 | 75 | –10 |
| **2001 (Drought Year)** | 90 | 78 | –12 | 94 | 4 |

Note: Calculations are based available data for the active storage portion of the reservoir.
[a] Year of highest *Alternative 1* maximum = 1933
[b] Year of highest *Alternatives 2, 3,* and *4* maximum = 1955
[c] Year of highest *Alternatives 5A, 5B,* and *5C* maximum = 1984
[d] Year of lowest *Alternative 1* minimum = 1930
[e] Year of lowest *Alternatives 2, 3,* and *4* minimum = 1929
[f] Year of lowest *Alternatives 5A, 5B,* and *5C* minimum = 1930

#### *Yakima River*

Downstream from Keechelus and Kachess dams, instream flows are expected to differ under Alternative 2 as compared with Alternative 1, resulting in impacts on spawning, rearing, and migration habitats. The reach-specific impacts are described below using modeled data from 1926 to 2015 (Section 4.3.4) and using impact indicators described in Section 4.3. Generally, benefits to migrating, rearing and spawning salmonids could occur if flow changes that occur bring flow conditions closer to normative flows for given reaches. Compared to existing conditions, flows that could improve conditions for salmonids include higher flows in the spring to support downstream smolt migration, lower flow in the summer to support fry and subyearling rearing, and higher flow in fall and winter to support adult spawning and egg incubation. Note that the modeling did not take into account habitat features such as large wood and therefore represents an underestimate of actual habitat availability, especially in reaches with large amounts of large wood (i.e., Easton reach).

**Keechelus reach.** Within the Keechelus reach, several modeled scenarios were identified where Alternative 2 flows are expected to differ Alternative 1 and potentially affect fish species:

- Under *Alternative 2*, decreased flow during July to August of drought years and decreased median flow (50 percent exceedance) during summer (June 16 to October 31) would benefit juvenile spring Chinook and coho. Reduced summer instream flows during drought years and reduced median summer flows would be closer to the instream flow target of 500 cfs, which would reduce water velocities that are currently too high for rearing fish (Reclamation, 2011).

**Easton reach.** Within the Easton reach, several modeled scenarios were identified in which Alternative 2 flows are expected to differ compared with Alternative 1 and potentially affect fish species (Table 4-83):

- Under *Alternative 2*, there is a modeled increase in annual and July to August instream flows during drought years. The increase in flow would decrease the quantity of rearing habitat available to spring Chinook and rainbow trout subyearlings during drought years compared to *Alternative 1*, resulting in a negative impact on these species during drought years (Reclamation, 2008a).
- Under *Alternative 2*, increased flows during spring (March 15 to June 15) of drought years are expected to decrease the quantity of available spring Chinook fry habitat and negatively affect the species (Reclamation, 2008a). The increase in low flows would benefit outmigrating smolts of all anadromous species, which addresses an instream flow objective for the Easton reach (Reclamation, 2011c). The net impact would be neutral for spring Chinook and beneficial for other species such as sockeye and coho.
- Under *Alternative 2*, decreased median flows (50 percent exceedance) during summer (June 16 to October 31); of refill years would remain above the instream flow targets of 220 cfs in September and October for spawning. The quantity of habitat available to rearing spring Chinook and rainbow trout is expected to decrease slightly (Reclamation, 2008a), but median flows are not expected to drop below the base instream flow target of 250 cfs for rearing (Reclamation 2011c); therefore, the impact of reduced rearing habitat is expected to be minor.
- Under *Alternative 2*, there would be an increase in high flows (10 percent exceedance) during summer (June 16 to October 31) in drought years; and would remain above the instream flow targets of 220 cfs in September and October for spawning. Small decreases in spring Chinook and rainbow trout subyearling habitat are expected (Reclamation, 2008a), but instream flows would remain above the 250 cfs target for rearing (Reclamation 2011c). Therefore, no impact is expected.

**Umtanum reach**. Within the Umtanum reach, one modeled scenario was identified where *Alternative 2* flows are expected to differ compared with *Alternative 1* (Section 4.3.4.2):

- Under *Alternative 2*, increased annual high flows (10 percent exceedance) during prorated years may cause minor changes in available spring Chinook and rainbow trout fry and subyearling habitat (Reclamation, 2008a). However, *Alternative 2* seasonal flow patterns would remain very similar to *Alternative 1* with less than 3 percent change during winter spring or summer and would have little if any impact on attainment of seasonal instream flow objectives (Reclamation, 2011c).

**Roza reach**. Within the Roza reach, one modeled scenario was identified where *Alternative 2* flows are expected to differ compared with *Alternative 1*:

- Under *Alternative 2*, increased high flows (10 percent exceedance) during prorated years are not expected to adversely change existing habitat conditions. Predicted seasonal flow patterns would be very similar to those expected under *Alternative 1* (less than 3 percent change during winter, spring, or summer) and would have little if any impact on attainment of seasonal instream flow objectives (Reclamation, 2011c).

**Wapato reach**. Within the Wapato reach, one modeled scenario was identified where *Alternative 2* flows are expected to differ compared with *Alternative 1*:

- Under *Alternative 2*, increased median flows (50 percent exceedance) during prorated years are not expected to change existing habitat conditions. Predicted seasonal flow patterns would be very similar to those expected under *Alternative 1* (less than 2 percent change during winter, spring, or summer) and would have little if any impact on attainment of seasonal instream flow objectives for fish (Reclamation, 2011c). As summarized in Tables 4-32 and 4-33 (Alternatives 2, 3, and 4), winter and spring flows at Parker are reduced by up to 1.2 percent. During refill years, high flows are reduced by 2.9 percent. A very small increase (less than 5 percent) in the quantity of available coho rearing habitat is also expected to occur at higher flows (Reclamation, 2008a).

**Table 4-83. Changes in Habitat Availability at the Easton Reach for Spring Chinook Fry and Subyearling Chinook**

| Change in Flow Associated with Modeled Scenario | Percentage Change in Flow under *Alternative 2* compared with *Alternative 1* (cfs) | Spring Chinook Fry Habitat[a] | Spring Chinook Subyearling Habitat[b] | Rainbow Trout Fry Habitat[a] | Rainbow Trout Subyearling Habitat[b] |
|---|---|---|---|---|---|
| Increase in annual flows during drought years[c] | 3.2-38.5% | Decrease | Decrease | NS | Decrease |
| Increase in July to August flows during drought years[c] | 32.3–46.7% | NA | Decrease | NA | Decrease |
| Increased low flows (90 percent exceedance) during spring (March 15 to June 15)[d] | 29.5% | Decrease | NA | NS | NA |
| Decreased median summer flows (50 percent exceedance) during summer (June 16 to October 31)[d] | –11.6% | NA | Decrease | NA | Decrease |
| Increased high flows (10 percent exceedance) during summer (June 16 to October 31)[d] | 5.0% | NA | Decrease | NA | Decrease |

| Change in Flow Associated with Modeled Scenario | Percentage Change in Flow under *Alternative 2* compared with *Alternative 1* (cfs) | Spring Chinook Fry Habitat[a] | Spring Chinook Subyearling Habitat[b] | Rainbow Trout Fry Habitat[a] | Rainbow Trout Subyearling Habitat[b] |
|---|---|---|---|---|---|
| Increased high flows (10 percent exceedance) during prorated years[e] | 38.5% | NS | Decrease | NS | Decrease |
| Decrease in median (50 percent exceedance) flow during refill year[e] | –10.8% | Increase | NS | NS | Decrease |
| Decreased high flows (10 percent exceedance) during refill years[e] | –13.6% | NS | Increase | NS | Increase |

Notes: NA = not applicable, NS = not significant, flow change would not result in a substantial (greater than 5 percent) change in available habitat
[a] Flow-based quantities of fry habitat were evaluated for the period of April and May (Reclamation, 2008a).
[b] Flow-based quantities of subyearling habitat were evaluated for the period of June to September (Reclamation, 2008a).
[c] Flow change described in Section 4.3.
[d] Flow change described in Section 4.3.
[e] Flow change described in Section 4.3.

### Volitional Bull Trout Passage Improvements

Under *Alternative 2* operations, the Volitional Bull Trout Passage Improvements would maintain upstream and downstream passage at the Narrows when the pool elevation of the lower Kachess Reservoir is drawn below 2,200. Passage would be provided through a roughened channel (see Section 2.3.5) that is designed to function over a wide range of reservoir elevations, flow, sediment, and debris conditions without the need for adjustment, modification, or maintenance. Water temperature in the channel would be equivalent to surface water temperatures observed in Little Kachess, which are not predicted to differ under *Alternative 2* compared to *Alternative 1*. The roughened channel would mimic conditions found in local tributary streams and provide hydraulic diversity and resting or staging habitat for fish moving through the channel. NMFS and WDFW guidelines available for the passage of juvenile salmonids are generally accepted as applicable for the purposes of design for fish passage structures required to accommodate bull trout. The specific design guidelines have been chosen to represent conditions under which adult and subadult bull trout and other salmonids would be able to successfully pass. These design guidelines include a minimum hydraulic depth of 10 inches, a specific flow velocity of 1.3 feet per second or less, an average cross-sectional velocity of 4.0 feet per second or less, and an energy dissipation factor of 11.25 feet per pound per cubic foot per second ($lb/ft^3/s$) (Reclamation and Ecology, 2017a). The roughened channel would improve connectivity of reservoir habitats and would reduce the negative impact of increased duration of separation between the upper and lower basins. During periods when the Little and Big Kachess basins already separate under existing conditions (occurring in 83 out of 91 years modeled, for 111 days average per year), the roughened channel would provide passage opportunities that are not currently available to fish.

### 4.6.5 Alternative 3 – KDRPP South Pumping Plant

#### *4.6.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

*Kachess Reservoir*

Construction of facilities for *Alternative 3* is expected to be completed over 3 years. For most facilities, construction impacts on fish would be similar to those described for *Alternative 2*. 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 adjacent to existing project infrastructure, whereas the East Shore Pumping Plant would include development of a new site and additional access roads and site preparation.

Under *Alternative 3*, construction impacts on fish would be smaller than those under *Alternative 2*. 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 would be as described in Section 4.6.4.1 for the Kachess River and would not cause long-term negative impacts.

*Kachess River*

Under *Alternative 3*, construction impacts on fish would be the same as those under *Alternative 2*.

*Keechelus Reservoir*

No construction activities for the pumping plant would occur at Keechelus Reservoir. All project facilities would be downstream from Keechelus Dam. No construction-related impacts would occur.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2*.

#### *4.6.5.2 Operation*

**KDRPP South Pumping Plant Facilities**

Under *Alternative 3*, KDRPP operations would be the same as those under *Alternative 2*. Therefore, impacts on fish would be the same.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2*.

### 4.6.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

#### *4.6.6.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

*Kachess Reservoir*

Construction of facilities for *Alternative 4 (Preferred Alternative)* would be similar to those described for *Alternative 2*. The inwater work required to construct the floating pumping plant facilities would include the following activities:

- Dredging of 6,000 cy of sediment beneath the floating pumping plant
- Inwater deposition of dredge materials near the floating pumping plant
- Installation of catenary mooring structures
- Pile driving associated with the public dock and project dock

These construction activities would cause a temporary reduction in habitat complexity, increase in turbidity, reduction in fish passage, and increase in disturbance during the construction period. Transfer of equipment from other water bodies without adequate washing could introduce of invasive species. The reduced onshore footprint for the floating pumping plant would reduce the area of shoreline disturbance and potential for upland erosion.

Benthic lake habitat will be permanently altered by the construction of mooring structures, reducing localized benthic habitat complexity, vegetation, and invertebrate productivity, and affecting benthic oriented fish species like mountain whitefish, peamouth, largescale sucker, and threespine stickleback.

Construction activities associated with *Alternative 4 (Preferred Alternative)* would create sound and vibration disturbances that negatively affect fish. Sound and vibration would occur during the following inwater construction activities:

- Pile driving associated with installation of flow control structure, rigid pipe bridge, and public dock and project dock
- Use of heavy equipment to install reservoir floor erosion protection

The impacts from sound would be limited to the construction period and would be reduced by the use of bubble curtains during pile driving or the use of physical barriers such as screens that prevent fish from coming near intense sound and vibrations. The impacts of sound and vibrations on fish were described for *Alternative 2* (Section 4.6.4.1).

*Keechelus Reservoir*

No construction activities for *Alternative 4 (Preferred Alternative)* would occur at Keechelus Reservoir. All project facilities would be downstream from Keechelus Dam. No construction-related impacts would occur.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2*.

#### *4.6.6.2 Operation*

**Kachess Reservoir**

Operations and impacts associated with *Alternative 4 (Preferred Alternative)* would be the same as *Alternative 2* for Kachess Reservoir except for specific impacts associated with (1) location of the pump intake and water withdrawals at an 18-foot depth below the surface of Kachess Reservoir and (2) the presence of the floating pumping plant itself.

Under *Alternative 4 (Preferred Alternative)*, withdrawing large volumes of water from near-surface depths could decrease productivity of zooplankton. Hydrodynamic modeling of the 18-foot pumping depth proposed under *Alternative 4 (Preferred Alternative)* demonstrates that water would generally be pumped from the uppermost layer of the reservoir (i.e., “epiliminion”; PSU, 2017b) where zooplankton production is high (Hansen et al., 2017). During summer, warm temperatures in the epilimnion greatly increase the production of Daphnia and other zooplankton important for supporting kokanee, other cold water fish prey, and warm water fish (e.g., redside shiners) that feed near the surface and support the feeding and growth of piscivores year-round (Hansen et al., 2017). The removal of a portion of the epiliminion during drought relief pumping in the summer months would, therefore, reduce zooplankton productivity and abundance and negatively affect the food-base for these fish species in Kachess Reservoir. The reduction in zooplankton production associated with pumping from the epilimnion has not been quantified but is expected to occur during drought relief pumping in summer months during and following drought years when the pool elevation in Kachess Reservoir would be below the current outlet elevation of 2,192.75.

Although zooplankton production may decrease under *Alternative 4 (Preferred Alternative)*, pumping large volumes of warm water from near-surface depths would improve the general thermal conditions for growth for cold water salmonid species in Kachess Reservoir (PSU, 2017b). However, the benefits of cooler surface temperatures would be limited for fish species such as kokanee that normally undergo vertical migrations between cooler water at depth and warmer surface water for foraging, predator avoidance, and maximized energetic efficiency (Bevelhimer and Adams, 1993). Removal of a temperature block to kokanee near the surface may expose more kokanee to predation by northern pikeminnow and burbot that feed in a diversity of water temperatures (Hansen et al., 2017). Overall, the potential benefits of improved thermal conditions for growth are not expected to be significant because of the loss of zooplankton production that is also anticipated under *Alternative 4 (Preferred Alternative).* The tradeoffs between changes in temperature stratification and available food were modeled based on water temperature, zooplankton availability, and salmonid biomass alone. The effects of surface withdrawal on salmonid growth are predicted to cause minor differences from *Alternative 1* across the majority of the growth season (April to November), resulting in better growth than *Alternatives 2* and *3*, but slightly lower growth at the end of the growth season (October; PSU, 2017b). Additional hydrodynamic and bioenergetic modeling would be needed to determine precise responses for individual species.

Under *Alternative 4 (Preferred Alternative)*, the operation of pumps on the pump barge may create noise or vibrations that disturb fish (Mitson and Knudsen, 2003) and preclude their use of habitats near the barge. Sound and vibration monitoring may be necessary to confirm the extent of disturbance created by the pumps. Because fish would be intentionally excluded from the area beneath the pumping barge with screens, the disturbance is not expected to result in impacts on fish.

Under *Alternative 4 (Preferred Alternative)*, the floating pumping plant, public dock, and private dock would shade habitat beneath the structures and limit or prevent the growth of aquatic plant species and algae that require sunlight (Radomski et al., 2010) and provide food for invertebrates and fish. The loss of aquatic plant life would cause a small reduction in the food-base. Additionally, docks and other overwater structures displace natural sources of habitat complexity such as large wood and aquatic plants that would otherwise provide cover from predators or foraging habitats (Tabor et al., 2011). The impacts of reduced habitat complexity resulting from *Alternative 4 (Preferred Alternative)* is expected to be negative for littoral species such as mountain whitefish, cutthroat trout, rainbow trout, longnose dace, leopard dace, speckled dace, chiselmouth, redside shiner, peamouth, northern pikeminnow, largescale sucker, mountain sucker, threespine stickleback, and sculpins.

*Kachess River*

Operations and impacts associated with *Alternative 4 (Preferred Alternative)* would be the same as with *Alternative 2* (Section 4.6.4.1) for the Kachess River except for smaller water temperature decreases that would be expected to occur as result of the pump intake located at the relatively shallow depth of 18 feet below the surface of Kachess Reservoir.

Under *Alternative 4 (Preferred Alternative),* Kachess River water temperatures would decrease slightly during drought relief pumping in summer months compared with *Alternative 1* (see Section 4.4.6.2). Climate change is not incorporated in the assessment but is expected to further increase the temperatures above those described for *Alternatives 1* and *2*.

Although the Kachess River is a lesser priority for river flows and is unlikely to provide quality rearing or spawning habitat for anadromous salmon, future introductions of salmon above Kachess Dam (Reclamation, 2005a) could make the Kachess River an important migratory corridor for juvenile and adult salmon if downstream passage is provided around Kachess Dam. High water temperatures during summer months that would occur more often with climate change would negatively affect juvenile and adult migrants. Temperatures greater than or equal to 21°C (70°F) may be lethal for some species, such as Chinook salmon, or cause barriers to passage (McCullough, 1999). Prolonged exposure to temperatures greater than or equal to 16°C (60.8°F) can cause physiological stress, behavioral changes, greater vulnerability to diseases, and reduced growth for salmonids (McCullough, 1999). The 16°C (60.8°F) temperature threshold has been identified as a criterion to protect core summer salmonid habitat in the Yakima River basin, including the Kachess River and the upper Yakima River (Ecology, 2016c).

For Alternative 4 (Preferred Alternative), during extended droughts, water would continue to be withdrawn from the reservoir's surface layer (epilimnion) and pumped into the Kachess River. As the reservoir's water levels continue to drop, a further reduction in the amount of nearshore shallow areas would occur limiting the amount of surface heating. Reservoir withdrawals have the potential to remain cooler (relative to Alternative 1) similar to a 1-year drought.

*Keechelus Reservoir*

Operations and impacts associated with *Alternative 4 (Preferred Alternative)* would be the same as with *Alternative 2* for Keechelus Reservoir.

*Yakima River*

Operations and impacts associated with *Alternative 4 (Preferred Alternative)* would be the same as *Alternative 2* for the Yakima River except for smaller water temperature decreases that would be expected to occur as result of the pump intake located at the relatively shallow depth of 18 feet below the surface of Kachess Reservoir rather than at the reservoir bottom. The benefit of a slight decrease in water temperature of 1 to 2°C is likely to attenuate a short distance downstream from the Kachess River after mixing with the upper Yakima River. Climate change is not incorporated in the assessment of water temperatures but is expected to further increase water temperatures within the Easton reach and downstream.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2*.

## 4.6.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

*Alternative 5A* would include construction of the KDRPP East Shore Pumping Plant (*Alternative 2*). The impacts from construction and operation of these components of *Alternative 5A* would be the same as described in Section 4.6.4 (*Alternative 2*). *Alternative 5A* would also include construction and operation of the KKC North Tunnel. The impacts of KKC North Tunnel are described below.

### *4.6.7.1 Construction*

**KKC North Tunnel Alignment Facilities**

*Kachess Reservoir*

*Alternative 5A* would affect 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 2-13). 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. 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 on the geology of the slope below the stilling basin, riprap may also need to be installed on the slope below the stilling basin.

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 2,* as discussed in Section 4.6.4.1, and are expected to be minor. 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 4 acres. The permanent loss of vegetation associated with these facilities is expected to have a small impact on fish in Kachess Reservoir because it would affect less than 1 percent of the reservoir's total shoreline.

*Kachess River*

Under *Alternative 5A,* no construction activity would occur in the Kachess River.

*Keechelus Reservoir*

No construction activities are proposed in the Keechelus Reservoir. All construction would be in the area downstream from the dam.

*Yakima River*

*Alternative 5A* would affect 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 from 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 near 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 most of the 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 affect fish because there is currently no fish passage at Keechelus Dam. The diversion would be designed to accommodate potential future fish passage at Keechelus Dam.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2*.

### *4.6.7.2 Operation*

**KKC North Tunnel Alignment Facilities**

*Kachess Reservoir*

Under *Alternative 5A*, Kachess Reservoir pool elevations would be reduced compared with *Alternative 1* conditions on average (see Figure 4-6). Operational flexibility would increase with *Alternative 5A*, allowing for greater drawdown of Kachess Reservoir during drought years. Under *Alternative 5A*, annual maximum and minimum reservoir elevations would be lower than under *Alternative 1*. In refill years following drought years, maximum reservoir pool elevations would remain lower than under *Alternative 1*. Decreases in maximum reservoir elevation would affect existing habitat connectivity between reservoir habitats, affect connectivity between tributary and reservoir habitats, influence the availability of zooplankton and invertebrate prey, and reduce habitat complexity.

Under *Alternative 5A*, lower reservoir levels would result in more frequent and longer separation of the Big Kachess and Little Kachess basins within Kachess Reservoir. The Kachess Reservoir pool level would be below the elevation at which the two basins become separated (elevation 2,220) (and at which fish can no longer pass between the two) in 76 out of 90 modeled years, an increase of 3 years from *Alternative 1*. The mean duration of this condition would be 140 days per year, an increase of 62 days per year relative to *Alternative 1*. Based on these changes, the negative impacts on within-reservoir habitat connectivity are expected to be nearly the same as described for *Alternative 2* (Section 4.6.4.2), but fish passage would be maintained by Volitional Bull Trout Passage Improvements as described for *Alternative 2*.

Under *Alternative 5A*, connectivity between reservoir and tributary habitats would be reduced. The number of days Kachess Reservoir would be below the level that impedes fish passage to tributary streams (elevation 2,226) would be similar to *Alternative 1*, but the reservoir would remain below the elevation 2,226 threshold for 157 days per year, an increase of 46 days per year. Because of the increased potential for disconnection between Kachess Reservoir and tributaries to Big Kachess, *Alternative 5A* is expected to have negative impacts on fish passage as described for *Alternative 2*. Reductions in Kachess Reservoir elevation and persistence of lower elevations for longer periods would also reduce the abundance of invertebrate prey and productivity of freshwater shellfish. The loss of invertebrates would negatively affect the food-base, as described for *Alternative 2*.

Under *Alternative 5A*, hydraulic residence time would decrease for Kachess Reservoir as compared with *Alternatives 1* and *2*, reducing zooplankton abundance and the food-base, as described for *Alternative 2*.

Prolonged periods of lower reservoir elevations under *Alternative 5A* 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 for *Alternative 2*.

The conveyance of 400 cfs from Keechelus Reservoir to refill Kachess Reservoir could result in a small localized temperature reduction in Kachess Reservoir, transfer nutrients to Kachess Reservoir, and potentially introduce disease or invasive species from Keechelus Reservoir to Kachess Reservoir.

As described in Section 4.4.7.2, cooler water conveyed from Keechelus Reservoir to Kachess Reservoir would reduce water temperature adjacent to the outfall in Kachess Reservoir. Because this impact would be small and limited to the vicinity of the outfall, impacts on fish are not expected as compared with *Alternative 1*. As part of project mitigation, a water quality monitoring program would be implemented to document changes in water temperature (see Section 4.4.10).

The transfer 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 change the productivity of Kachess Reservoir (from oligotrophic to something more productive) or result in impacts on fish in Kachess Reservoir as compared with *Alternative 1*.

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 as compared with *Alternative 1*. The impacts of either disease or exotic species could affect resident fish species that have been isolated from other waters of the upper Yakima River 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 be similar to other situations in which anadromous salmon are reintroduced above barriers to passage (Brenkman et al., 2008) and would represent a potentially negative impact.

*Kachess River*

Under *Alternative 5A*, instream flow (based on the 1925 to 2015 period of record) in the Kachess River downstream from Kachess Dam is predicted to increase in all seasons compared with existing conditions, 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. The Kachess River is a lesser priority for improving river flow because of other objectives in the Integrated Plan (Reclamation and Ecology, 2012).

Kachess River water quality impacts during operations would be similar to those under *Alternative 2.*

*Keechelus Reservoir*

Under *Alternative 5A*, the mean Keechelus Reservoir pool elevation would decrease by 2.4 feet (based on the 1926 to 2015) record and the mean annual maximum pool elevation would decrease by 5.9 feet, with the mean annual minimum predicted to increase by 3.7 feet. Overall, the pool elevation changes expected under *Alternative 5A* would slightly dampen reservoir fluctuations compared with *Alternative 1* and would result in a small improvement in the food-base and habitat complexity for fish. Reducing the level of reservoir fluctuations would result in a small increase in 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. The benthic community includes freshwater shellfish for which species, distribution and abundance are currently not well documented in Lake Keechelus but could be adversely affected by more prolonged exposure of reservoir bed materials to air. 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).

Under *Alternative 5A*, small changes in reservoir elevation would also affect the frequency of barriers forming between tributary and reservoir habitats. The pool elevation in Keechelus Reservoir would be below the elevation that restricts fish passage to tributary streams (elevation 2,466) in 69 of the 90 years modeled (1926 to 2015), a decrease of 11 years from *Alternative 1*. However, the mean duration in which passage is restricted each year would increase by 5 days to 134 days per year. The combined impact of both minor positive and negative changes in the frequency and duration, respectively, is likely to be passage conditions that are largely the same as *Alternative 1* when averaged over many years.

Under *Alternative 5A*, the hydraulic residence time in Keechelus Reservoir is expected to be similar to that under *Alternative 1*. In most years, the hydraulic residence time would be slightly less (-8 days) and in drought years it may increase or decrease. These changes are not expected to result in significant impacts on the food-base.

*Yakima River*

**Keechelus reach**. Under *Alternative 5A*, instream flow targets would be met more often in summer months than under *Alternative 1*. Meeting the summer flow targets would increase suitable habitat for fish species and represent a substantial beneficial impact. 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*) 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 Sections 3.6.4 and 4.6.3.

During winter and spring, flows are expected to meet the Keechelus reach instream flow target slightly less often than under *Alternative 1*. 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 5A*, instream flow targets would be met at a frequency similar to that of *Alternative 1*. Based on hydraulic modeling results, average instream flows would be nearly the same as baseline conditions; however, during drought years, flows would be higher. The increase in streamflow during drought years would remain within current operating ranges and impacts on fish would be the same as those expected under *Alternative 1*.

**Downstream of Easton reach.** Predicted seasonal flow patterns would be very similar to those expected under Alternative 1 (less than 2 percent change during winter, spring, or summer) and would have little if any impact on attainment of seasonal instream flow objectives for fish (Reclamation, 2011c). As summarized In Table 4-62, spring flows are reduced by up to 1.6 percent. During refill years, high flows are reduced by 4.6 percent.

### Volitional Bull Trout Passage Improvements

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2*.

### 4.6.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 3*. Impacts would be the same as those associated with the North Tunnel discussed in *Alternative 5A*. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.6.7 (*Alternative 5A*).

### 4.6.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 4 (Preferred Alternative)*. Impacts would largely be the same as those associated with the North Tunnel discussed in *Alternative 5A*.

Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.6.7 (*Alternative 5A*).

### 4.6.10 Avoidance, Minimization, and Mitigation Measures

As part of the project implementation, project proponents would use BMPs to reduce sediment mobilization and turbidity levels as described in Sections 4.3.10 and 4.4.10. 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.

Design modifications would be employed that are protective of fish. The shading impact of docks and other over-water structures would be reduced by using deck materials that allow light penetration wherever feasible. Screens for pumping plant facility intakes would be designed in compliance with criteria developed by NMFS (2011) to protect fish species and life stages that are vulnerable to entrainment.

As part of project mitigation, Reclamation and Ecology would continue their water quality monitoring program as described in Section 4.3.10. Based on the selected alternative, Reclamation and Ecology would evaluate monitoring data and conduct further analysis, as warranted, during final design to refine estimates of water quality and pump operation impacts to fish.

All project activities would comply with Federal, State, and local regulations and ESA consultation requirements with the Service and NMFS.

Reclamation will document the final list of mitigation and environmental commitments in its Record of Decision.

# 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
- Changes in Keechelus and Kachess reservoir water surface elevations and potential downstream effects on the Kachess River and the 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) NWI geographic information system (GIS) database, observations from an August 2014 field visit of Keechelus and Kachess reservoirs, and GIS overlays of facility designs. 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 area during the permitting phase for the preferred alternative. Impacts caused by proposed reservoir operations were assessed by using preliminary results of KDRPP and KKC hydrologic modeling reported in Section 4.3and by reviewing literature regarding effects of water regime changes on reservoir and riparian vegetation composition and productivity (Auble et al., 2007; Cooke and Azous, 1997; Howard and Wells, 2009; Kercher and Zedler, 2004; Reclamation, 2011; Vartapetian and Jackson, 1996; Walters et al., 1980). These sources provided the basis for evaluating potential short- and long-term effects of changes in reservoir water surface elevations on wetland and vegetation communities along Kachess and Keechelus reservoirs and of downstream effects on the 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 Volitional Bull Trout Passage Improvements. Negative impacts are defined as the loss of existing upland or riparian vegetation and vegetated wetlands, whether from clearing and grading activities or from changes in water surface elevations at the Keechelus and Kachess reservoirs, which would 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 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 and to support the permanent footprint of these facilities. 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 then 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 and the 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 impact indicators presented in Table 4-84 were developed based on consideration of context and intensity of the environmental effects, as required under NEPA.

**Table 4-84. Impact Indicators for Vegetation and Wetlands**

| Issues | Impact Indicators |
|---|---|
| Changes to upland and riparian vegetation | Loss of native vegetation that decreases the extent, connectivity, or integrity of riparian or upland habitat in the watershed<br>Establishment of invasive plant species that decreases the extent, connectivity, or integrity of native riparian and upland habitat in the watershed<br>Loss of USFS Survey and Manage individual plants or suitable habitat<br>Loss of State sensitive individual plants or suitable habitat<br>Increase in extent, connectivity, or integrity of native riparian and upland habitat |
| Changes to wetlands | Loss of wetland acreage or impairment of wetland functions that cannot be mitigated.<br>Enhancement of, restoration of, or increase in extent of wetland habitat |

## 4.7.2 Summary of Impacts

Action alternatives would have minor construction and operational impacts on wetlands and vegetation. No impacts on wetlands and vegetation are anticipated under *Alternative 1*. Construction activities under *Alternative 2 – KDRPP East Shore Pumping Plant* and *Alternative 3 – 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 4 (Preferred Alternative)* would have no temporary or permanent impacts on wetlands due to construction. *Alternative 2* would have a larger construction footprint that would disturb more upland vegetation than *Alternative 3* or *Alternative 4 (Preferred Alternative)*. However, permanent changes to vegetation under both alternatives would be small relative to the Kachess Reservoir watershed—approximately 18 acres under *Alternative 2,* 8 acres under *Alternative 3,* and 7 acres under *Alternative 4 (Preferred Alternative)*. 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 2, 3,* or *4*.

*Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* would have the same permanent wetland impacts as *Alternative 2*. *Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment* would have the same permanent wetland impacts as *Alternative 3*, and *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment* would have no permanent wetland impacts (the same as *Alternative 4 [Preferred Alternative]*). Wetland and vegetation impacts would be avoided to the extent practicable in detailed design and in mitigated per permit requirements.

Table 4-85 summarizes the estimated permanent impacts on wetlands and vegetation under the action alternatives.

**Table 4-85. Summary of Estimated Permanent Impacts (Acres) to Wetlands and Vegetation Due to Construction of Each Alternative**

| Alternative | Permanent Wetland Impacts (acres) | Permanent Vegetation Impacts (acres) |
|---|---|---|
| *Alternative 2* | 0.7 | 18 |
| *Alternative 3* | 0.5 | 8 |
| *Alternative 4* | 0.0 | 7 |
| *Alternative 5A* | 0.7 | 22 |
| *Alternative 5B* | 0.5 | 12 |
| *Alternative 5C* | 0.0 | 11 |

Construction dewatering activities under *Alternative 5A*, *5B*, and *5C* would potentially affect wetlands 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 Keechelus Reservoir, the project is not likely to result in a permanent loss of wetlands at this site. *Alternative 5A* would have a larger construction footprint and disturb more upland vegetation than *Alternatives 5B* and *5C*, but permanent changes to vegetation under both alternatives would be small relative to the combined Kachess and Keechelus reservoir watersheds (approximately 22 acres under *Alternative 5A*, 12 acres under *Alternative 5B*, and 11 acres under *Alternative 5C*). Most of this loss of upland vegetation would be second-growth coniferous forest, although some areas of higher-quality mature to sub-mature forest may be impacted. No known special or unique plant communities or associations would be altered.

Operations under all action alternatives would affect wetland and vegetation assemblages around Kachess Reservoir. *Alternatives 2*, *3*, *4*, *5A*, *5B*, and *5C*, 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 the Keechelus reach of the Yakima River are anticipated to be minor under any alternative.

Table 4-86 summarizes the impacts on vegetation and wetlands.

**Table 4-86. Summary of Impacts on Vegetation and Wetlands**

| Impact Indicator | Summary of Impact |
|---|---|
| Loss of native vegetation that decreases the extent, connectivity, or integrity of riparian or upland habitat in the watershed<br>Establishment of invasive plant species that decreases the extent, connectivity, or integrity of native riparian and upland habitat in the watershed<br>Loss of USFS Survey and Manage individual plants or suitable habitat<br>Loss of State sensitive individual plants or suitable habitat<br>Increase in extent, connectivity, or integrity of native riparian and upland habitat | *Alternatives 2, 3,* 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 implementation of invasive species monitoring and control.<br>*Alternatives 5A, 5B,* and *5C* would have a beneficial impact on riparian vegetation on the Keechelus reach of the Yakima River because of reestablishment of flows that mimic an unregulated flow regime.<br>Temporary or permanent loss of riparian and upland vegetation would be minor under any alternative. |
| Loss of wetland acreage or impairment of wetland functions that cannot be mitigated.<br>Enhancement, restoration, or increase in extent of wetland habitat | *Alternatives 2* and *3* would cause a permanent loss of 0.7 acre and 0.5 acre, respectively, of wetlands and would be mitigated to ensure no net loss of wetlands.<br>*Alternatives 2, 3*, and *4* would cause prolonged drawdown of Kachess Reservoir, which may change wetland hydrology and vegetation communities along the reservoir shoreline during drought years. This impact would offset with the implementation of wetland monitoring and appropriate mitigation to ensure no net loss of wetlands.<br>Construction of the KKC North Tunnel under *Alternatives 5A*, *5B*, and *5C* is anticipated to result in minor impacts on wetlands. |

### 4.7.3 Alternative 1 – No Action

Under *Alternative 1*, existing wetland and vegetation conditions would remain largely the same. Reservoir levels would continue to fluctuate as what currently occurs, and discharges to the Kachess River and the Keechelus reach of the Yakima River would continue as what 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, 2011), which aims to restore late-successional forest conditions to the area.

## 4.7.4 Alternative 2 – KDRPP East Shore Pumping Plant

### *4.7.4.1 Construction*

#### KDRPP East Shore Pumping Plant Facilities

*Vegetation*

Construction of *Alternative 2* would require the removal of vegetation. The cleared areas would 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 Kachess River discharge (outlet works) on the south side of Kachess Dam. Table 4-87 identifies the area of temporary and permanent clearing and the dominant vegetation type.

**Table 4-87. Vegetation Disturbance Area Associated with Construction of *Alternative 2 – 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) | 1.0 | 1.0 | Riparian/second-growth and mature coniferous forest |
| Power supply substation | 1.0 | 1.0 | Second-growth coniferous forest |
| Transmission line | 8.0* | 0.0 | Second-growth coniferous forest |
| Permanent access roads | 2.5 | 0.0 | Riparian/second-growth coniferous forest |
| Temporary access roads, staging and stockpile areas | 0.0 | 49.5 | Mixed disturbed/second-growth/mature coniferous forest |
| Temporary construction facilities (construction basin and boat launch) | 0.0 | 1.0 | Riparian |
| **Total Impact Area (acres)** | **18.0** | **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.

Construction would disturb approximately 75.5 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 south of Kachess Dam would be affected by construction activities, with approximately 1.5 acres permanently affected. 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 by 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). Because the regeneration of second-growth and mature forests would take several decades, these are considered long-term temporary effects. The overall permanent and long-term temporary effects of construction on vegetation are anticipated to be minor because the permanent impacts would be small-scale, totaling approximately 18 acres of approximately 40,600 acres of relatively undisturbed forest within the Kachess Reservoir watershed (USGS, 2014). Thus, the project would have negligible effects on the extent, connectivity, and overall integrity of forested habitat in the immediate Kachess Reservoir watershed or in the larger tracts of forest land encompassed by 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 2* 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.

The proposed construction of KDRPP facilities may affect State sensitive species and USFS Survey and Manage plant species if suitable habitat exists 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 Okanogan-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 minimal because disturbance to vegetated areas would be mainly limited to second-growth forest habitat.

*Wetlands*

Construction of the pumping plant on the east shore of 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 wildlife habitat. Grading and clearing of wetlands or buffers may temporarily affect wetland hydrology, vegetation, and structure. Table 4-88 summarizes the estimated acreage of permanent impacts on wetlands attributable to construction of the East Shore Pumping Plant facilities.

**Table 4-88. Permanent Wetland Impact Area Associated with Construction of *Alternative 2 – 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 affect a 0.2-acre forested wetland on the east shore, and the discharge structure south of Kachess Dam would likely permanently affect one 0.5-acre emergent wetland. Construction of the intake tunnel and pipeline and use of the soil disposal area would occur either 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 interconnect 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 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).

Reclamation anticipates construction of the East Shore Pumping Plant to have minor effects 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 would potentially permanently impact small areas of wetland along the transmission line route. The estimated 0.7 acre 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 account for less than 5 percent of the over 38 acres of palustrine (freshwater) wetlands mapped within the Kachess Reservoir watershed (Service, 2013; USGS, 2014). Reclamation would implement compensatory mitigation for unavoidable wetland impacts (discussed in Section 4.7.10), resulting in an overall effect of no net loss of wetlands.

**Volitional Bull Trout Passage Improvements**

To encourage resident bull trout migration through the Narrows when Kachess Reservoir pool elevations drop below 2,226 for KDRPP operations, a roughened channel, flow bifurcation weir, flow isolation berm, and hill slope stabilization soldier pile wall would be constructed between Little Kachess and Big Kachess.

Construction of the improvements would temporarily impact 0.13 acre of palustrine, scrub-shrub wetland for construction of the Narrows Shore West Access Road, Option B. Impacts are anticipated to be negligible and would result in no net loss of wetlands with rectification of temporary wetland impacts after construction. Construction of the roughened channel is not anticipated to affect upland vegetation because Reclamation would use existing roads and dry, unvegetated portions of the reservoir bed for construction of the improvements, staging, and access and because Reclamation would use existing roads to access the reservoir bed.

### *4.7.4.2 Operation*

**KDRPP East Shore Pumping Plant Facilities**

Once construction of the facilities is complete, operation of the facilities under *Alternative 2* would not disturb vegetation or wetlands. The transmission interconnect 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 2* 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. 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 2* would change reservoir levels in both Kachess and Keechelus reservoirs from conditions under *Alternative 1*. 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 could persist over the next 2 to 5 years until the reservoir returns to normal operating levels. At Keechelus Reservoir, peak water surface elevations would be close to those of *Alternative 1* during a 2- to 3-year period following a drought, and its lowest level would be about 18 feet lower than *Alternative 1*. 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 to 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 historic non-drought 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). However, trees immediately adjacent to and those further from the shoreline would not be expected to be impacted by prolonged reservoir drawdown. The primary coniferous trees in this area (Douglas fir, western hemlock, western red cedar, ponderosa pine) rely on soil moisture present in the unsaturated zone that is derived from precipitation and snowmelt, not groundwater from below the water table. On average, the water table lies approximately 60 feet below ground surface, which is much deeper than the roots of these trees. Therefore, tree mortality would not be expected to increase due to reservoir drawdown.

In summary, Reclamation anticipates that prolonged drawdown of reservoir levels under *Alternative 2*, particularly on Kachess Reservoir, would cause periodic shifts in wetland vegetation over the duration of operations of the reservoir. Because of the prolonged, dynamic effects of water level fluctuations in the reservoir, wetlands have the potential to be impacted by proposed reservoir operations. Proper monitoring and implementation of mitigation would need to be implemented to ensure no net loss of wetlands. Likewise, the operation of the reservoirs has the potential to cause an impact on nonwetland vegetation with the potential encroachment of invasive species. Reclamation would implement appropriate invasive species control techniques to limit encroachment into native vegetation communities to ensure no adverse changes to nonwetland vegetation.

The reservoir drawdowns would have variable effects on sensitive species and USFS Survey and Manage plant species if any are present 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 the 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 2* could have downstream effects on wetlands and riparian vegetation along the Kachess River and the Keechelus reach of the Yakima River. For the Kachess River, the greatest change would occur during a drought year, when summer flows would increase by 460 to 660 cfs over flows under *Alternative 1*, although releases during drought years would remain within the 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 flows with *Alternative 1*. The greatest change would be flow rates during drought years, when mean flows would drop from the normal summer operating range of 614 to 673 cfs to 564 to 534 cfs. Wetlands along the Keechelus reach may experience slight changes in vegetation because of 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 over time due to ongoing seasonal changes in flows may cause prolonged, substantial shifts in wetland and riparian vegetation communities. Wetland and nonwetland vegetation communities would need to be monitored and appropriate mitigation implemented to ensure no net loss of wetlands or changes to vegetation communities.

**Volitional Bull Trout Passage Improvements**

Once construction of the Volitional Bull Trout Passage Improvements is complete, operation of the improvements would not affect vegetation or wetlands. The facility would be operated under adaptive management practices to ensure that the efforts are meeting fish passage objectives. Operation of the improvements would not require additional clearing or grading outside the final footprints.

### 4.7.5 Alternative 3 – KDRPP South Pumping Plant

#### *4.7.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

*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 be approximately 44.5 acres, 8 acres of which would be permanently affected by proposed facilities (Table 4-89). 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 affected by construction of the pumping plant. The overall permanent effects of construction on vegetation are anticipated to be minor because the permanent effects would be small-scale, totaling approximately 8 acres of approximately 40,600 forested acres within the Kachess Reservoir watershed. Thus, the overall extent, connectivity, and integrity of forested habitat in the watershed are anticipated to remain intact.

**Table 4-89. Vegetation Disturbance Area Associated with *Alternative 3 – 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 | 1.0 | 1.0 | Second-growth coniferous forest |
| Transmission line* | 2.0 | 0.0 | Second-growth coniferous forest |
| Permanent access roads | 0.5 | 0.0 | Riparian/second-growth coniferous forest |
| Temporary access roads, staging and stockpile areas | 0.0 | 32.0 | Mixed disturbed/second-growth/mature coniferous forest |
| Temporary construction facilities (construction basin and boat launch) | 0.0 | 1.0 | Riparian |
| **Total Impact Area (acres)** | **8.0** | **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.

The potential effect of construction of *Alternative 3* on State sensitive and USFS Survey and Manage plant species would be less than that of *Alternative 2* because the construction area requiring vegetation clearing would be substantially smaller (44.5 versus 75.5 acres). 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 Okanogan-Wenatchee National Forest. Mature coniferous forest that may provide suitable habitat for certain Survey and Manage species (Appendix D) is located in the proposed south pumping plant footprint. 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 low to moderate, since construction disturbance would be more likely to affect suitable habitat for Survey and Manage species.

*Wetlands*

The pumping plant and facilities would likely permanently affect the same 0.5-acre emergent wetland south of the dam as *Alternative 2* (Figure 3-16). *Alternative 3* 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 2*, but the route would be shorter overall because it would tie in to the pumping plant south of 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 would 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 *Alternative 2*.

Reclamation does not anticipate *Alternative 3* would affect wetlands along the Kachess Reservoir shoreline or elsewhere in the Kachess Reservoir watershed. The pumping plant facilities would permanently affect a total of approximately 0.5 acre of wetlands in the immediate vicinity of the Kachess Reservoir, and potentially permanently affect small areas of wetland along the transmission line route. Wetlands permanently affected by construction activities would be a fraction of the over 38 acres of palustrine wetlands mapped within the Kachess Reservoir watershed (Service, 2013; USGS, 2014). Reclamation would implement compensatory mitigation for unavoidable wetland impacts (discussed in Section 4.7.10), resulting in an overall effect of no net loss of wetlands.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.7.4.1).

### 4.7.5.2 Operation

**KDRPP South Pumping Plant Facilities**

Operation of the completed *Alternative 3* would be similar to that of *Alternative 2*. 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 on the Kachess River and the Keechelus reach of the Yakima River attributable to the operation of *Alternative 3* would be the same as those described for *Alternative 2*.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.7.4.2).

## 4.7.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.7.6.1 Construction*

**Vegetation**

Construction of *Alternative 4 (Preferred Alternative)* would require removal of vegetation. Approximately 4 acres of existing second-growth Douglas-fir forest would be permanently cleared to accommodate the proposed switch yard. The proposed east shore boat ramp and parking area would permanently clear 3 acres of second-growth coniferous forest. To the extent feasible, Reclamation would minimize disturbance to vegetation by using existing roads, cleared areas, and dry unvegetated portions of the reservoir bed for staging and access to construction sites. Table 4-90 identifies the area of temporary and permanent clearing and the dominant vegetation type.

**Table 4-90. Vegetation Disturbance Area Associated with Construction of *Alternative 4 (Preferred Alternative)***

| Construction Feature | Permanent Impact (acres) | Temporary Impact (acres) | Habitat/Forest Type |
|---|---|---|---|
| KDRPP switch yard | 4 | 0 | Second-growth coniferous forest |
| East shore boat ramp and parking area | 3 | 0 | Second-growth coniferous forest |
| **Total Impact Area (acres)** | **7** | **0** | **7 acres** |

The overall permanent effects of construction on vegetation are anticipated to be minor because the permanent effects would be small-scale, totaling approximately 7 acres of approximately 40,600 forested acres in the Kachess Reservoir watershed. Thus, the overall extent, connectivity, and integrity of forested habitat in the watershed would remain intact.

The potential effect of construction of *Alternative 4 (Preferred Alternative)* on State sensitive and USFS Survey and Manage plant species would be less than that of *Alternative 2* or *Alternative 3* because the construction area requiring vegetation clearing would be substantially smaller (7 acres versus 75.5 and 44.5 acres for *Alternatives 2* and *3*, respectively).

Indirect impacts could result from construction activities, such as modification of vegetation, partial shading of vegetation, water quality degradation, and alteration of wetland hydrology sources. *Alternative 4 (Preferred Alternative)* could also indirectly affect vegetation through the potential spread of nonnative plants and noxious weeds from ground-disturbing activities and dispersal from construction equipment and personnel. The project would use pumps that were previously located in a different body of water, which may result in the introduction of invasive plant species currently not present in Kachess Reservoir. Erosion and sedimentation from construction activities could also indirectly affect vegetation communities. Reclamation would implement measures to reduce erosion and sediment deposition during construction and reduce the spread of noxious weeds.

**Wetlands**

The potential effect of construction of *Alternative 4 (Preferred Alternative)* on wetlands would be less than that of *Alternatives 2* or *3*. *Alternative 4 (Preferred Alternative)* is not anticipated to result in temporary or permanent wetland impacts, compared with 0.7 and 0.5 acre of permanent wetland impacts for *Alternatives 2* and *3*, respectively.

Construction of the KDRPP floating pumping plant would result in no direct temporary or permanent effects on wetlands identified in the primary study area. Construction of the temporary and permanent reservoir facilities would occur entirely within unvegetated portions of the reservoir bed and is not anticipated to directly affect vegetated wetlands.

*Alternative 4 (Preferred Alternative)* could indirectly affect wetlands through shading of wetland vegetation and the inadvertent spread of nonnative plants and noxious weeds from ground-disturbing activities and from dispersal from construction equipment and personnel. Erosion and sedimentation from construction activities could also indirectly affect wetland vegetation communities; however, Reclamation would implement erosion and weed control measures to reduce potential indirect impacts on wetland vegetation. Construction of *Alternative 4 (Preferred Alternative)* facilities would have minor effects on wetlands along the Kachess Reservoir shoreline or other wetlands in the Kachess Reservoir watershed because there would be no direct impacts on wetlands, and any indirect impacts on wetlands would be limited and localized with the implementation of appropriate BMPs (see Section 4.7.10 for additional information).

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.7.4.1).

#### *4.7.6.2 Operation*

Operation of the completed *Alternative 4 (Preferred Alternative)* would be similar to that of *Alternative 2.* 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 on the Kachess River and Keechelus reach of the Yakima River attributable to the operation of *Alternative 4 (Preferred Alternative)* would be the same as those described for *Alternative 2.*

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.7.4.2).

## 4.7.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

### *4.7.7.1 Construction*

**Vegetation**

Construction of the pumping plant on the east shore of Kachess Reservoir under *Alternative 5A* would disturb the same amount of vegetation as that described for *Alternative 2* (approximately 75.5 acres of vegetation, 18 acres permanently).

The North Tunnel between Kachess and Keechelus reservoirs 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 4-91). 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 mature and sub-mature coniferous forest, 3.5 acres of which would be permanently cleared. Temporary construction corridors would be revegetated upon completion of construction.

**Table 4-91. Vegetation Disturbance Area Associated with Construction of the 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 | 0.0 | 4.0 (Option A)<br>0.0 (Option B) | Riparian/second-growth coniferous forest and disturbed land |
| Keechelus portal | <0.1 | 0.0 | Second-growth coniferous forest |
| Kachess Lake Road portal, discharge structure, spillway, stilling basin | 3.5 | 2.0 | Mature and sub-mature forest |

| Construction Feature | Permanent Impact (acres) | Temporary Impact (acres) | Habitat/Forest Type |
|---|---|---|---|
| Temporary access roads, staging and stockpile areas | 0.0 | 1.0 | Second-growth coniferous forest |
| **Total Impact Area** | **4.0** | **8.5** | **12.5** |

In total, *Alternative 5A* would disturb approximately 88 acres of vegetation, 22 acres permanently. The overall effects of construction on vegetation are anticipated to be minor because permanent impacts would be small-scale, totaling 21.5 acres of approximately 40,600 forested acres within the Kachess Reservoir watershed, and 0.5 acre of approximately 34,000 forested acres within the Keechelus Reservoir 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.

### Wetlands

Construction of the pumping plant on the east shore of Kachess Reservoir under *Alternative 5A* would have the same wetland impacts described for *Alternative 2 (*0.7 acre of permanent impacts on wetlands).

Construction of the Yakima River diversion, fish screens, intake, Yakima River-to-Keechelus portal conveyance, and Keechelus tunnel portal shaft 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 east of Keechelus Dam and would avoid siting structures within the wetland (Figure 3-27). Tunneling under the wetland mitigation site is not anticipated to permanently affect its hydrology. The mitigation site's primary source of hydrology is surface water discharge from a drain system that collects seepage from the dam, and the source 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. Temporary dewatering may cause minor shifts in the wetland vegetation community. However, because groundwater levels are expected to return to preconstruction conditions within a year and because 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 given 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 to minimize disturbance to wetlands and vegetation.

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 affect a fraction of the 352 acres of palustrine wetlands mapped within Keechelus Reservoir and 38 acres of wetlands mapped in the Kachess Reservoir watershed (Service, 2013; USGS, 2014). Reclamation would implement compensatory mitigation for unavoidable wetland impacts (discussed in Section 4.7.10), resulting in an overall effect of no net loss of wetlands.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.7.4.1).

#### *4.7.7.2 Operations*

**KKC North Tunnel Alignment Facilities**

Operation of the facilities under *Alternative 5A* would not disturb or otherwise affect 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 5A* 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. 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, effects from loss of water from the pipeline into surrounding soil, as known as exfiltration, 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). 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.

Operational effects of *Alternative 5A* would change reservoir levels in both Kachess and Keechelus reservoirs. During multiyear droughts, Kachess Reservoir would be drawn down to as much as 80 feet below minimum pool level, with recovery occurring 2 to 5 years later. Effects on wetlands and vegetation are expected to be similar to those under *Alternative 2.*

On average, Kachess Reservoir would have a slightly higher maximum water level (average of 2.1 feet) during most years during the growing season; however, the maximum pool elevation would not exceed the maximum pool elevation under *Alternative 1*. The anticipated timing of Kachess Reservoir pool refill and drawdown is expected to be nearly identical to the conditions under *Alternative 1*, 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 has likely developed at the site because of the reservoir. However, wetland vegetation communities around 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 notable 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 5A*, maximum water levels in Keechelus Reservoir would be reduced by 10 to 25 feet and minimum water levels would be reduced by about 12 feet during the 2 to 3 post-drought years and when Keechelus Reservoir is refilling. Drawdown effects on wetlands and vegetation would be more pronounced compared with *Alternative 2* since the duration of drawdown could persist for several years.

In summary, Reclamation anticipates the operation of *Alternative 5A* to result in minor loss of vegetation around either the Kachess or Keechelus Reservoir shorelines. The higher reservoir levels at Kachess and lower reservoir levels at Keechelus may cause temporary shifts in wetland vegetation, but overall no substantial change to vegetation communities within the reservoirs would occur.

*Alternative 5A* 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 mean summer flows would increase by 170 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*. The greatest change is that mean summer flows would be reduced by over 50 percent in all years. Restoring summertime flows to a regime that mimics unregulated conditions in this reach would likely shift 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 change would be a beneficial impact on vegetation communities as native riparian vegetation is reestablished under more natural river flow regimes.

Operation of *Alternative 5A* 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 Kachess Reservoir, whereas species requiring drier conditions may experience mortality during prolonged inundation.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.7.4.2).

### 4.7.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 3* (Sections 4.7.5). Impacts associated with the KKC North Tunnel would be the same as those discussed for *Alternative 5A* (Section 4.7.7). Permanent wetland impacts for *Alternative 5B* would total 0.5 acre, and permanent vegetation impacts would total 12 acres. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.7.7 (*Alternative 5A*).

### 4.7.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 4 (Preferred Alternative)* (Section 4.7.6). Impacts associated with the North Tunnel would be the same as those discussed in *Alternative 5A* (Section 4.7.7). No permanent wetland impacts are anticipated for *Alternative 5C*, and permanent vegetation impacts would total 11 acres. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.7.7 (*Alternative 5A*).

### 4.7.10 Avoidance, Minimization and Mitigation Measures

The Preferred Alternative is not anticipated to have impacts to wetlands regulated under the Clean Water Act. However, prior to construction in areas where any type of construction or temporary disturbance is proposed, project proponents would conduct on-the-ground wetland surveys using the current wetland delineation and categorization methodologies accepted by Federal, State, and local agencies. Project proponents would obtain any applicable permits and comply with mitigation measures, if applicable, as established in permit conditions from applicable agencies.

Project proponents 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 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 seek to 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. Project proponents would replant disturbed areas with native vegetation where replanting would not interfere with the function of shoreline protection measures. Project proponents would coordinate with WDFW and USFS to identify additional mitigation for permanent or long-term loss of terrestrial habitat, particularly forested habitat.

Reclamation would coordinate with USFS to determine whether 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.

Project proponents would develop an invasive species management plan or integrated pest management plan to assess the areas where facilities would be installed to determine whether there were any invasive species or undesirable vegetation. If present, project proponents would suppress this vegetation prior to ground disturbance and monitor for infestations of invasive plant species associated with ground disturbances and periods of prolonged drawdowns on the Kachess and Keechelus reservoirs. Project proponents 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 are shown in Table 4-92. Reclamation assessed all criteria relative to *Alternative 1 – No Action*.

**Table 4-92. Impact Indicators for Wildlife**

| Issues | Impact Indicators |
|---|---|
| Loss of wildlife habitat (forest and wetland) | Loss of ability to support activities of local species including habitation, breeding, foraging, or transient movements |

| Issues | Impact Indicators |
|---|---|
| Alteration of shoreline habitat (littoral fringe) | Loss of shoreline habitat's ability to support local wildlife species including habitation, breeding, foraging, or transient movements |
| Disturbance of wildlife species from construction noise | Zones of impact for construction noise |
| Disturbance of wildlife species from operational noise | Zones of impact for operations noise |

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. Construction impacts include 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 Volitional Bull Trout Passage Improvements. To analyze potential habitat loss, Reclamation quantified available suitable habitat in the Kachess and Keechelus Reservoir watersheds from GIS maps. To analyze changes in wildlife habitat because of 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 because of 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). Analysts determined that the following distances from construction sites would allow construction noise to reach background levels:

- 4,200 feet for pumping plant construction (*Alternative 2 – KDRPP East Shore Pumping Plant* and *Alternative 3 – KDRPP South Pumping Plant*)
- 4,200 feet for construction of Upstream Fish Passage at the Narrows (*Alternative 4 [Preferred Alternative]*)
- 5,450 feet for portal construction (*Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment, 5B Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment*, and *Alternative 5C– KDRPP Floating Pumping Plant with KKC North Tunnel Alignment*)
- 1,650 feet for general construction (all alternatives) including the transmission line construction (*Alternative 2 only*)
- Figure 4-13 and Figure 4-14 show the zone of potential noise impact for wildlife disturbance associated with all alternatives.

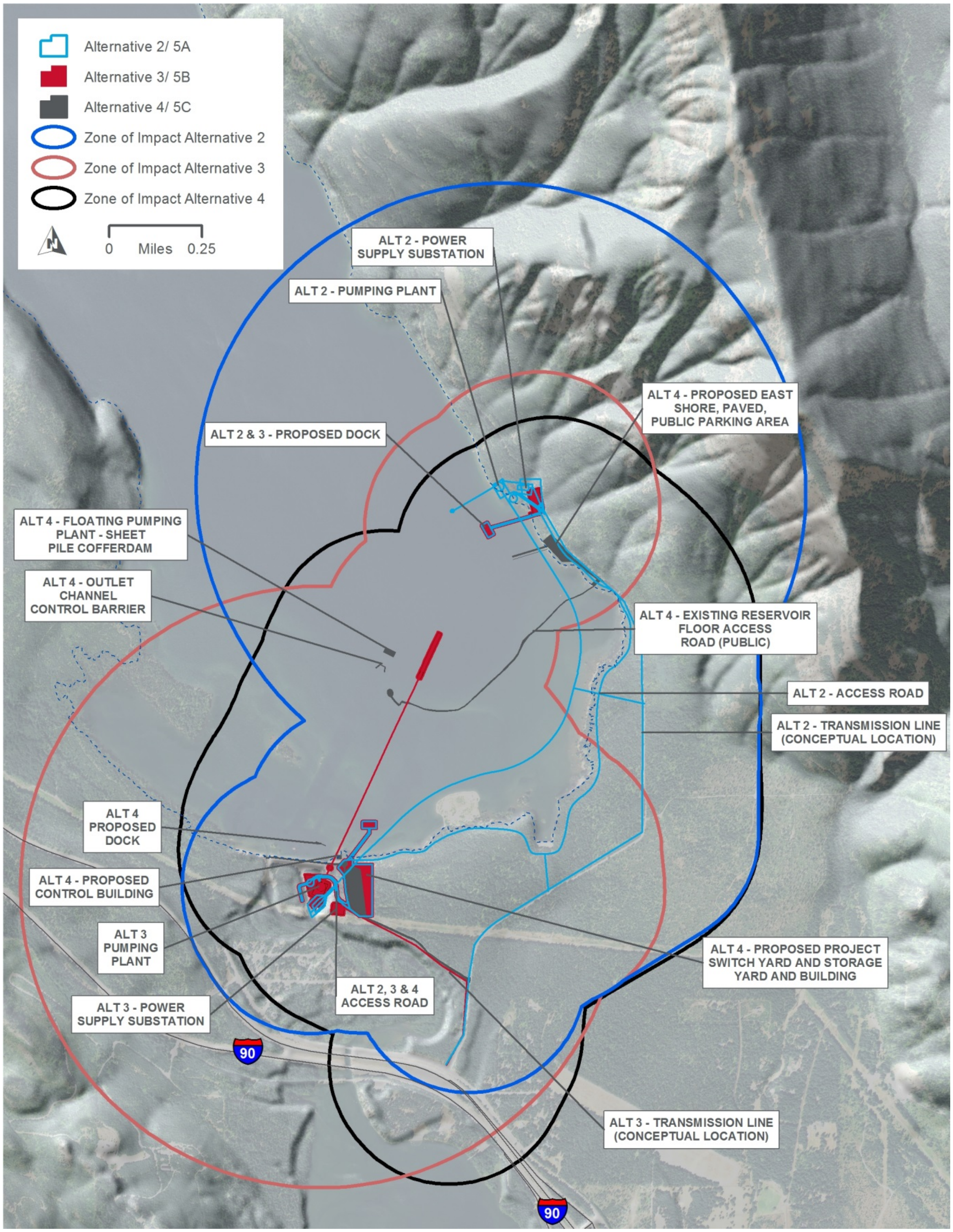



**Figure 4-13. Potential Noise Wildlife Impact Zone in the Kachess Reservoir Study Area**

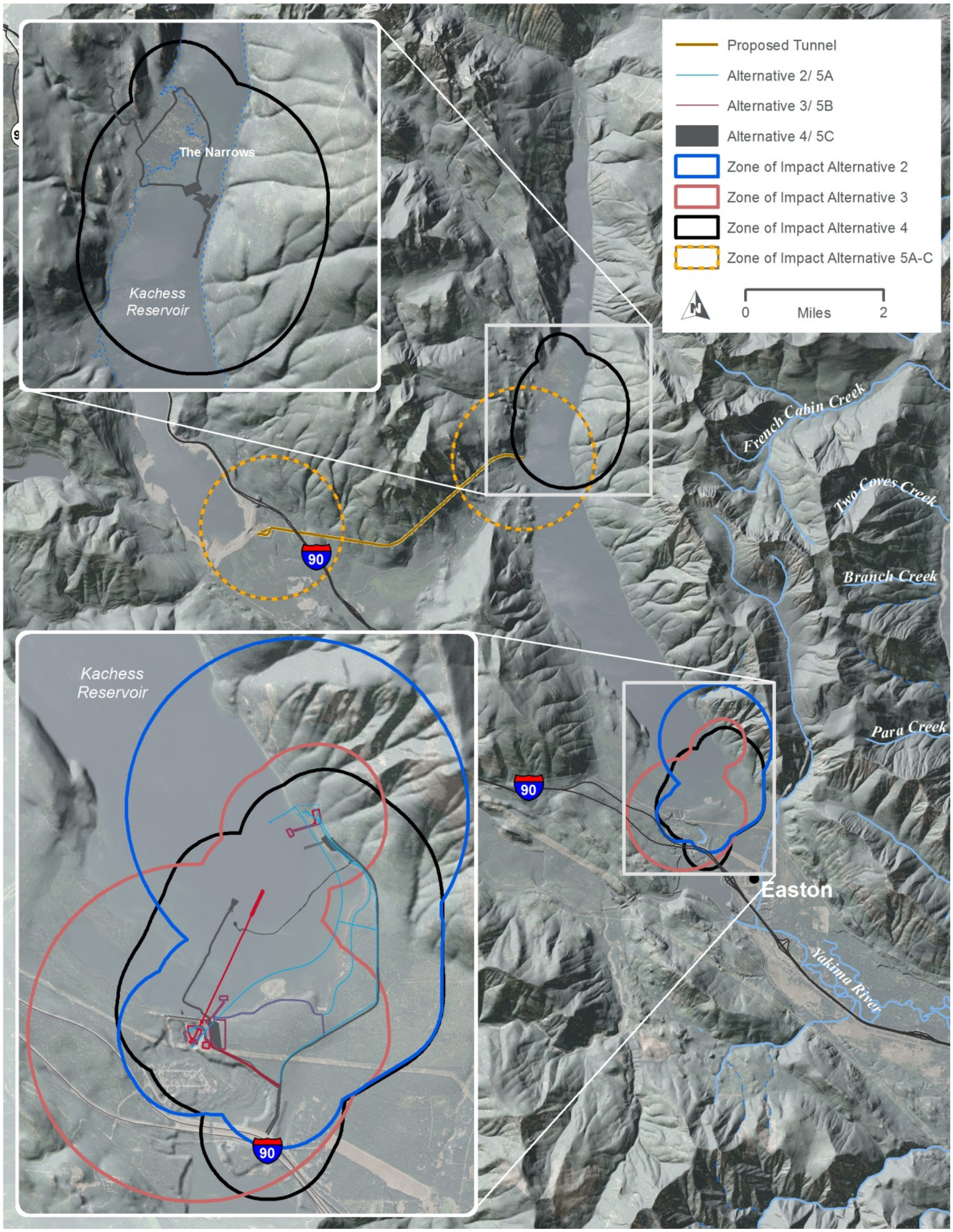



**Figure 4-14. Potential Noise Wildlife Impact Zone in the Keechelus and Kachess Reservoir Study Areas**

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, or grading)
- Injury, death, or harassment of wildlife in the primary study area (e.g., from equipment operation, vegetation clearing, or construction-generated noise)
- Habitat degradation (e.g., because of alterations in water levels or erosion)

The significance of a negative impact on wildlife habitat depends on the amount of expected habitat loss and the type of habitat that is lost or altered relative to existing conditions, and on the species using the habitat, see Table 4-92.

### 4.8.2 Summary of Impacts

Under *Alternative 1*, wildlife conditions would remain similar to existing conditions. The project alternatives for KDRPP and KKC would result in temporary and permanent loss of wildlife habitat in the proposed construction areas of each alternative. In the case of forested habitat, temporary loss would extend beyond construction of the project for many years until trees have regrown. *Alternative 2* would result in greater permanent and temporary habitat loss (18 acres and 57.5 acres respectively) than *Alternative 3* (8 acres and 36.5 acres). *Alternative 4 (Preferred Alternative)* would have the least impact at 7 acres of permanent habitat loss, and no temporary loss of acreage. 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. These permanent changes to habitat associated with *Alternatives 2, 3*, and *4* would, however, be small relative to the large areas of available habitat throughout the Kachess Reservoir watershed.

*Alternative 5A* would have a larger construction footprint and disturb more upland vegetation than *Alternative 5B* and *5C* (approximately 22 acres under *Alternative 5A,* 12 acres under *Alternative 5B,* and 11 acres under *Alternative 5C*). Temporary habitat losses would also be highest for *Alternative 5A* at 66 acres, and *Alternative 5B* at 45 acres, while *Alternative 5C* would have only 8.5 acres of temporary impact associated with the KCC tunnel. Permanent changes to habitat under either of these alternatives would be small relative to the combined Kachess and Keechelus watersheds and the majority of habitat lost would be second-growth coniferous forest.

In addition to habitat loss, KDRPP and KKC would disturb wildlife during construction and cause long-term alteration of habitat. Shoreline vegetation could be altered under drawdown operations for all alternatives by changes in hydrologic conditions. Prolonged reservoir drawdowns could cause a shift in existing wetland plant communities as described in Section 4.7.4, and alter shoreline habitat during these periods.

**Table 4-93. Summary of Impacts for Wildlife**

| Impact Indicator | Summary of Impact |
|---|---|
| Loss of ability to support activities of local species including habitation, breeding, foraging, or transient movements | *Alternative 2* would result in greater permanent habitat loss (18 acres) than *Alternative 3* (8 acres) and greater temporary habitat loss (57.5 acres compared with 36.5 acres).<br>*Alternative 4* would result in the smallest area of impact on wildlife habitat at 7 acres, similar to *Alternative 3* but with no temporary habitat loss because of the pumping plant being on the reservoir.<br>*Alternative 5A* would result in the greatest amount of permanent habitat loss (22 acres). *Alternative 5B* would result in loss of 12 acres, and *Alternative 5C* would result in loss of 11acres. |
| Loss of shoreline habitat's ability to support local wildlife species including habitation, breeding, foraging, or transient movements | Shoreline vegetation could be altered under *Alternatives 2, 3* and *4* by changes in hydrologic conditions. |
| Zones of impact for construction noise | *Alternatives 2, 3, 4, 5A, 5B,* and *5C* could result in direct harm or harassment of wildlife using habitat within or near the construction areas. |
| Zones of impact for operations noise | *Alternatives 2, 3*, and *4* would create noise, light, and daily human activity in the vicinity of the pumping plant locations. *Alternative 4* would also have human activity at the east shore boat ramp and dock.<br>*Alternatives 5A*, *5B,* and *5C* would create noise, light, daily human activity in the vicinity of the KKC discharge. |

## 4.8.3 Alternative 1 – No Action

Under *Alternative 1*, 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 reservoir basins would continue over the long term.

## 4.8.4 Alternative 2 – 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 (see Figure 2-1, Table 4-85, and Table 4-87) (see Section 4.7for a discussion of wetland impacts). In addition to habitat loss, KDRPP and KKC would disturb wildlife during construction and cause long-term alteration of habitat. Shoreline vegetation could be altered under drawdown operations for all alternatives by changes in hydrologic conditions. Prolonged reservoir drawdowns could cause a shift in existing wetland plant communities as described in Section 4.7.4, and alter shoreline habitat during these periods.

Construction would temporarily impact an additional 57.5 acres of forest, but this area would be re-vegetated 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. 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 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, mountain goat, and deer. The amount of habitat permanently lost under *Alternative 2* would be minor in comparison with the home ranges of these large mammal species. As a result, there would be a minor effect on large mammals because of 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, and 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 interconnect could disturb wildlife within 1,650 feet (Figure 4-13 and Figure 4-14).

Construction noise and increased human activity would cause short-term disturbance to wildlife within these zones during the 3-year construction period. Elk and mountain goat winter range are next to impacted terrestrial areas. Elk may be displaced slightly if construction occurs during the fall and winter months since the KDRPP construction area is at the edge of their mapped winter range, but displacement from this area is not expected to have a large impact on this winter range area (WDFW, 2015). The clearing of second growth forest by KDRPP is not likely to impact mountain goat seasonal movements to a large degree, but they could be in the area during construction of the project and could be displaced by construction activity (WDFW, 2015).

Some individuals of any of the local wildlife species may not stay in the vicinity because of the disturbance; background levels of noise are expected outside these impact zones (as described in detail in Section 4.13). 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 on wildlife associated with construction of *Alternative 2* would result in permanent loss of wildlife habitat and potential injury, death, or harassment of nesting wildlife in habitats of the primary study area.

**Volitional Bull Trout Passage Improvements**

Construction associated with the roughened channel and the Narrows flow bifurcation weir would require clearing and vegetation removal, excavation, hauling, and placement of wood and rock. The fish passage improvements at the Narrows would result in clearing of 0.7 acres of terrestrial forest habitat along the shore of Kachess Reservoir. Construction of the roughened channel and instream features including the weir would occur in the channel and not impact terrestrial habitat. An access road and work area would be established on the west side of the Narrows for construction. Both the access road and work areas would be located entirely within non forested areas along the reservoir shoreline that are inundated during full pool, but would be exposed and dry during construction of the Volitional Bull Trout Passage Improvements (Chapter 2, Figure 2-4). Therefore, there would be no permanent or temporary loss of forest habitat from construction of the roughened channel and weir, as well as the staging areas, and west access road. Impacts on terrestrial wildlife would be limited to noise from construction and human presence and vehicle traffic along the access road.

Noise from construction of the fish passage channel and associated staging area at the Narrows would disturb wildlife in the vicinity. Noise from excavation, grading, and general construction traffic could disturb wildlife using habitats within 4,200 feet. This disturbance would be temporary during construction activities and would be minor in impact as adjacent suitable habitat is plentiful, and any temporarily displaced wildlife could return following construction.

### *4.8.4.2 Operation*

**KDRPP East Shore Pumping Plant Facilities**

Under *Alternative 2*, Reclamation would draw down 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 because of 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 2*. 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 2* 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 2* are considered minor.

**Volitional Bull Trout Passage Improvements**

Operation of the Volitional Bull Trout Passage Improvements at the Narrows are expected to have some beneficial impacts for wildlife and wildlife habitat. Improved surface water connectivity and consistent flows would benefit birds and animals that inhabit riparian areas and use riverine habitats.

### 4.8.5 Alternative 3 – 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 would permanently replace approximately 8 acres of wildlife habitat (Section 4.7.5). Construction would temporarily impact an additional 36.5 acres of forest, but this area would be re-vegetated with native species after construction is completed. The new pumping plant would permanently replace approximately 4.5 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 2* (for the outlet works and discharge), more vegetation would be cleared under *Alternative 3*. *Alternative 2* would have the greatest impacts on species with small home ranges (e.g., songbirds, chipmunks, frogs, snakes) while impacts on large mammals would be less due to their mobility and larger ranges, and given the availability of suitable habitat in the surrounding area. This alternative would impact the same 0.5-acre wetland located south of the dam, similar to *Alternative 2* (as described in Section 4.7.5).

Disturbance of wildlife using habitats in the primary study area would be slightly less under *Alternative 3* than under *Alternative 2* because the extent of construction would be approximately 10 acres less than the 18-acre loss expected under *Alternative 2* (Section 4.7.5, Vegetation, and Wetlands). In addition, construction activities would occur in a smaller area (44.5 acres of permanent and temporary impact) than under *Alternative 2* (75.5 acres total of permanent and temporary impact).

Overall impacts associated with the construction of *Alternative 3* are expected to be slightly less than those for *Alternative 2* because of the reduced area of cleared vegetation. The impacts would result in permanent loss of wildlife habitat and potential injury, death, or harassment of nesting wildlife in habitats of the primary study area.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.8.4.1).

### *4.8.5.2 Operation*

**KDRPP South Pumping Plant Facilities**

Operation of *Alternative 3* would have the same level of impact on wildlife and wildlife habitat along the shoreline of Kachess Reservoir as *Alternative 2*. Reclamation would operate KDRPP the same regardless of the location of the facilities.

**Volitional Bull Trout Passage Improvements**

Operational impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.8.4.2).

## 4.8.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.8.6.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

Construction of *Alternative 4 (Preferred Alternative)* would require removal of some wildlife habitat. To the extent feasible, Reclamation would minimize disturbance to vegetation by using existing roads, cleared areas, and dry unvegetated portions of the reservoir bed for staging and access to construction sites. Construction is expected to last 1 year, although some features would be completed in subsequent years when the reservoir is drawn down further during drought relief pumping (see Section 2.5.2).

Impacts on wildlife from construction noise and disturbance would be similar to those described for *Alternatives 2* and *3*, however with less impact on terrestrial habitat because of this alternative requiring a substantially smaller area of cleared vegetation. The floating pumping plant would be situated on the reservoir and total permanent impacts on wildlife habitat for this alternative would be 7 acres, compared with 18 acres and 8 acres for *Alternatives 2* and *3*, respectively. The permanent impacted area is similar to *Alternative 3* but without the temporary habitat loss during construction that would need time for revegetation to mature. Approximately 4 acres of existing second growth Douglas-fir forest would be permanently cleared to accommodate the proposed switch yard. The proposed east shore boat ramp and parking Area would permanently clear 3 acres of second-growth coniferous forest.

Installation of the floating pumping plant itself would not impact any terrestrial wildlife or habitat other than through construction noise from machinery. The pumping plant barge would be manufactured offsite in sections and assembled in an existing laydown area. All work would then be conducted out on the reservoir. Dredged material would be disposed of in a location within the reservoir and not brought out for upland deposition. During construction, the reservoir would be drawn down to facilitate construction activities. Under existing conditions, shoreline vegetation shifts periodically in response to the 60- to 80-foot fluctuation in pool level each year. The reservoir draw down during construction would be within the range of typical pool level fluctuations. Therefore, there would be no impacts on wildlife habitat from the dredging and construction of the pump plant.

Construction of *Alternative 4 (Preferred Alternative)* would include clearing of 7 acres for landward facilities including construction staging and laydown areas as described in Section 2.5. The 1.5 acre paved surface parking area for the east shore boat ramp would be used as a parking area by the public when construction is completed. Temporary impacted areas during construction would effectively be contained within staging areas and roads that would become part of the permanent project footprint in particular because of the construction of the pumping plant components off-site, and its location and assembly on the reservoir itself. Therefore, unlike with *Alternatives 2* and *3*, additional acres of clearing for construction would not be needed and replanting not required.

To minimize disturbance to forest and vegetation habitat, existing on-site access roads would be utilized to the greatest degree possible. One new proposed access road is required for project construction, operation, and maintenance purposes.

The permanent impacts from construction of *Alternative 4 (Preferred Alternative)* total approximately 7 acres of approximately 40,600 acres of relatively undisturbed forest within the Kachess Reservoir watershed (USGS, 2014). The loss of such a small area would have negligible effects on the extent, connectivity, and overall integrity of forested habitat in the watershed. The forest currently provides habitat for wildlife, such as songbirds, woodpeckers, small mammals (such as chipmunks and squirrels), and deer. 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. 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, mountain goat, and deer. The amount of habitat permanently lost under *Alternative 4 (Preferred Alternative)* would be very small in comparison with the home ranges of these large mammal species. As a result, there would be no significant effect on large mammals because of 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, and 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 4-13).

Construction noise and increased human activity would cause short-term disturbance to wildlife within these zones during the 1 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, Threatened and Endangered Species. 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.

These impacts are considered minor since construction activities would be temporary, adjacent suitable habitat is plentiful. Permanently impacted areas are much smaller than for *Alternative 2*, although the areas that are impacted would result in some permanent loss of wildlife habitat and potential injury, death, or harassment of nesting wildlife in habitats of the primary study area.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.8.4.1).

### *4.8.6.2 Operation*

**KDRPP Floating Pumping Plant Facilities**

Operation of *Alternative 4 (Preferred Alternative)* would have the same level of impact on wildlife and wildlife habitat along the shoreline of Kachess Reservoir as described for operation of *Alternative 2* (Section 4.8.4.2). Reclamation would operate the floating pumping plant the same as the shore based pumping plants regardless of the location of the facilities.

Existing operations at the reservoir seasonally separate the reservoir pool from the adjoining forest habitats. This gap in forest cover can be a barrier to some wildlife species intent on accessing the reservoir as a water source. The additional drawdown would not exacerbate this effect since the reservoir sides are steep, and the distance between the forest and the reservoir pool would not change drastically. The changes described would be temporary, as the reservoir is drawn down and refilled during the fall and winter.

Noise and increased human activity from the new east shore boat ramp and parking area as well as maintenance and operation of the facilities would cause disturbance to wildlife. Some individuals may not stay in the vicinity because of the disturbance. 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.

**Volitional Bull Trout Passage Improvements**

Operational impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.8.4.2).

## 4.8.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

### *4.8.7.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**

Construction of the pumping plant on the east shore of Kachess Reservoir under *Alternative 5A* would have similar impacts as described for *Alternative 2* and would disturb approximately 88 acres of vegetation, 22 acres permanently, as described in Section 4.7.7.

**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 2-13 and Section 4.7.7.1). Construction would temporarily impact an additional 8.5 acres of forest, but this area would be re-vegetated 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. A talus area just north of the KKC North Tunnel Alignment portal to Kachess has the potential to contain Larch Mountain salamander, a state sensitive species. Habitat for this species is limited in the area and this talus area should be avoided to the extent possible by keeping project activities to existing roads in the area. 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 mountain goat, black bear, cougar, and deer. The amount of permanent habitat lost under *Alternative 5A* would be minor in comparison with the home ranges of these large mammal species. As a result, there would no significant effect on large mammals because of 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 and 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 4-13). This area includes the new wildlife crossing overpass being constructed for the I-90 Snoqualmie Pass East project. Therefore, noise and disturbance could deter some individuals from using the crossing. 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. Additionally, because the new wildlife crossing over I-90 is in the area of noise disturbance, construction activities for the tunnel facilities could deter some animals from using the crossing and impede their access to habitats on the opposite side of the interstate. In summary, impacts associated with construction of *Alternative 5A* would be the same as those described for *Alternative 2* with the addition of a small area of impacts for the KKC North Tunnel.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.8.4.1).

#### 4.8.7.2 Operation

**KKC North Tunnel Alignment Facilities**

Operation of *Alternative 5A* would have no permanent impacts on wildlife habitat and minimal disturbance-related impacts on wildlife in the primary study area. Under *Alternative 5A,* maximum water levels in Keechelus Reservoir would be reduced by 10 to 25 feet and minimum water levels would be reduced by about 12 feet during the 2 to 3 post-drought years and when Keechelus Reservoir is refilling. However, Reclamation does not anticipate the operation of *Alternative 5A* to result in substantial loss of vegetation around either the Kachess or Keechelus reservoir shorelines. The higher reservoir levels at Kachess Reservoir and lower reservoir levels at Keechelus Reservoir may cause temporary shifts in wetland vegetation, but there would be no substantial change to vegetation communities within the reservoirs.

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 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 to or harassment of wildlife.

**Volitional Bull Trout Passage Improvements**

Operational impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.8.4.2).

### 4.8.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 3* (Section 4.8.5.1). Impacts for the North Tunnel component would be the same as those discussed in *Alternative 5A* (Section 4.8.7.1). Permanent wetland impacts for *Alternative 5B* would total 0.5 acre, and permanent vegetated habitat impacts would total 12 acres. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.8.7 (*Alternative 5A*).

### 4.8.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 4 (Preferred Alternative)* (Section 4.8.6.1). Impacts would be the same as those associated with the North Tunnel discussed in *Alternative 5A* (Section 4.8.7.1). Permanent vegetated habitat impacts would total 11 acres. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements at the Narrows would be the same as described in Section 4.8.7 (*Alternative 5A*).

### 4.8.10 Avoidance, Minimization and Mitigation Measures

Similar to the mitigation measures identified in Section 4.7.10, the project proponents would minimize impacts on wildlife during construction. Avoidance and minimization of vegetation removal to the extent possible would reduce impacts on wildlife and wildlife habitats. Reclamation will conduct ongoing coordination with WDFW and the Service to comply with avoidance and minimization procedures for MBTA species including construction timing to avoid nesting periods. Areas cleared for construction and temporary access would be replanted where possible, using plant species of the same type and proportion as the native vegetation removed. For the Volitional Bull Trout Passage Improvements, the disturbed streambed and riparian habitats along the stream corridor would be re-graded and re-vegetated.

## 4.9 Threatened and Endangered Species

This section describes the potential impacts on 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.** In compliance with Section 7(a)(2) of the ESA, Reclamation will prepare a Biological Assessment (BA) once a preferred alternative has been identified, and at that time Reclamation will consult with the Service and NMFS. The list of issues and indicators below is responsive to issues raised by the Service, NMFS and WDFW (Table 4-94 and Table 4-95).

Reclamation reviewed Federal and State databases to determine the presence of ESA-listed species likely to be present in the analysis area. Reclamation conducted a literature review to determine the preferred habitat and life cycles of those species and to analyze how additional inundation around the shoreline would affect that habitat. In addition, WDFW conducted surveys in 2014 through 2016 for listed species.

Reclamation evaluated potential noise impacts by comparing expected construction noise levels with thresholds established by the Service. 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) would display 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 include the use of noise-reducing conservation measures (Service, 2003).

The threshold distances for the spotted owl 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. In 2015, the Service published a BO for WSDOT activities (Service, 2015) which establishes harassment or injury distances for noise-generating activities specific to marbled murrelets and northern spotted owls and changes the thresholds from a noise-based measurement to a distance threshold. Disturbance distances to nesting, foraging, or roosting areas used by the owls from heavy equipment and construction activities can occur out to a distance of 0.25 mile, and for blasting from 0.25 to 1 mile distance (WSDOT, 2015). During the nesting period between March 1 and July 15, adverse effects or harm to owls is considered to occur within 195 feet for general construction activities, and within 0.25 mile for blasting (WSDOT, 2015).

**Impact Indicators.** Table 4-94 and Table 4-95 show the Federal threatened and endangered species impact indicators. Reclamation assessed all criteria relative to the *Alternative 1 – No Action*.

The impact indicators for listed bull trout and MCR steelhead are the same as for fish species discussed in Section 4.6.1, with the exception of water temperature, for which bull trout have specific impact indicators (Table 4-94).

**Table 4-94. Impact Indicators for Bull Trout and MCR Steelhead**

| Issues | Indicators |
|---|---|
| Change in reservoir levels in Kachess Reservoir low pool gravity outlet operation reducing growth of benthic invertebrates | Number of days at or below elevation 2,192.75 |
| Change in reservoir levels in Kachess Reservoir impeding fish passage (bull trout) | Number of days at or below elevation 2,220 (the elevation of separation of Big and Little Kachess) |
| Change in water temperatures in Kachess Reservoir affecting bull trout | Frequency and duration of water temperature increases in Kachess Reservoir. |
| Change in water temperatures downstream from Kachess Dam affecting MCR steelhead and bull trout | Beneficial decrease in water temperature downstream from Kachess Dam |
| Flows supporting bull trout and MCR steelhead rearing downstream from Kachess Dam rearing | Maintenance of suitable flows in the Keechelus reach of the Yakima River - days in July at or below 500 cfs out of the period modeled (more days is positive impact). Maintenance of flows in Easton reach. |

**Table 4-95. Impact Indicators for Northern Spotted Owl**

| Issue(s) | Indicator(s) |
|---|---|
| Finding of effect per Endangered Species Act (50 CFR 402.02) | Blasting (92 dBA or higher) between March 1 and September 30 within 1 mile of nesting, foraging, or roosting areas used by northern spotted owl<br>Other construction noise disturbance between March 1 and July 15 within a quarter-mile of areas used by northern spotted owl including nest sites |
| Loss or degradation of habitat that supports northern spotted owl | Acres of suitable habitat lost, including degraded during recovery from temporary impacts |

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, and increased noise and human activity during construction.

## 4.9.2 Summary of Impacts

### *4.9.2.1 Bull Trout and MCR Steelhead*

Impacts on bull trout and MCR steelhead (Table 4-96) would be similar to those described in Section 4.6.2. The most significant long-term impacts would be related to project operations; however, short-term construction impacts are also anticipated. Potential impacts would originate from changes in operations, changes in reservoir elevation and construction activities, and climate change.

**Table 4-96. Summary of Impacts for Bull Trout and MCR Steelhead**

| Impact Indicator | Summary of Impact |
|---|---|
| Number of days at or below elevation 2,192.75 | *Alternative 1* – 0 days<br>*Alternatives 2, 3*, and *4* – 6,225 days (occurs in 34 years, 183 days average per year)<br>*Alternatives 5A, 5B*, and *5C* – 4,976 days (occurs in 32 years, 156 days average per year) |
| Number of days at or below elevation 2,220 (the elevation of separation of Big and Little Kachess) | *Alternative 1* – 5,681 days (occurs in 73 years of 91 modeled), 78 days average per year)<br>*Alternatives* 2, *3*, and *4* – 11,692 days (occurs in 76 years of 91 modeled), 154 days average per year)<br>*Alternatives 5A, 5B,* and *5C* – 10,626 days (occurs in 76 years of 91 modeled), 140 days average per year) |
| Frequency and duration of water temperature increases in Kachess Reservoir | *Alternative 1*– no change.<br>*Alternatives 2*, *3*, 4, *5A, 5B, and 5C* – decrease Kachess Reservoir surface temperatures 1-2°C in mid-August, increase surface temperatures approximately 1°C in late September |
| Beneficial water temperature downstream of Kachess Dam | *Alternative 1*– no change.<br>*Alternatives 2*, *3*, 4, *5A, 5B and 5C* – decrease Kachess River temperatures from mid-August to early October |
| Maintenance of suitable flows in Keechelus reach of the Yakima River - Days in July at or below 500 cfs out of the period modeled (more days is positive impact).<br>Maintenance of flows in Easton reach. | *Alternative 1* – 42 days (occurs in 13 years, 3 days average per year). No change in Easton reach flows.<br>*Alternatives 2, 3*, and *4* – 110 days (occurs in 16 years, 7 days average per year). Up to approximately 30% increase in Easton reach summer flow in drought years.<br>*Alternatives 5A, 5B,* and *5C* – 2,677 days (occurs in 89 years, 30 days average per year). Up to approximately 30% increase in Easton reach summer flow in drought years. |

Based on modeled surface water elevations, all action alternatives would:

- Increase the number of days Kachess Reservoir is at or below elevation 2,192.75, which could reduce growth of benthic invertebrates;
- Increase the number of days Kachess Reservoir is at or below elevation 2,220, which would impede fish passage between Big and Little Kachess and would be addressed by construction of the Volitional Bull Trout Passage Improvements;
- Increase the number of days that there are suitable flows in the Keechelus reach of the Yakima River, which supports spring MCR steelhead smolt out migration and summer rearing for subyearling bull trout and fry and subyearling MCR steelhead.

- In drought years, increase summer flow in the Easton reach of the Yakima River, reducing rearing area for subyearling bull trout and fry and subyearling MCR steelhead.

Under Alternatives 2, 3, 5A, and 5B, water temperature downstream of Kachess River would be expected to decrease and Kachess Reservoir water temperatures would be expected to decrease in mid-August, but increase slightly by the end of the pumping season at the end of September. Under Alternatives 4 and 5C, water temperature downstream of Kachess River are expected to decrease and Kachess Reservoir water temperatures are expected to decrease.

#### *4.9.2.2 Northern Spotted Owl*

Recent surveys have indicated that suitable habitat occurs throughout much of the areas surrounding the project alternatives, but the area was not found to be currently occupied by spotted owls (WDFW, 2016). Historically owls have occupied areas near the Kachess east shore and they have never been detected in the south shore area (WDFW, 2016).

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 on individual or nesting northern spotted owls if present. When compared with the other action alternatives, *Alternative 2 – KDRPP East Shore Pumping Plant* has the potential for the greatest loss or degradation of suitable habitat because it would involve the greatest amount of mature and second-growth forest removal. Designated critical habitat (Service, 2012) is located in the forested areas surrounding much of the Kachess and Keechelus reservoirs and would therefore be impacted to varying degree by the project alternatives as described in the following sections. In addition, the East Shore Pumping Plant location is within a historical northern spotted owl site known as Kachess Ridge. Pre-construction surveys would be conducted to confirm whether this area remains unoccupied. Project impacts would be considered to have no potential effects on northern spotted owls if pre-construction surveys verify that no owls are present within the threshold distances for disturbance or harm.

Due to the distances to historic or potential nesting sites (more than 0.25 mile), none of the action alternatives would be at the noise thresholds to cause direct harm, or nesting disruption to northern spotted owl from general construction activity (WSDOT, 2015). Potential spotted owl sites are however within 1 mile of noise impacts from blasting activities for the deep shafts in *Alternatives 2 and 3*. Blasting would however be scheduled to occur outside the nesting season (nesting typically occurs from March 1 through September 30). The area surrounding the project area is potential foraging and dispersal habitat where there is potential for an individual to be present throughout the year and therefore 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 greatest potential to adversely affect northern spotted owl. *Alternative 2* would have the most project areas near potentially occupied habitat and, therefore, a higher potential to result in disturbance behaviors given the proximity of project areas to potentially occupied habitats under *Alternative 2*. Table 4-97 summarizes these impacts on northern spotted owl.

**Table 4-97. Summary of Impacts for Northern Spotted Owl**

| Impact Indicator | Summary of Impact |
|---|---|
| Blasting (92 dBA or higher) between March 1 to September 30 within 1 mile to nesting, foraging, or roosting areas used by northern spotted owl<br>Other construction noise disturbance between March 1 to July 15 within a quarter-mile of areas used by northern spotted owl including nest sites | All action alternatives would result in increased noise and human activity. No alternatives are expected to result in noise that would harm or injure threatened or endangered terrestrial species; however, noise exceeding the noise-only disturbance threshold may occur, resulting in adverse impacts under all action alternatives. *Alternatives 2* and *5A* would have construction activities closer to habitat potentially occupied by northern spotted owls and, therefore, would have the highest potential for noise impacts. |
| Acres of suitable habitat lost, including degraded during recovery from temporary impacts | Although there is critical habitat within the project area, project impacts on habitat would be considered to have no potential effects on northern spotted owls.<br>For *Alternatives 2*, *3,* and *4*, the amount of permanent vegetation removal within suitable habitat would be 18, 8, and 7 acres, respectively. *Alternative 5A* would have the largest area of vegetation removal (22 acres). |

## 4.9.3 Alternative 1 – No Action

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 historic condition.

### *4.9.3.1 Bull Trout*

Under *Alternative 1*, Reclamation would operate both Keechelus and Kachess reservoirs in the same manner as existing conditions. The habitat available to bull trout in 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*, bull trout are expected to continue to be rare in the upper Yakima and Kachess rivers (Reiss et al., 2012) because instream flows are too high in summer months.

Bull trout 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, prey availability, and other risks (Reiss et al., 2012). Because bull trout require clean, cool water, future climate change may pose a risk to bull trout throughout their existing range (Rieman et al., 2007) and particularly those populations currently isolated in 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 on. 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).

#### *4.9.3.2 MCR Steelhead*

Under *Alternative 1*, 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*, flows in 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 to 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 reach's production potential for steelhead (Hubble, 2014b).

Under *Alternative 1*, flows in the Keechelus reach would also remain too low in winter, and flow pulses would be absent in the spring because of 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 that mimic natural freshets 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 by 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*, 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 noise from I-90 as well as intermittent activity associated with road maintenance and recreational use of the area..

### 4.9.4 Alternative 2 – 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 2* would be the same as those described for fish in Section 4.6.4.1. Construction activities would affect habitats in Kachess Reservoir and the 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 the 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 the Kachess River, *Alternative 2* would require construction of a discharge spillway at the headwaters of the Kachess River immediately downstream from 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 4.6.4.1describes the impacts of shoreline disturbance and turbidity. Bull trout are rarely observed in the Kachess River (Hubble, 2014a; Reiss et al., 2012), so few if any fish would be affected by construction activities.

Inwater work that uses equipment or boats that have been used in other water bodies would create the risk of introducing invasive aquatic species that can alter aquatic ecosystems, such as zebra mussels or quagga mussels. Kachess Reservoir experiences high boating activity and the increase in the number of boat launchings, and therefore the increase in risk of invasive species introduction, would be minimal. The risk of introductions can be minimized by washing equipment prior to transfer into water in accordance with State guidelines.

Under *Alternative 2,* 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 2*.

*Northern Spotted Owl*

Construction of *Alternative 2* 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 adverse impacts on northern spotted owl. The East Shore Pumping Plant facility is the only alternative that is within a historic spotted owl activity area where nesting has been reported in the past (WDFW, 2016), and therefore this has the greatest potential for adverse impacts. While much of this habitat near *Alternative 2* is not likely to support nesting habitat for northern spotted owls, the habitat demonstrates similar qualities as habitat that is listed on adjacent land and that was surveyed to determine potential impacts on the species (WDFW, 2016).

**Noise.** 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, construct the pipeline from the East Shore Pumping Plant to the outlet works and discharge area at the Kachess River, construct the transmission line, operate the concrete batch plant, construct staging and stockpile areas, build the construction basin and boat launch, and dispose of spoils.

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 dBA less per doubling of distance. An additional 10 dB attributable to dense vegetation would reduce each calculation further. Anticipated background noise is approximately 40 dBA. 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 mile (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 harm or injure 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 because of the presence of unconsolidated materials, but blasting would be required at depths below 150 feet, at which point the soil and bedrock interface would be reached. Since blasting noise is infrequent and of short duration, impacts from blasting activities are generally assessed using a different metric than the more continuous construction noises described previously. Other considerations regarding 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 would occur, which directs the force of the blast upward more than horizontally, thereby lessening the blast’s noise impacts. For that reason, noise from blasting within the shaft would be 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 with 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 previously, 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 harm or injure 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, power transmission line interconnect, permanent maintenance access road to the pumping plant pipeline, a portion of pipeline near the dam, and the Kachess River discharge (outlet works) on the south side of Kachess Dam. Overall, the project would require approximately 75.5 acres of vegetation clearing, much of which is mature conifer forest. Of this, 18 acres would remain permanently lost. 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 4-85 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 within designated critical habitat for the northern spotted owl, but surrounding critical habitat is within 0.25 mile. A portion of the transmission line and the outlet works construction area would be within designated critical habitat. Removal of trees in these areas would constitute an adverse impact on designated critical habitat for the northern spotted owl.

**Volitional Bull Trout Passage Improvements**

*Bull Trout*

The impacts on bull trout resulting from construction of the Volitional Bull Trout Passage Improvements would be the same as those described for fish in Section 4.6.4.1.

*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 Volitional Bull Trout Passage Improvements.

*Northern Spotted Owl*

The forested areas surrounding the bull trout passage improvement site are part of designated critical habitat for northern spotted owls. Construction associated with stream restoration would require clearing and vegetation removal, excavation, hauling, and placement of wood and rock. Noise from construction of the fish passage channel and associated staging area at the Narrows would disturb wildlife in the vicinity. Noise from excavation, grading, and general construction traffic could disturb wildlife using habitats within 4,200 feet. This disturbance would be temporary during construction activities and would be minor in impact because adjacent suitable habitat is plentiful and because any temporarily displaced wildlife could return following construction.

The fish passage improvements at the Narrows would clear 0.74 acre of terrestrial forest habitat along the shore of Kachess Reservoir. Construction of the roughened channel and instream features would occur in the channel and would not affect terrestrial habitat. An access road and work area would be established on the west side of the Narrows for construction. Both the access road and work areas would be entirely within nonforested areas along the reservoir shoreline that are inundated during full pool, but would be exposed and dry during construction of the Volitional Bull Trout Passage Improvements. Therefore, no permanent or temporary loss of forest habitat would result from construction of the roughened channel and weir, staging areas, and west access road. Impacts on northern spotted owl would, therefore, be restricted to noise from construction activities.

### *4.9.4.2 Operation*

**KDRPP East Shore Pumping Plant Facilities**

*Bull Trout*

Under *Alternative 2*, operations would affect bull trout in Kachess Reservoir, Kachess River, Keechelus Reservoir, and the Yakima River.

**Kachess Reservoir.** The operation impacts of *Alternative 2* on bull trout would be the same as described for fish in Section 4.6.4.2and would include the following:

- Reduction in Kachess Reservoir minimum pool elevation could decrease 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 with existing conditions.
- Decreased hydraulic residence time and lower minimum reservoir elevation would reduce available zooplankton prey in Kachess Reservoir compared with the baseline. Zooplankton provide the forage base for resident fish species that bull trout prey upon.

**Kachess River**. *Under Alternative 2*, flows in the Kachess River would be similar to the baseline on average but would increase substantially during summer drought years. Increases in summer instream flow would represent a negative impact on bull trout (Section 4.6.4.2, Fish). However, bull trout are rarely observed in the Kachess River (Hubble, 2014a; Reiss et al., 2012), 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 2* on bull trout would be the same as described for fish in Section 4.6.4.2and 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 with 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 with existing conditions.

*Yakima River Keechelus reach.* Operational impacts on bull trout would be the same as described for fish in Section 4.6.5.2, Fish. The quantity of bull trout subyearling habitat in the Keechelus reach would increase due to increases in days in July at or below 500 cfs from 42 days under Alternative 1 (occurs in 13 years, 3 days average per year), to 110 days under Alternative 2 (occurs in 16 years, 7 days average per year).

*Easton reach.* The quantity of bull trout subyearling habitat in the Easton reach would be reduced under the following flow scenarios (Table 4-98):

- Increases in annual flows during drought years and increases in July to August flows during drought years
- Decreased median summer flows (50 percent exceedance; June 16 to October 31)
- Increased high flows (10 percent exceedance) during summer (June 16 to October 31) in prorated years
- Decrease in median flows (50 percent exceedance) during refill years

Decreased high flows (10 percent exceedance) during refill years would increase the quantity of bull trout subyearling habitat in the Easton reach and represent would be a beneficial impact on the species.

*Umtanum reach.* Operational impacts on bull trout would be the same as described for fish in Section 4.6.4.2.

*Roza reach.* Operational impacts on bull trout would be the same as described for fish in Section 4.6.4.2.

*Wapato reach.* Operational impacts on bull trout would be the same as described for fish in Section 4.6.4.2.

*MCR Steelhead*

The general impacts on MCR Steelhead under *Alternative 2* would be 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. Specific impacts on steelhead are discussed below. In keeping with the goals of the Integrated Plan, under *Alternative 2* during Kachess Reservoir refill Reclamation would operate the Yakima Project to ensure spring (March 1 to May 31) flows for MCR steelhead smolt outmigration are at least what they would be under current operating conditions without KDRPP. Current operating conditions vary by year depending on hydrologic conditions.

*Keechelus Reach*

Operational impacts on MCR Steelhead would be the same as described for fish in Section 4.6.4.2, Fish. The quantity of MCR steelhead subyearling habitat in the Keechelus reach would increase due to increases in days in July at or below 500 cfs from 42 days under Alternative 1 (occurs in 13 years, 3 days average per year), to 110 days under Alternative 2 (occurs in 16 years, 7 days average per year).

An increase in the numbers of juvenile MCR steelhead in Keechelus reach is ultimately achievable if flow conditions are maintained and impairment to fish passage in downstream reaches are improved for migration.

*Easton Reach*

The quantity of MCR steelhead habitat in the Easton reach would be reduced under the following flow scenarios, resulting in a negative impact on MCR steelhead (Table 4-98):

- Both subyearling and fry habitat would be reduced by increased annual flows during drought years, increased high flows (10 percent exceedance) during prorated years, and decreased median flows (50 percent exceedance) during refill years (Table 4-98).
- Subyearling habitat would be reduced by increased July to August flows during drought years, decreased median summer flows (50 percent exceedance) during summer (June 16 to October 31), and increased high flows (10 percent exceedance) during summer (June 16 to October 31; Table 4-98).

The quantity of MCR steelhead habitat in the Easton reach would be increased under the following flow scenarios, resulting in a beneficial impact on MCR steelhead:

- Fry habitat would be increased by low flows (90 percent exceedance) during spring (March 15 to June 15; Table 4-98), resulting in a positive impact on MCR steelhead.
- Both subyearling and fry habitat would be increased under decreased high flows (10 percent exceedance) during refill years Table 4-98.

*Umtanum Reach*

Operational impacts on MCR Steelhead would be the same as described for fish in Section 4.6.4.2.

*Roza Reach*

Operational impacts on MCR Steelhead would be the same as described for fish in Section 4.6.4.2.

*Wapato Reach*

Operational impacts on MCR Steelhead would be the same as described for fish in Section 4.6.4.2.

**Table 4-98. Changes in Habitat Availability for Fry and Subyearling Steelhead and Bull Trout**

| Change in Flow Associated with Modeled Scenario | Percentage Change in Flow under *Alternative 2* Compared with *Alternative 1* (cfs) | Steelhead Fry Habitat[a] | Steelhead Subyearling Habitat[b] | Bull Trout Fry Habitat[a] | Bull Trout Subyearling Habitat[b] |
|---|---|---|---|---|---|
| Increase in annual flows during drought years[c] | 14.8–29.9% | Decrease | Decrease | NS | Decrease |
| Increase in July-August flows during drought years[c] | 32.3–46.7% | NA | Decrease | NA | Decrease |
| Increased low flows (90% exceedance) during spring (March 15 to June 15)[d] | 29.5% | Increase | NA | NS | NA |
| Decreased median summer flows (50% exceedance) during summer (June 16 to October 31)[d] | –11.6% | NA | Decrease | NA | Decrease |
| Increased high flows (10% exceedance) during summer (June 16 to October 31)[d] | 5.0% | NA | Decrease | NA | Decrease |
| Increased high flows (10% exceedance) during prorated years[e] | 38.5% | Decrease | Decrease | NS | Decrease |
| Decrease in median (50% exceedance) flow during refill year[e] | –10.8% | Decrease | Decrease | NS | Decrease |

| Change in Flow Associated with Modeled Scenario | Percentage Change in Flow under *Alternative 2* Compared with *Alternative 1* (cfs) | Steelhead Fry Habitat[a] | Steelhead Subyearling Habitat[b] | Bull Trout Fry Habitat[a] | Bull Trout Subyearling Habitat[b] |
|---|---|---|---|---|---|
| Decreased high flows (10% exceedance) during refill years[e] | –13.6% | Increase | Increase | NS | Increase |

Notes: Modeled scenarios where instream flows would change by more than 5% under KDRPP alternatives.
NA = not applicable, NS = not significant, flow change does not result in a substantial (more than a 5%) change in available habitat
[a] Fry habitat availability was evaluated for the period of April and May (Reclamation, 2008a).
[b] Subyearling habitat availability was evaluated for the period of June to September (Reclamation, 2008a).
[c] Flow change described in Table 4-30.
[d] Flow change described in Table 4-31.
[e] Flow change described in Table 4-32.

*Northern Spotted Owl*

Noise impacts associated with operation of the East Shore Pumping Plant would be similar to that described for *Alternative 2* operations. The disturbance to northern spotted owl caused by increased noise and human activity would be minor because noise levels are anticipated to be at or below the noise-only alert and noise-only detectability thresholds. Increased human activity at the boat launch and parking lot would also introduce a source of noise and human activity but would be at or below the noise-only detectability thresholds, depending on the proximity of any individuals that may be in the area.

Most equipment, especially that with the potential to raise ambient noise levels, such as pumps, would be below ground within the pumping plant shaft. Adverse impacts on northern spotted owl in relation to noise from pumping plant operations are not anticipated because noise levels would not exceed the noise-only injury or noise-only disturbance thresholds.

**Volitional Bull Trout Passage Improvements**

*Bull Trout*

The Volitional Bull Trout Passage Improvements would increase habitat connectivity, improve the food-base within Kachess Reservoir for bull trout, and directly increase the abundance of bull trout in the reservoir through connections to tributary habitats. Section 4.6.4discusses these positive impacts.

*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 operations associated with Volitional Bull Trout Passage Improvements.

*Northern Spotted Owl*

Operation of Volitional Bull Trout Passage Improvements in the Narrows is not expected to affect the northern spotted owl. The improved passage structures are designed to operate without human intervention, and human activities in the area would be limited to occasional inspections or repairs, if needed. Improved surface water connectivity and consistent flows would benefit birds and animals that inhabit riparian areas and use riverine habitats. Once construction is completed and the passage is operational, access to the site would be limited, and people would visit the site only on occasion, and noise and disturbance impacts would not be significant.

### 4.9.5 Alternative 3 – KDRPP South Pumping Plant

#### *4.9.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

*Bull Trout*

The impacts on bull trout resulting from *Alternative 3 – KDRPP South Pumping Plant* would be the same as described for fish in Section 4.6.5.1. Construction activities would affect habitats in Kachess Reservoir and Kachess River and overall would be similar to the impacts from *Alternative 2*, as described in Section 4.9.4.1.

*Alternative 3* would include the following activities that would differ from *Alternative 2*, with respect to bull trout impacts:

- *Alternative 3* would use a TBM to construct the intake and tunnel in Kachess Reservoir, resulting in less noise compared with the blasting proposed for *Alternative 2*. 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 3* 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 3* is expected to have less turbidity and a smaller negative impact on habitat complexity for bull trout within Kachess Reservoir. Section 4.6.4.1, Fish 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 3*.

*Northern Spotted Owl*

Noise generated during construction for *Alternative 3* would be similar to that identified in Section 4.9.4 for *Alternative 2*. 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 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) to the northeast. While much of this habitat near the *Alternative 3* is not likely to support nesting habitat for northern spotted owls, the habitat demonstrates similar qualities to habitat that is listed on adjacent land and was surveyed to determine potential impacts on the species (WDFW, 2016). Noise levels would not injure northern spotted owls, if present. However, noise may elicit disturbance behaviors within 260 feet of construction activities and cause any individuals that may be present to leave the area. Their presence within this distance is unlikely; therefore, construction of the south pumping plant is not anticipated to cause adverse noise impacts on northern spotted owls. Pre-construction surveys would be conducted to confirm if this area remains unoccupied.

Vegetation clearing would be necessary to accommodate the south pumping plant, permanent access road to the pumping plant, power supply substation, and 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 4-85 in Section 4.7, identifies the area of clearing and grading, whether the clearing is permanent, and the dominant vegetation type.

*Alternative 3* would be 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 designated critical habitat. Removal of suitable nesting trees in areas designated as critical habitat would be considered an adverse impact on northern spotted owl.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (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 3* would be the same as those described in Section 4.9.4.2.

*MCR Steelhead*

The impacts on MCR steelhead resulting from *Alternative 3* would be the same as those described in Section 4.9.4.2.

*Northern Spotted Owl*

Noise impacts on northern spotted owl associated with operation of the south pumping plant would be similar to those described for *Alternative 2*.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.9.4.2).

## 4.9.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.9.6.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

*Bull Trout*

The impacts from construction of *Alternative 4 (Preferred Alternative)* would be the same for bull trout as those described for fish in Section 4.6.6.1. Changes to relevant impact indicators are summarized below by the geographic location of the construction impact.

*Kachess Reservoir*

Construction impacts in Kachess Reservoir and its tributaries would occur with the development and construction of the floating pumping plant facilities and the Volitional Bull Trout Passage Improvements at the Narrows. Specific construction activities and impacts on fish are described in detail in Section 4.6.6.1.

Construction activities would cause a temporary reduction in habitat complexity, increase in turbidity, reduction in connectivity within the Kachess Reservoir, and an increase in noise-based disturbance during the construction period.

*Kachess River*

Under *Alternative 4 (Preferred Alternative)*, the impact of turbidity on bull trout would be the same as described for fish in *Alternative 4* in Section 4.6.6.1. Bull trout are rarely observed in the Kachess River (Hubble, 2014a; Reiss et al., 2012), so few if any fish would be affected by construction activities. Erosion protection would be installed in the outlet channel to minimize the impact of mobilized sediments and turbidity on fish in the Kachess River during construction.

*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 4 (Preferred Alternative)*.

*Northern Spotted Owl*

Impacts on northern spotted owl from construction noise and disturbance for *Alternative 4 (Preferred Alternative)* would be similar to those described previously for *Alternatives 2* and *3*, but with less impact on habitat because *Alternative 4 (Preferred Alternative)* would require a substantially smaller area of vegetation clearing since the pumping plant would be situated on the reservoir. Installation of the floating pumping plant itself would not affect any northern spotted owl habitat other than through construction noise from machinery. The pumping plant barge would be manufactured offsite in sections and assembled in an existing laydown area. All work would then be conducted out on the reservoir. Dredged material would be disposed of in a location within the reservoir and not brought out for upland deposition.

Noise generated during construction for access roads, outlet works, and other facilities landward of the reservoir would be similar to that identified in Section 4.9.4 for *Alternative 2*. The distance from construction activities to documented spotted owl nesting and detection locations would be similar to *Alternative 3*, which is farther away from these areas than the east shore plant. The closest documented northern spotted owl nest site to the 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 and cause any individuals that may be present to leave the area. Their presence within this distance is unlikely; therefore, construction of the south pumping plant is not anticipated to cause adverse noise impacts on northern spotted owls. Pre-construction surveys would be conducted to confirm if this area remains unoccupied.

Although the pumping plant itself would be located on the reservoir, vegetation clearing would be necessary to accommodate permanent maintenance and access roads, control building, project switch yard and storage building, and the parking area for the boat ramp. Construction of *Alternative 4 (Preferred Alternative)* would require approximately 7 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. As described in the vegetation impacts discussion (Section 4.7), approximately 4 acres of existing second-growth Douglas-fir forest would be permanently cleared to accommodate the proposed switch yard. The proposed east shore boat ramp and parking area would permanently clear 3 acres of second-growth coniferous forest. The east shore Narrows access road would permanently clear 2 acres of second-growth and mature coniferous forest

The landward facilities and roads for the floating pumping plant are not located within designated critical habitat for the northern spotted owl. However, a portion of 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.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.9.4.1).

### *4.9.6.2 Operation*

**KDRPP Floating Pumping Plant Facilities**

*Bull Trout*

Under *Alternative 4 (Preferred Alternative),* operations would affect bull trout in Kachess Reservoir, the Kachess River, Keechelus Reservoir, and the Yakima River. The impacts would be the same as described for *Alternative 2* except for slight temperature benefits associated with 1 to 2°C cooling at the surface of Kachess Reservoir due to less shallow water heating (PSU, 2017b), and conveying cooler water downstream to the Kachess and Yakima rivers. This section focuses on the temperature impacts on the Kachess and Yakima rivers. Impacts of changes to Kachess and Keechelus reservoir temperatures on fish, including bull trout, are described in Section 4.6.6.2.

**Kachess River.** Under *Alternative 4 (Preferred Alternative),* flows in the Kachess River below Kachess Dam would be similar to flows with *Alternative 1* on average but would increase substantially during summer drought years. Increases in summer instream flow would be a negative impact on fish species including bull trout (Section 4.6.6.2). However, bull trout are rarely observed in the Kachess River (Hubble, 2014a; Reiss et al., 2012), so few if any fish would be affected. The Kachess River is a lesser priority for improving river flow because of other objectives in the Integrated Plan (Reclamation and Ecology, 2011c).

Under *Alternative 4 (Preferred Alternative),* water temperatures in the Kachess River would decrease slightly during summer months (during drought and refill years) as compared with *Alternative 1*, but the effect is likely to attenuate over a short distance with mixing in the upper Yakima River. Climate change is expected to further increase water temperatures above the modeled values for *Alternatives 4* and *1* within the Kachess River, potentially resulting in an increase in the number of days in which temperatures exceed 12°C (53.6°F). Reduced fish passage between bull trout subpopulations has contributed to the fragmentation of subpopulations within the upper Yakima River basin and has been identified as an important risk to the species (Reiss et al., 2012). Therefore, increases in summer water temperatures in the Kachess River expected with climate change would cause a negative impact on bull trout.

**Yakima River.** The operation impacts of *Alternative 4 (Preferred Alternative)* on bull trout in the Yakima River are generally similar to those described for other fish species in Section 4.6.6.2. The benefits of releasing slightly cooler water from Kachess Reservoir are likely to attenuate upon mixing in the upper Yakima River.

*MCR Steelhead*

The impacts of *Alternative 4 (Preferred Alternative)* on MCR steelhead would be the same as described for fish in Section 4.6.6.2.

*Northern Spotted Owl*

Noise impacts associated with operation of the south pumping plant would be similar to that described above for *Alternative 3*. Under *Alternative 4 (Preferred Alternative)* operations, the disturbance to northern spotted owl from increased noise and human activity would be minor because noise levels are anticipated to be at or below the noise-only alert and noise-only detectability thresholds.

**Volitional Bull Trout Passage Improvements**

Operational impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Sections 4.9.4.2 and 4.6.4.2).

## 4.9.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

### *4.9.7.1 Construction*

*Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* would include construction of the KDRPP East Shore Pumping Plant (*Alternative 2*). The impacts from construction and operation of these components of *Alternative 5A* would be the same as described in Section 4.9.4. *Alternative 5A* would also include construction and operation of the KKC North Tunnel. The impacts of the KKC North Tunnel are described below.

**KKC North Tunnel Alignment Facilities**

*Bull Trout*

The impacts on bull trout resulting from *Alternative 5A* would the same as those described for fish in Section 4.6.7.1. Construction activities would affect habitats in the Kachess Reservoir and the 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 4.6.7.1, 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 4.6.7.1.

Under *Alternative 5A,* 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 the 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 4.6.7.1.
- 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 4.6.7.1.
- Displacement of bull trout from habitat in 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 affected by construction activities.

*MCR Steelhead*

Under Alternative 5A, construction activities would affect MCR steelhead in the Yakima River. The construction impacts on MCR steelhead habitat would be the same as those described for bull trout in the Yakima River in Section 4.9.7.1 and other salmonids described in Section 4.6.7.1. Overall, construction activities are expected to have a minimal impact on MCR steelhead because they are rarely observed in the Keechelus reach (Hubble, 2014b).

An increase in the numbers of juvenile MCR steelhead in Keechelus reach is ultimately achievable if flow conditions are maintained and impairment to fish passage in downstream reaches are improved for migration.

*Northern Spotted Owl*

Construction of Alternative 5A 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 adverse impacts on northern spotted owl.

General construction noise would be similar to that described in Sections 4.9.4 and 4.9.5. Construction activities would include 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 are not anticipated. Noise levels are still expected to exceed the noise-only disturbance threshold; therefore, adverse impacts on northern spotted owl would still result from increased construction noise and human activity.

*Alternative 5A* 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 is 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, 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 are not 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 are not 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. Most 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 4-91 in Section 4.7, identifies the area of clearing and grading, whether the clearing would be permanent, and the dominant vegetation type. The facilities associated with *Alternative 5A* 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 on northern spotted owl.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.9.4.1).

#### *4.9.7.2 Operation*

**KKC North Tunnel Alignment Facilities**

*Bull Trout*

Under *Alternative 5A*, operations would affect bull trout in habitats including Kachess Reservoir, the Kachess River, Keechelus Reservoir, and the Yakima River.

**Kachess Reservoir.** The operation impacts of *Alternative 5A* on bull trout would be the same as described in Section 4.6.7.2, and include the following:

- Decreased hydraulic residence time and lower reservoir levels would reduce available prey in Kachess Reservoir compared with the baseline. Zooplankton provide the forage base for resident fish species that bull trout prey on.
- Lower reservoir levels and greater fluctuations in reservoir level would reduce shoreline vegetation and habitat complexity in the reservoir compared with the baseline.
- The conveyance of water from Keechelus Reservoir to Kachess Reservoir may cause minor, localized changes in Kachess Reservoir temperature or nutrient levels, but these are not anticipated to cause an adverse impact on fish.
- The conveyance of water from Keechelus Reservoir to Kachess Reservoir may increase the risk of disease transmission or introduction of exotic species from Keechelus Reservoir to Kachess Reservoir compared with the baseline.

**Kachess River.** The operation impacts of *Alternative 5A* on bull trout would be the same as described for fish in Section 4.6.7.2, Fish. 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 5A* on bull trout would be the same as described for fish in Section 4.6.7.2, 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 with 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.
- The frequency that bull trout passage between reservoir and tributary habits would become disconnected would decrease allowing more frequent access to spawning and rearing habitats and seasonal refugia, but duration of each period of disconnection would increase in duration. The combined impact of both minor positive and negative changes

in the frequency and duration, respectively, is likely to be passage conditions that are largely the same as Alternative 1 when averaged over many years.

**Yakima River.** The operation impacts on bull trout would be the same as described for other fish species in Section 4.6.7.2, and would 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 with the baseline. Section 4.6.7.2discusses the improvement in habitat connectivity and function. 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 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 4-63 in Section 4.3.7). 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 4.3.7.2) and impacts on fish would be the same as expected under *Alternative 1*.

*MCR Steelhead*

Under *Alternative 5A*, operations would affect MCR steelhead in the Yakima River. The operation impacts on MCR steelhead habitat would be the same as those described for bull trout in the Yakima River in Section 4.9.7.2 and other salmonids described in Section 4.6.7.2.

Reduced summer instream flows and regular attainment of instream flow targets in the Keechelus reach are expected to 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 in the reach are expected to accrue through improved flow conditions and through natural colonization processes (Hubble, 2014b). Because the reach’s productivity 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 5A* operations, the disturbance to northern spotted owl from increased noise and human activity would be minor because noise levels are anticipated to be at or below the noise-only alert and noise-only detectability thresholds. Once construction is completed, most noise generated would be contained underground in the tunnels and conveyance features. During operation, minor impacts on northern spotted owl would result from increases in noise and human activity at the intake and discharge points for *Alternative 5A* as a result of these activities' proximity to suitable habitat.

**Volitional Bull Trout Passage Improvements**

Operational impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.9.4.2).

### 4.9.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 3* (Sections 4.9.5.1 and 4.9.5.2). Impacts would be the same as those associated with the North Tunnel discussed in *Alternative 5A* (Section 4.9.7.1). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.9.7 (*Alternative 5A*).

### 4.9.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 4 (Preferred Alternative)* (Sections 4.9.6.1 and 4.9.6.2). Impacts would be the same as those associated with the North Tunnel discussed in *Alternative 5A* (Section 4.9.7.1). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.9.7 (*Alternative 5A*).

### 4.9.10 Avoidance, Minimization and Mitigation Measures

Project proponents would implement measures to reduce impacts on 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 4.6.10).

WDFW completed preconstruction surveys for listed fish and wildlife species in 2014 through 2016. At a minimum, Reclamation would update these surveys prior to construction.

In compliance with ESA Section 7(a)(2), Reclamation has prepared a biological assessment and has initiated ESA Section 7 consultation with both NMFS and USFWS. Any changes to the proposed action that may be necessary as a result of the Section 7 consultation with NMFS and USFWS will be addressed as required by law. Reclamation would implement specific mitigation for listed fish and wildlife species that the agencies require as part of consultation. Reclamation will document the final list of mitigation and environmental commitments in a ROD approving an action alternative.

#### *4.9.10.1 Bull Trout and MCR Steelhead Mitigation*

**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 4.2.10 and 4.4.10. Additionally, temporary construction and staging areas would be regraded and replanted with native vegetation.

**Operation**

Mitigation for project impacts would be the same as described for non-ESA listed fish in Section 4.6.10.

#### *4.9.10.2 Northern Spotted Owl Mitigation*

**Construction**

To minimize impacts on 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 to September 30). Timing restrictions for construction activities would not be required for *Alternatives 3,* or *4* because no nest sites are within 1 mile of the construction activities.

Recent surveys have not detected northern spotted owls in the area (WDFW, 2015) and pre-construction surveys would be conducted to confirm whether the impacted areas remain unoccupied. Project impacts would be considered to have no potential effects on northern spotted owls if pre-construction surveys verify that no owls are present within the threshold distances for disturbance or harm.

**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 on the aesthetic quality of the setting (Table 4-99). 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.

**Table 4-99. 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

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 are shown in Table 4-100. 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.

USFS manages much of the Federal land in the primary study area, including areas above the current full pool elevation of Kachess Reservoir. 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 SILs and VQOs established in the 1990 Wenatchee National Forest Plan and the USFS Scenery Management System (USDA, 1995).

**Table 4-100. Impact Issues and Indicators for Visual Resources**

| Issues | Impact Indicator |
|---|---|
| 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 in 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 | Potential 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* 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.

During construction, all action alternatives would involve visual quality impacts on local residents and visitors as local views change (Table 4-101and Table 4-102). None of these short-term impacts would be significant. In the long term, all alternatives 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 2 – KDRPP East Shore Pumping Plant* and *Alternative 5A – KDRPP East Shore Pumping Plant with KKC*, the East Shore Pumping Plant building would substantially contrast with the existing landscape. *Alternative 4 (Preferred Alternative)* and *Alternative 5C – KDRPP Floating Pumping Plant with KKC* would have an impact on visual quality because the floating pumping plant would substantially contrast with and interrupt the visual character and integrity of the landscape. Drawdown of Kachess Reservoir under all action alternatives would have impacts on visual quality due to changes in overall landscape character and desirability from a recreation perspective. Changes to landscape character and sense of place for local residents and recreational users would vary by alternative and would include new infrastructure facilities and increased exposed shoreline during pool drawdown as viewed from the Kachess Reservoir viewshed. Kachess Reservoir drawdowns during drought years under all action alternatives would not meet the intent of the established SIL/VQO.

**Table 4-101. Summary of Impacts for Visual Resources**

| Impact Indicator | Summary of Impacts |
|---|---|
| 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. | Construction of the KDRPP East Shore Pumping Plant under *Alternatives 2* and *5A* and KDRPP Floating Pumping Plant under *Alternatives 4* and *5C* would substantially contrast with and interrupt the visual character and integrity of the landscape. |
| 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. | Increased Kachess Reservoir drawdowns during drought years under *Alternatives 2, 3, 4, 5A, 5B,* and *5C* would change the overall landscape character and desirability from a recreation perspective. |
| Erosion of riverbanks or creation of flow pathways outside the range of existing flows. | None of the alternatives would have significant impacts; instream flows would be within the existing flow range. |
| Conflict with SIL/VQO established in the 1990 Wenatchee National Forest Plan and the USFS Scenery Management System (USFS, 1995). | Kachess Reservoir drawdowns during drought years under *Alternatives 2, 3, 4, 5A, 5B,* and *5C* could conflict with the established SIL/VQO. |

**Table 4-102 Comparison of Visual Impacts from the KDRPP alternatives during construction**

| | Alternative 2 | Alternative 3 | Alternative 4 |
|---|---|---|---|
| Under all alternatives, construction activities would detract visually from the setting. | | | |
| Duration of visible construction activities | 3 years | 3 years | 1 year |
| Overall Construction Impact | Minor, Short-term | Minor, Short-term | Minor, Short-term; however, impacts would be lessened due to the shorter construction duration. |

## 4.10.3 Alternative 1 – No Action

Under the No Action the U.S. Forest Service rates the reservoir VQO as moderate. Foreground views (up to ½ mile) from the campground and boat launch are managed according to moderate/partial retention. Likewise, views in the middle ground distance (up to 4 miles) are also managed according to moderate/partial retention. Background views are beyond 4 miles from the viewer and visual contrasts are less visible. *Alternative 1* visual quality within the primary study area, 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. The shoreline would continue to be exposed below maximum pool level every year during the irrigation season. The exposure between mean high and mean low pool level is 43 vertical feet, and the maximum possible exposure is approximately 69 vertical feet. Therefore, *Alternative 1* would maintain the existing range of landscape character and scenic integrity conditions within the primary study area. The No Action Alternative would not change the landscape character or sense of place.

Visual effects within the extended study area are not anticipated. The existing irrigated agricultural areas in the Yakima River basin would continue to be cultivated.

## 4.10.4 Alternative 2 – KDRPP East Shore Pumping Plant

### *4.10.4.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**
Construction of *Alternative 2* would be in the background distance zone from the campground and due to limited visibility, would not alter the moderate rating. For recreational users in the middle ground or foreground, visual contrast would be moderately- to heavily-altered.

**Volitional Bull Trout Passage Improvements**

From the campground to the construction area of the volitional bull trout passage, is approximately 2 miles (middle ground). Construction activity would introduce heavy equipment, stockpiled material, and construction workers into the moderate landscape. These effects would be short term and would not alter the moderate VQO rating.

### *4.10.4.2 Operation*

**KDRPP East Shore Pumping Plant Facilities**

Visual impacts from operation of *Alternative 2* relate to changes in reservoir pool elevations, the presence of new facilities on the landscape, and downstream effects.

*Reservoir Pool Elevations*

Figure 4-15 provides a simulation that illustrates Kachess Reservoir levels under current full pool, current minimum pool and full drawdown under KDRPP from a viewpoint on the southeastern shore of Kachess Reservoir.

Drawdowns in drought years would affect 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 on recreation). Observers on the south end of the reservoir would see the pumping plant and the landscape would appear heavily altered. From Kachess

Campground and from residential areas along the west shore the landscape would appear moderately altered.

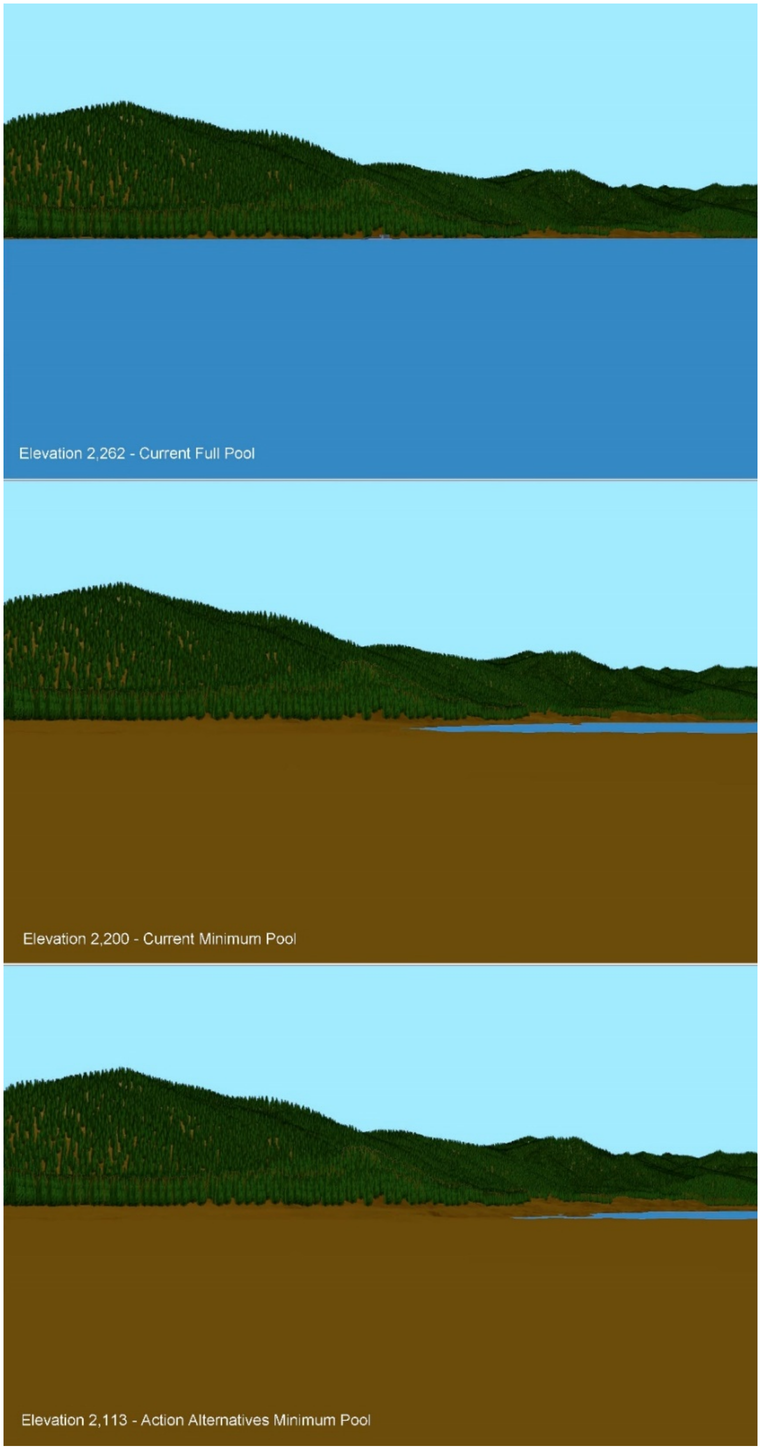



**Figure 4-15. Visual Simulation of Kachess Reservoir Pool Levels for Current Full Pool, Current Minimum Pool, and KDRPP Maximum Drawdown from Southeast Shore**

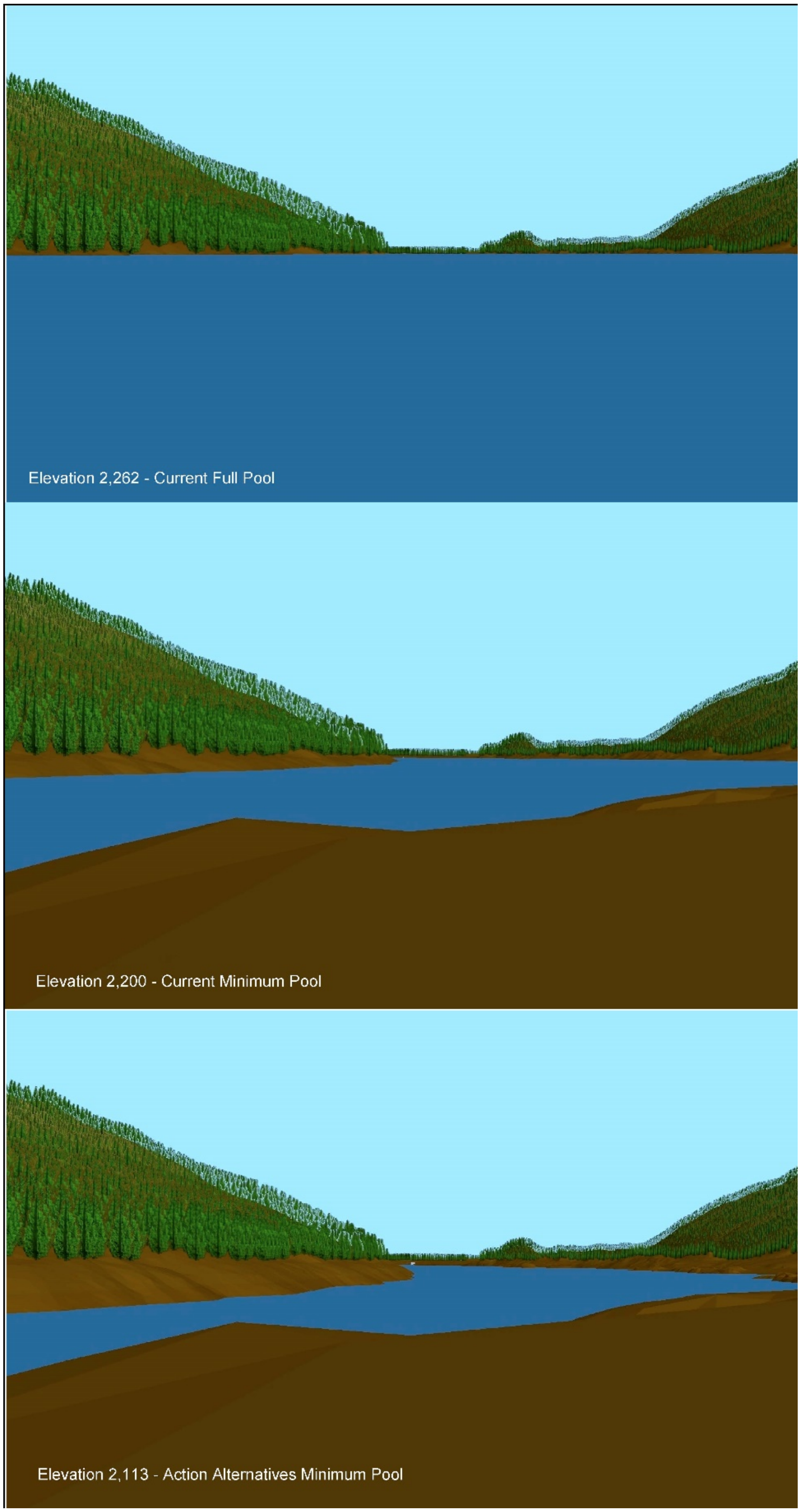



**Figure 4-16. Visual Simulation of Kachess Reservoir Pool Levels for Current Full Pool, Current Minimum Pool, and KDRPP Maximum Drawdown from Boat Launch**

*New Facilities*

From the campground, the aboveground portion of the pumping plant will be in the background. While this will create a visual contrast because the aboveground portion will be housed in a steel building approximately 150 feet long by 220 feet wide and 65 feet high, (Figure 2-3). The building would be located on the immediate shoreline where forested landscape conditions predominate (Figure 4-17). Therefore, the view will be moderately altered.

**Figure 4-17. 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 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 see a heavily altered landscape. Therefore, *Alternative 2* 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.

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.

**Downstream Effects**

Additional releases to the Kachess River would increase the volume of water in the river during drought years 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.

**Volitional Bull Trout Passage Improvements**

Upstream passage of adult bull trout from the drawn down reservoir caused by operation of the drought relief pumping plant is anticipated to be accomplished with a roughened channel having a natural stone lining that is approximately 1,500 feet long with a constant slope of approximately 6 percent. The roughened channel would be founded on and anchored to the underlying bed rock. The volitional fish passage structure would be visible only when the pool level is drawn down below elevation 2,220. For viewers in the foreground or middle ground distance zone, the visual contrast would be slightly altered. From the background distance zone, it would appear unaltered.

## 4.10.5 Alternative 3 – KDRPP South Pumping Plant

### *4.10.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

Construction of *Alternative 3 – 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 2*, although impacts would be less for the south pumping plant since much of the construction would be located south of Kachess Dam (Figure 4-18).

Construction of *Alternative 3* would be in the background distance zone from the campground and due to limited visibility, would not alter the moderate rating. For recreational users in the middle ground or foreground, visual contrast would be moderately to heavily altered.


**Figure 4-18. South Pumping Plant Location (South of Kachess Dam)**

### Volitional Bull Trout Passage Improvements

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.10.4.1).

## *4.10.5.2 Operation*

### KDRPP South Pumping Plant Facilities

As for *Alternative 2*, 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 2 (Section 4.10.4.2). From Kachess Campground and from residential areas along the west shore the landscape would appear moderately altered. New Facilities

*Alternative 3* 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 2*, 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 2*. 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 2*.

*Alternative 3* would be consistent with the SIL/VQO established by the 1990 *Wenatchee National Land and Resource Management Plan* for Kachess Reservoir. The new facilities and features of *Alternative 3* would not be visible from the campground. Therefore, foreground and middle-ground views from the campground and boat launches would appear unaltered.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.10.4.2).

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.10.4.2).

### 4.10.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

#### *4.10.6.1 Construction*

Construction of *Alternative 4* would create localized and temporary visual impacts for approximately 1 year. Construction activities would be concentrated on the southern shore of Kachess Reservoir and would extend both out into the reservoir (floating pumping plant construction and discharge channel improvements) and south to the existing inlet channel. This portion of the southern shore is part of a contiguous segment of 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 floating pumping plant and discharge channel would be highly visible from the southern reservoir and surrounding shorelines (note that the discharge basin would be visible only if the water level in the reservoir were drawn down to elevation 2,174.1). 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 area may be visible from Kachess Dam Road, but intervening trees limit viewpoints.

Those looking at the construction area would notice mechanized equipment, grading activity, material movement and stockpiling, construction of the floating pumping plant barge and operations yard facilities, and human activity, all of which would detract visually from the setting. The east shore temporary construction area would be left as an unimproved public parking and boat launch area, the appearance of this area would change from forested to cleared land (approximately 2.0 acres would be cleared). Based on limited public viewpoints to the construction area, the temporary nature of construction, and the one-year duration of construction, Alternative 4 (Preferred Alternative) would have a minor short-term effect on the visual character and integrity of the landscape, and constitute less overall impacts to the visual resource than all other action alternatives.

In order to facilitate construction activities, the reservoir would be drawn down to facilitate construction. This drawdown would have impacts on visual quality as it relates to overall landscape character of the reservoir and desirability from a recreation perspective (refer to Section 4.14.6 for a discussion of impacts on recreation). However, this drawdown during construction would be temporary.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.10.4.1).

### *4.10.6.2 Operation*

Visual impacts from operation of *Alternative 4 (Preferred Alternative)* relate to changes in reservoir pool elevations, the presence of new facilities on the landscape, and downstream effects.

**Reservoir Pool Elevations**

Visual impacts from pool drawdown would be similar to *Alternative 2*.

**New Facilities**

Visual impacts from the floating pumping plant, control building, boat launch and dock, and east shore parking area would likely vary from minor to moderate, depending on the observer's location. The floating pumping plant would be located immediately north of the existing outlet channel along the southern shore of the southeast portion of the reservoir.

The East Shore Marina would consist of a 600-foot-long, 20-foot-wide boat ramp having an adjacent dock. Once completely constructed, the boat ramp would be useable over the full range of both gravity and drought relief pumping operations (i.e., from a high pool reservoir elevation of 2,262 to a low pool elevation of 2,113). These East Shore features would initially be used for construction of the flow control structure, pipe bridges and pipelines, and the pump barge and its moorage features. These features would become permanent facilities and comprise the parking area and the boat ramp and its associated dock. They would be visible from the south end of the reservoir and associated shoreline.

The pump barge is a permanent project feature that would remain floating on the surface of the reservoir at all times upon completion of construction. The pump barge is anticipated to have approximate dimensions of 80 feet wide by 90 feet long by 7 feet deep.

The floating pumping plant would be visible from areas along the southeastern portion of the reservoir. Figure 4-19. illustrates the floating pumping plant as it would be seen from the southeastern shore of Kachess Reservoir, and Figure 4-20 illustrates the floating pumping plant as it would be seen from Kachess boat ramp approximately 5 miles north and west of the proposed pumping plant. The floating pumping plant would interrupt the form, line, color, and texture of the undeveloped reservoir surface, resulting in localized changes in visual character at the Kachess Reservoir shoreline. People walking along the reservoir shoreline, boating on the reservoir near this location, or viewing from the opposite (west) shore would notice these changes.


**Figure 4-19. Rendered View of Alternative 4 from East Shore of Kachess Reservoir**


**Figure 4-20. Rendered View of Alternative 4 from Kachess Boat Ramp**

The control building, operations yard, and associated power supply substation switch yard would be visible from areas along the southeastern portion of the reservoir. A one-story, concrete block building having approximately 3,200 square feet of floor space would be located on the shoreline of Kachess Reservoir on the point of land near the left abutment of Kachess Dam for the control building. The operations yard would 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.

The flow control structure would be built across the north end of the existing Outlet Channel where the channel originates at the edge of the low pool reservoir. Impacts would be outside public view and would not affect visual quality.

Exterior lighting at the operations yard and floating pumping plant would be limited to safety, security and emergency lighting. To the extent possible, it would be located away from the reservoir-side of the control building and would direct light inward on the floating 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. The floating pumping plant will be equipped with lights for purposes of ensuring it is visible to boaters using the reservoir at night.

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 floating pumping plant would present an altered landscape appearance.

The landscape character and sense of place for residents in the area and recreational users would be changed. Installing a floating pump plant north of the dam would create a visual impact viewed from Kachess Reservoir. The views from Kachess Reservoir would present visual impact with the presence of a floating pumping plant and associated infrastructure viewed from the reservoir, the shoreline, developed recreational facilities, dispersed recreational places, and private or public lands surrounding the area.

**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 the established high/retention SIL/VQO.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.10.4.2).

### 4.10.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

#### *4.10.7.1 Construction*

*Alternative 5A* would include construction of the KDRPP East Shore Pumping Plant (*Alternative 2*) and the KCC North Tunnel. The impacts from construction and operation of these components would be the same as described for *Alternative 2* (Section 4.10.4). Impacts of the KKC North Tunnel are described below.

**KKC North Tunnel Alignment Facilities**

Construction of the 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 KKC North Tunnel Alignment from the Keechelus portal to 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 (see Figure 4-21).


**Figure 4-21. 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 sheet pile 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, KKC North Tunnel Alignment would have a minor short-term effect on the visual character and integrity of the landscape.

#### *4.10.7.2 Operation*

**KDPRPP East Shore Pumping Plant and KKC North Tunnel Alignment Facilities**

Visual impacts from operation of *Alternative 5A* relate to changes in reservoir pool elevations, the presence of new facilities and features on the landscape, and downstream effects.

*Reservoir Pool Elevations*

The operations of KKC would change reservoir levels in both Keechelus and Kachess reservoirs compared to *Alternative 1*. However, *Alternative 5A* would have no long-term impacts on visual quality at Kachess Reservoir because operations would not impact reservoir levels outside 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 the USFS SIL/VQO 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 5A* 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 KKC North Tunnel Alignment to Kachess Reservoir would be underground and would have no visual impacts.

The only visual quality impacts would occur at the Kachess Lake Road portal and discharge structure and at 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 that the visual impacts of the permanent facilities would be minor.

The 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 Kachess Reservoir. Water would then flow over a 200-foot-long by 30-foot-wide riprap pad directly into Kachess Reservoir (Figure 2-10). 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 KKC by diverting water downstream from Keechelus Reservoir and conveying water directly to Kachess Reservoir. The KKC North Tunnel Alignment would reduce summer flows in the Keechelus reach of the Yakima River by 50 percent in the summer to improve fish habitat in this reach (see Section 4.3.7), 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 the established SIL/VQO of high/retention.

### 4.10.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 3* (Section 4.10.5). Impacts associated with the KKC North Tunnel would be the same as those discussed in *Alternative 5A* (Section 4.10.7.1). Impacts of construction and operation of the

### 4.10.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 4 (Preferred Alternative)* (Section 4.10.6). Impacts associated with the KKC North Tunnel would be the same as those discussed in *Alternative 5A* (Section 4.10.7.1). Mitigation Measures

### 4.10.10 Avoidance, Minimization and 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. Use design measures such as siting facilities in areas not highly visible from designated viewsheds in order to maintain a natural-appearing landscape character as much as feasible with.

The impacts on visual quality under *Alternatives 2, 3, 4, 5A, 5B,* and *5C* due to the increased drawdown of Kachess Reservoir would not be mitigated.

## 4.11 Air Quality

### 4.11.1 Methods and Impact Indicators

**Methods.** Construction of the action alternatives could generate short-term, direct effects due to emissions from construction equipment, workers' vehicles, delivery trucks, and fugitive dust. Long-term operational effects of the alternatives could generate fugitive dust from exposure of reservoir shorelines. Off-road construction emissions for the proposed project were estimated using emission rates from EPA's NONROAD functionality in its Motor Vehicle Emissions Simulator (MOVES 2014a). Fugitive dust emissions were calculated using EPA's AP-42 emission rates. On road emissions, from haul trucks and employee commutes, were calculated using emission rates from EPA's model. For the purposes of this analysis, the duration of construction effects is approximately 1 year. The assessment of construction-related emissions of the alternatives focused on determining the need for an air quality general conformity determination, as specified by EPA in 40 CFR 93.153. EPA establishes *de minimis* thresholds for nonattainment and maintenance areas as the emissions levels under which conformity determination is not required for an action. For comparative purposes in this EIS, the *de minimis* thresholds are 100 tons per year for CO, $PM_{10}$, $NO_x$, and VOC. The *de minimis* threshold for lead is 25 tons per year.

The evaluation of impacts associated with greenhouse gas emissions is discussed in Section 4.12.

## 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 *Alternative 2 – KDRPP East Shore Pumping Plant*, *Alternative 3 – KDRPP South Pumping Plant*, and *Alternative 4 (Preferred Alternative)*, 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.

**Table 4-103. Summary of Impacts for Air Quality**

| Impact Indicator | Summary of Impacts |
|---|---|
| Exceedance of EPA General Conformity *de minimis* thresholds | Construction would increase emissions and fugitive dust as stated below:<br>Alternative 2 – 2.5 to 22.6 tons per year<br>Alternative 3 – 1.1 to 13.1 tons per year<br>Alternative 4 – 0.1 to 6.0 tons per year<br>Alternative 5 – 2.1 to 34.4 tons per year |

## 4.11.3 Alternative 1 – No Action

No new emissions or fugitive dust sources are anticipated under *Alternative 1*.

## 4.11.4 Alternative 2 – KDRPP East Shore Pumping Plant

### *4.11.4.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**

During construction of *Alternative 2*, short-term minor emissions affecting air quality would occur because of the release of particulate emissions generated by excavation, grading, hauling, transmission lines, access roads and other activities. Emissions from construction equipment and truck trips are also anticipated and would include CO, $NO_X$, VOC, and directly emitted particulate matter. Construction emissions and generation of fugitive dust associated with *Alternative 2* would be primarily associated with excavation for the intake tunnel and pumping plant shaft. These activities would require excavation, handling, and transport of spoils, all involving extended use of heavy construction equipment and trucks, including a proposed temporary concrete batch plant.

Under *Alternative 2* construction activities would result in minor emissions that are less than the EPA General Conformity *de minimis* thresholds for all relevant criteria pollutants (Table 4-104).

**Table 4-104. Emissions from *Alternative 2 – KDRPP East Shore Pumping Plant* Construction and Hauling**

| Criteria Pollutant | Emissions – Worst-case Scenario (tons/year) | NAAQS *De Minimis* Threshold (tons/year) | Percentage of *De Minimis* Threshold |
|---|---|---|---|
| **Carbon monoxide (CO)** | **22.65** | **100** | **23** |
| **Ozone** | | **100** | |
| $NO_x$ | 37.25 | 100 | 37 |
| VOC | 3.84 | | 4 |
| **Particulate pollutants** | | | |
| $PM_{10}$ | 5.93 | 100 | 6 |
| $PM_{2.5}$ | 2.53 | 100 | 3 |

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 because of the distance, prevailing wind patterns (see Section 3.11.1), and the low level of emissions anticipated.

**Volitional Bull Trout Passage Improvements**

Construction of the Volitional Bull Trout Passage Improvements would result in minor, short term localized generation of emissions and fugitive dust, primarily from heavy equipment and truck trips required for moving fill material. Construction activities would be temporary and construction best management practices would minimize fugitive dust emissions and associated impacts. Volitional Bull Trout Passage Improvements 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**

*Alternative 2* would increase the area of Kachess Reservoir bed exposed when the reservoir is drawn down (a maximum of an additional 80 vertical feet of shoreline along the entire reservoir).

**Volitional Bull Trout Passage Improvements**

The Volitional Bull Trout Passage Improvements 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 3 – KDRPP South Pumping Plant

### *4.11.5.1 Construction*

#### KDRPP South Pumping Plant Facilities

Construction impacts would be similar to those with *Alternative 2* as described in Section 4.11.4.1. *Alternative 3 – KDRPP South Pumping Plant* would require less overall excavation and result in less emissions.

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 2*.

Fugitive dust from clearing, grading, and truck trips would result in impacts similar to those of *Alternative 2*; however, the fewer truck trips required would reduce emissions.

**Table 4-105. Emissions from *Alternative 3 – KDRPP South Pumping Plant* Construction and Hauling**

| Criteria Pollutant | Emissions – Worst-case Scenario (tons/year) | NAAQS *De Minimis* Threshold (tons/year) | Percent of *De Minimis* Threshold |
|---|---|---|---|
| **Carbon monoxide (CO)** | 13.14 | 100 | 13 |
| **Ozone** | | 100 | |
| $NO_x$ | 13.16 | 100 | 13 |
| VOC | 1.57 | | 2 |
| **Particulate pollutants** | | | |
| $PM_{10}$ | 4.51 | 100 | 5 |
| $PM_{2.5}$ | 1.16 | | 1 |

#### Volitional Bull Trout Passage Improvements

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.11.4.1).

### *4.11.5.2 Operation*

#### KDRPP South Pumping Plant Facilities

Operation impacts would be similar to those described for *Alternative 2* in Section 4.11.4.2.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.11.4.2).

## 4.11.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.11.6.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

Emissions from construction equipment are also anticipated and would include CO, $NO_x$, VOC, and directly emitted particulate matter ($PM_{2.5}$ and $PM_{10}$) (Table 4-106).

Construction of *Alternative 4 (Preferred Alternative)* would involve clearing, cut-and-fill activities, grading, and building activities; however, *Alternative 4 (Preferred Alternative)* would involve less of these types of ground-disturbing construction activities than *Alternatives 2 or 3*. These conditions would lead to less fugitive dust emissions than the *Alternatives 2 or 3*. Construction-related effects on air quality from *Alternative 4 (Preferred Alternative)* would be greatest during the site preparation phase because most engine emissions are associated with the excavation, handling, and transport of soil on the site. Construction BMP's will reduce the emissions to *de minimis* levels.

Heavy trucks and construction equipment powered by gasoline and diesel engines would generate CO, $NO_X$, VOCs and some soot particulate ($PM_{2.5}$ and $PM_{10}$) in exhaust emissions. These emissions would be temporary and limited to the immediate area surrounding the construction sites as shown in Table 4-106.

**Table 4-106. Construction Emission Summary (Tons) – *Alternative 4 (Preferred Alternative)***

| Criteria Pollutant | Emissions – Worst-case Scenario (tons/year) | NAAQS *De Minimis* Threshold (tons/year) | Percent of *De Minimis* Threshold |
|---|---|---|---|
| **Carbon monoxide (CO)** | 6.805 | 100 | 7 |
| **Ozone** | | 100 | |
| $NO_x$ | 3.080 | 100 | 3 |
| VOC | 0.384 | | <1 |
| **Particulate pollutants** | | | |
| $PM_{10}$ | 1.505 | 100 | 2 |
| $PM_{2.5}$ | 0.345 | | <1 |

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.11.4.1).

#### *4.11.6.2 Operations*

**KDRPP Floating Pumping Plant Facilities**

Impacts under *Alternative 4 (Preferred Alternative)* would be the same as those under *Alternative 2.*

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.11.4.2).

### 4.11.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

*Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* would include construction of the KDRPP East Shore Pumping Plant. The impacts from construction and operation of these components of *Alternative 5A* would be the same as described for Alternative 2. *Alternative 5A* would also include construction and operation of the KKC North Tunnel. The impacts of the KKC North Tunnel are described below.

#### *4.11.7.1 Construction*

**KKC North Tunnel Alignment Facilities**

Construction emissions and fugitive dust associated with *Alternative 5A* 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 on 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), which would be likely to occur concurrently with KDRPP. Table 4-107shows the projected emissions.

**Table 4-107. Emissions from KKC North Tunnel Alignment Construction and Hauling**

| Criteria Pollutant | Emissions – Worst-case Scenario (tons/year) | NAAQS *De Minimis* Threshold (tons/year) | Percent of *De Minimis* Threshold |
|---|---|---|---|
| **Carbon monoxide (CO)** | 21.13 | 100 | 21 |
| **Ozone** | | 100 | |
| $NO_x$ | 34.42 | 100 | 34 |
| VOC | 2.98 | | 3 |
| **Particulate pollutants** | | | |
| $PM_{10}$ | 5.54 | 100 | 6 |
| $PM_{2.5}$ | 2.18 | | 2 |

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.11.4.1).

#### 4.11.7.2 Operation

**KKC North Tunnel Alignment Facilities**

There would be no measurable effects to air quality from operation of the tunnel.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.11.4.2).

### 4.11.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation of *Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment* would be the same as described in Section 4.11.7; however, KDRPP would be constructed at the south shore location as described in Section 4.11.5 rather than the east shore location.

### 4.11.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation of *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment* would be the same as described in Section 4.11.7; however, the KDRPP floating pumping plant would be constructed as described in Section 4.11.6 rather than the east shore location.

### 4.11.10 Avoidance, Minimization, and Mitigation Measures

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

Reclamation and Ecology considered impacts of emissions of GHGs from the proposed alternatives and the operational, water supply, and instream flow effects of climate change on the proposed alternatives.

As noted in Section 3.12 in 2017 the UW Hydro/Computational Hydrology group at the University of Washington and the Oregon Climate Change Research Institute at Oregon State University developed updated hydrology and meteorology datasets for the Columbia River Basin, which are called “RMJOC-II”. (BPA et al., 2018) RMJOC-II results from the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC, 2014) are an update to the previous Columbia River climate change hydrologic data developed for the RMJOC that was used in evaluating climate change impacts in the SDEIS.

Reclamation and Ecology compared the new RMJOC-II datasets with the previous RMJOC datasets used for the SDEIS assessment, and assessed how the new datasets would affect the evaluation of water resource impacts presented in this FEIS for the No Action and action alternatives. Methods used in the analysis with the RMJOC-II data are identical to those used previously, except the hydrological data were changed to incorporate the new climate change datasets. As in the previous climate change analysis, three scenarios of potential climate change were evaluated, and the scenario representing changes in the middle of the range of the three (termed “adverse”) was selected for focused review.

The characteristics and differences between the historical streamflows and projected future streamflows in the selected scenario were evaluated by Reclamation and Ecology and used for an assessment of change since the SDEIS. Compared with the previously used RMJOC adverse flows, the RMJOC-II adverse flows are higher, including average annual flow, winter flow and summer flow. Simulations using the RiverWare model for the No Action and action alternatives under the “adverse” RMJOC-II scenario are documented in a technical memorandum (HDR, July 2018).

Overall, the RMJOC-II climate change results are within the range of conditions that were presented in the SDEIS. The water supply results under the “adverse” RMJOC-II scenario are generally better compared with the previously documented adverse climate change results analyzed in the SDEIS. Under RMJOC-II conditions, more water supply would be available, and instream flows would be higher. Since RMJOC-II is considered less impactful than the RMJOC conditions, a full, updated analysis using RMJOC-II is not included in the FEIS. Therefore Section 4.12 of the FEIS retains the climate change analysis for water resources that was presented in the SDEIS.

#### *4.12.1.1 Methods – Greenhouse Gas Emissions*

Reclamation and Ecology analyzed climate change impacts by considering the GHG emissions that construction and operation of the proposed alternatives would generate. Construction activities would generate GHG emissions through construction equipment use, worker commuting, and transportation of materials and spoils to and from the construction sites. The proposed alternatives' operations would generate GHG emissions through worker commuting and operation of pumps and other equipment. Reclamation and Ecology estimated GHG emissions related to off-road construction using emission rates from EPA's NONROAD functionality in its Motor Vehicle Emissions Simulator model (known as MOVES 2014a). On-road emissions, from haul trucks and employee commutes, were calculated using emission rates from EPA's model. Reclamation also considered potential emissions associated with operation of the proposed alternatives; these emissions were evaluated qualitatively because of the short-term, intermittent nature of operational activities. For construction, Reclamation and Ecology assumed that the GHG emissions generated would result predominantly from the use of diesel fuel, which has higher carbon dioxide equivalent ($CO_2e$) emissions than gasoline. Some gasoline-powered equipment and commuter vehicles were also included in the GHG emission estimate. Total GHG emissions are reported as the total $CO_2e$ emissions that are expected from every gallon of diesel and gasoline 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 and gasoline fuel required for construction of the proposed alternatives and the expected $CO_2e$ GHG emissions per gallon of fuel consumed (10.302 kilograms per gallon [kg/gal]). Table 4-108 presents the expected emissions of the three major GHGs from 1 gallon of diesel fuel burned, which are referred to as emission factors (EIA, 2016). To convert CH4 and N2O into $CO_2e$, the global warming potential of each gas was compared with the global warming potential of $CO_2$. For example, one unit of CH4 warms the atmosphere at 25 times the rate of $CO_2$ (Table 4-108). In other words, every unit of CH4 emitted is equivalent to 25 units of $CO_2$. As shown in Table 4-108, the expected $CO_2e$ emissions for all three gases is 10.302 kg/gal of diesel fuel burned.

**Table 4-108. $CO_2$ Equivalents and Emission Factors per 1 Gallon of Diesel Fuel**

| Greenhouse Gas | Emission Factor (kg/gal) | Global Warming Potential | $CO_2$ Equivalent Emission Factor* (kg $CO_2e$/gal) |
|---|---|---|---|
| Carbon dioxide ($CO_2$) | 10.21 | 1 | 10.210 |
| Methane ($CH_4$) | 0.00058 | 25 | 0.015 |
| Nitrous oxide ($N_2O$) | 0.00026 | 298 | 0.077 |
| Total | | | 10.302 |

*Emission factors from Energy Information Administration.

Calculations of the GHG emissions from truck trips were based on the estimated number of trucks required for each project element, the distance each truck would be required to travel, and the emissions factor for each vehicle type. The analysis assumed a travelling distance of 4 to 50 miles for each truck, depending on the project element being constructed.

While running, construction equipment would consume diesel fuel. The potential $CO_2e$ emissions from operation of construction equipment were based on the types of construction equipment required, the time that each piece of equipment would operate during construction, and the emissions factor for each equipment type.

#### *4.12.1.2 Methods – Climate Modeling*

The hydrologic model described in Section 3.12 was used to evaluate the impacts of climate change on all alternatives. The historic and adverse scenarios described in Section 3.12 would occur independently from the action alternatives. Modeling methods and assumptions are found in *Yakima River Basin Integrated Water Resource Management Plan Technical Memorandum: Hydrologic Modeling of System Improvements Phase 3 Report* (Reclamation and Ecology, 2017b). The following sections describe the results under the historic and adverse climate scenarios for water supply and stream flow.

#### *4.12.1.3 Impact Indicators*

The impact indicator 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).

An impact would also occur if the hydrologic changes produced by climate change resulted in a decrease in the benefits of the proposed alternatives. An 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 could no longer assist in meeting the target river flows defined in Section 3.3. This section also recognizes the impacts that could result under the No Action alternative, since water users and instream uses could be affected by the potentially worsening conditions caused by climate change.

The climate change and hydrologic modeling described in Section 3.12 evaluated the potential for these changes. Climate change impact indicators are shown in Table 4-109. All indicators were assessed relative to all alternatives under the historic climate scenario, and all action alternatives were compared with *Alternative 1 – No Action* under the adverse climate scenario. For additional information, see the *Hydrologic Modeling Report* that Reclamation and Ecology prepared for the Proposed Action (Reclamation and Ecology, 2017c).

**Table 4-109. Impact Indicators for Climate Change**

| Issues | Impact Indicators |
|---|---|
| GHG emissions | GHG emissions >25,000 metric tons per year (Ecology, 2011) |
| Effect of climate change on water supply to proratable water users | Percentage change in water supply metrics between historic hydrology and adverse scenario of climate change hydrology |
| Effect of climate change on stream flow | Percentage change in stream flow metrics between historic hydrology and adverse scenario of climate change hydrology |

## 4.12.2 Summary of Impacts

### *4.12.2.1 Greenhouse Gas Emissions Impacts*

None of the alternatives would generate enough GHG emissions to exceed the threshold for impacts of 25,000 metric tons per year.

## 4.12.3 Climate Change Impacts on Operation

### *4.12.3.1 Reservoir Levels*

Under *Alternative 1*, climate change could adversely affect operation of the reservoirs because of changes in runoff timing and volume, as described in Section 3.12. These changes would increase the need for the action alternatives, but could also decrease the effectiveness of each alternative. Under *Alternative 2 – KDRPP East Shore Pumping Plant*, *Alternative 3 – KDRPP South Pumping Plant*, and *Alternative 4 (Preferred Alternative)*, 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. The predicted changes in snowpack and runoff associated with climate change would alter KDRPP operations by producing larger and more frequent drawdowns, and would more frequently result in years when Kachess Reservoir fails to refill. Under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment*, *Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment*, and *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment*, climate change would alter the timing and volume of inflow to Keechelus Reservoir, slightly decreasing the need to bypass water through the KKC North Tunnel. However, an impact is not anticipated because the No Action and action alternatives are expected to continue to contribute toward increasing water supply toward 70 percent of proratable water rights or achieving target flows defined in Section 3.3.

### *4.12.3.2 Water Supply*

Climate change would reduce available supply and increase demands. 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. The action alternatives would have a positive impact on the ability of water agencies, the economy's agriculture sector, and fish and wildlife to better withstand and adapt to changing conditions, including those associated with climate change.

#### *4.12.3.3 Streamflow*

Climate change would generally reduce the achievement of streamflow targets in the Keechelus and Easton reaches, with the exception of increasing the achievement of Keechelus reach streamflow targets during the summer. This would slightly decrease the need to bypass water through the KKC tunnel. *Alternative 2* is expected to remain within existing flow levels compared with *Alternative 1*, while *Alternatives 3* and *4* would continue to contribute toward achieving streamflow targets.

#### *4.12.3.4 Volitional Bull Trout Passage Improvements*

Volitional Bull Trout Passage Improvements at the Narrows 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. Volitional Bull Trout Passage Improvements were developed to improve bull trout populations' passage through the Narrows during drought relief pumping and refill, and would provide that benefit regardless of the effect of climate change on reservoir operations.

Table 4-110 summarizes the impacts for each alternative.

**Table 4-110. Summary of Impacts for Climate Change**

| Impact Indicator | Summary of Impacts |
|---|---|
| GHG emissions >25,000 metric tons per year (Ecology, 2011) | All alternatives would generate less than 25,000 metric tons per year of GHG emissions; therefore, impacts would not be significant. |
| Percentage change in water supply metrics between historic hydrology and adverse scenario of climate change hydrology | Under all alternatives, climate change under the adverse scenario modeled would decrease proratable water supply during the high-demand period.<br>*Alternative 1*: Climate change would reduce water deliveries to proratable water users. A significant impact is not anticipated because water deliveries to proratable water users under *Alternative 1* would still be within the current operating range. However, climate change would increase the need for the action alternatives to meet water supply demands.<br>*Alternatives 2, 3,* and *4*: Climate changes under the adverse scenario modeled would result in decreased deliveries to proratable water users. However, climate change would result in increased demand for irrigation water. For this reason, there would be increased need for the extra storage and operational flexibility provided by KDRPP. A significant impact is not anticipated because KDRPP would continue contributing to supplying 70%of proratable water rights.<br>*Alternatives 5A, 5B,* and *5C*: Climate change impacts on the water supply benefits under the adverse scenario modeled would be similar to those described for *Alternative 1*. The impacts associated with KDRPP would be the same as described for *Alternatives 2*, *3*, and *4*. |

| Impact Indicator | Summary of Impacts |
|---|---|
| Percent change in stream flow metrics between historic hydrology and adverse scenario of climate change hydrology | Under all alternatives, the effects of climate change would reduce streamflows in the Keechelus reach, especially during the summer months. This reduction in flows would contribute to the goal of reducing the artificially high streamflows in the Keechelus reach during the summer.<br>*Alternative 1*: Climate change would reduce the achievement of streamflow targets in the Keechelus and Easton reaches, with the exception of increasing the achievement of streamflow targets in the Keechelus reach during the summer. A significant impact is not anticipated because streamflows would still be within the existing operating range.<br>*Alternatives 2, 3,* and *4*: Climate change would reduce the achievement of streamflow targets in the Keechelus and Easton reaches, with the exception of increasing the achievement of streamflow targets in the Keechelus reach during the summer. Compared with *Alternative 1*, during drought years summer flows in the Easton reach would be higher, while summer flows in the Keechelus reach would be lower. This is likely attributable to smaller proratable water supply deliveries during times of shortage and greater operational flexibility provided by the KDRPP. This reduction in flows would contribute to the goal of reducing the artificially high streamflows in the Keechelus reach during the summer. A significant impact is not anticipated because streamflows would still be within the existing operating range.<br>*Alternatives 5A, 5B,* and *5C*: Climate change would reduce the achievement of streamflow targets in the Keechelus and Easton reaches. However, July and August instream flow targets in the Keechelus reach would be met nearly 100 percent of the time. Therefore, a significant impact is not anticipated because operation of KKC is expected to continue to help reduce the artificially high summer Keechelus reach streamflows. The impacts associated with KDRPP would be the same as described for *Alternatives 2, 3,* and *4*. |

## 4.12.4 Alternative 1 – No Action

### *4.12.4.1 Greenhouse Gas Emission Impacts*

*Alternative 1* would not result in an increase of carbon emissions.

### *4.12.4.2 Climate Change Impacts on Operation*

**Reservoir Levels**

Possible changes in precipitation, snowmelt, and runoff with climate change could affect the existing Keechelus and Kachess reservoir facilities included in *Alternative 1*. Changes in water availability for irrigation, fish, and municipal uses may occur. As discussed in Section 3.12, under the adverse scenario, average annual inflow to the five reservoirs would decrease by 8.1 percent and unregulated flows at the Parker gage would decrease by 7.6 percent. Under the adverse scenario, the average annual inflow to Keechelus and Kachess reservoirs would decrease an average of 11 percent compared with the historic scenario (Reclamation and Ecology, 2017c). Average spring runoff to these reservoirs is expected to decrease by 24 percent, and summer runoff is expected to decrease by 52 and 63 percent, respectively. Fall and winter runoff is expected to increase by an average of 11 and 13 percent, respectively. On average, Keechelus Reservoir is predicted to be 11 feet lower, with a monthly average difference ranging from 0 to 20 feet lower under the adverse climate change scenario. On average, Kachess Reservoir is predicted to be 9 feet lower, with a monthly average difference ranging from 5 to 14 feet lower under the adverse climate change scenario.

Predicted water levels for Keechelus and Kachess reservoirs are tabulated in Table 4-111 and Table 4-112, respectively. These tables summarize and compare annual mean, maximum, and minimum water levels for the period of record and during drought years. Under the adverse scenario, mean reservoir water levels over the full period of record would be reduced by approximately 12 feet.

**Table 4-111. Keechelus Reservoir Pool Elevation under *Alternative 1 – No Action***

| Modeled Year | Pool Elevation (feet) *Alternative 1* Historic | Pool Elevation (feet) *Alternative 1* Adverse | Percentage Change |
|---|---|---|---|
| **1925–2015** | | | |
| Mean | 2,480 | 2,468 | –0.5% |
| Mean of annual maximum | 2,509 | 2,502 | –0.3% |
| Mean of annual minimum | 2,446 | 2,432 | –0.6% |
| **1994 (Drought Year)** | | | |
| Mean | 2,453 | 2,458 | 0.2% |
| Maximum | 2,487 | 2,481 | –0.3% |
| Minimum | 2,431 | 2,433 | 0.1% |
| **2001 (Drought Year)** | | | |
| Mean | 2,460 | 2,446 | –0.5% |
| Maximum | 2,490 | 2,475 | –0.6% |
| Minimum | 2,432 | 2,431 | –0.1% |

**Table 4-112. Kachess Reservoir Pool Elevation under *Alternative 1 – No Action***

| Modeled Year | Pool Elevation (feet) *Alternative 1* Historic | Pool Elevation (feet) *Alternative 1* Adverse | Percentage Change |
|---|---|---|---|
| **1925–2015** | | | |
| Mean | 2,236 | 2,227 | –0.4% |
| Mean of annual maximum | 2,254 | 2,246 | –0.4% |
| Mean of annual minimum | 2,212 | 2,202 | –0.5% |

| Modeled Year | Pool Elevation (feet) *Alternative 1* Historic | Pool Elevation (feet) *Alternative 1* Adverse | Percentage Change |
|---|---|---|---|
| **1994 (Drought Year)** | | | |
| Mean | 2,220 | 2,219 | 0.0% |
| Maximum | 2,237 | 2,232 | –0.2% |
| Minimum | 2,203 | 2,202 | –0.1% |
| **2001 (Drought Year)** | | | |
| Mean | 2,225 | 2,216 | –0.4% |
| Maximum | 2,239 | 2,231 | –0.4% |
| Minimum | 2,205 | 2,201 | –0.2% |

## Water Supply

Climate change effects would result in reduced available supply and increased irrigation demand to meet irrigation needs and instream flow targets. Currently, during some drought years the Yakima Project reservoirs cannot meet these demands. Modeling of *Alternative 1* under the historic scenario shows that September 30 prorationing would occur in 15 out of 90 years. Under the adverse climate scenario, September 30 prorationing would occur in 43 out of 90 years. Table 4-113 summarizes the water supply conditions under the historic and adverse scenarios. Under the adverse scenario, average September 30 water available for prorationing is reduced by 21 percent compared with the historic scenario. Average July 1 TWSA is reduced by 318,000 acre-feet, and average delivery to the major irrigation districts is reduced by 124,000 acre-feet.

**Table 4-113. Comparison between Simulated Water Supply Conditions under Historic and Adverse Climate Change Scenarios**

| Range | | Sept 30 Prorationing (Percentage) | July 1 TWSA (kaf)* | April–Sept Deliveries (kaf) |
|---|---|---|---|---|
| Historic scenario | Min | 19 | 857 | 997 |
| | Average | 89 | 1,523 | 1,642 |
| | Max | 100 | 2,225 | 1,742 |
| Adverse scenario | Min | 0 | 696 | 653 |
| | Average | 68 | 1,205 | 1,518 |
| | Max | 100 | 1,844 | 1,890 |
| Change attributable to adverse scenario | Min | –19 | –161 | –344 |
| | Average | –21 | –318 | –124 |
| | Max | 0 | –381 | 148 |

Source: Reclamation and Ecology, 2017c
*kaf = thousand acre-feet

This decrease in available irrigation water supply under the adverse scenario 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 requires the early release of stored water to meet irrigation demands. The combined effects would likely cause a decrease in overall supply during the high-demand period.

### Streamflow

Climate change would generally reduce streamflows in the Yakima River basin, especially during the summer months. In the Keechelus reach, average annual flows would be reduced approximately 11 percent under the adverse scenario compared with the historic scenario. Average summer (July to August) flows would be greatly reduced, while average winter flows would be greatly increased. This finding suggests that the timing of precipitation and runoff is projected to change, with increased precipitation during the winter and decreased precipitation during the summer. Drought year flows would be reduced by approximately 20 percent. This reduction in flows would contribute to the goal of reducing the artificially high summer Keechelus reach streamflows. These changes are summarized in Table 4-114.

**Table 4-114. Mean Keechelus Reach Flow under *Alternative 1 – No Action***

| Modeled Year | Mean Flow (cfs) *Alternative 1* Historic | Mean Flow (cfs) *Alternative 1* Adverse | Percentage Change |
|---|---|---|---|
| **1926–2015** | | | |
| Annual | 337 | 301 | –11% |
| July–August | 866 | 131 | –85% |
| January | 154 | 741 | 381% |
| **1994 (Drought Year)** | | | |
| Annual | 230 | 183 | –20% |
| July–August | 614 | 370 | –40% |
| January | 81 | 90 | 11% |
| **2001 (Drought Year)** | | | |
| Annual | 261 | 203 | –22% |
| July–August | 673 | 497 | –26% |
| January | 132 | 114 | –13% |

Predicted Keechelus reach seasonal flow exceedances for *Alternative 1* under the historic and adverse scenarios are summarized in Table 4-115. Median spring and summer flow exceedances for the Keechelus reach under the adverse scenario would be substantially lower compared with the historic scenario. Median winter flows would be unchanged.

**Table 4-115. Keechelus Reach Seasonal Flow Exceedance under *Alternative 1 – No Action***

| Season | Flow (cfs) *Alternative 1* Historic | Flow (cfs) *Alternative 1* Adverse | Percentage Change |
|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 100 | 100 | 0% |
| High (10% exceedance) | 153 | 127 | –17% |
| Low (90% exceedance) | 80 | 80 | 0% |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 350 | 308 | –12% |
| High (10% exceedance) | 675 | 700 | 4% |
| Low (90% exceedance) | 100 | 80 | –20% |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 527 | 311 | –41% |
| High (10% exceedance) | 1,070 | 1,016 | –5% |
| Low (90% exceedance) | 80 | 80 | 0% |

Changes in Easton reach streamflow are summarized in Table 4-116. In the Easton reach, average annual flows would be reduced by approximately 7 percent under the adverse scenario compared with the historic scenario. Average summer flows would also decrease, while average winter flows would increase. The decrease in summer flow during drought years would be 2 to 143 cfs.

**Table 4-116. Mean Easton reach Flows under *Alternative 1 – No Action***

| Modeled Year | Mean Flow (cfs) *Alternative 1* Historic | Mean Flow (cfs) *Alternative 1* Adverse | Percentage Change |
|---|---|---|---|
| **1926–2015** | | | |
| Annual | 458 | 425 | –7% |
| July–August | 530 | 477 | –10% |
| January | 450 | 557 | 24% |
| **1994 (Drought Year)** | | | |
| Annual | 366 | 387 | 6% |
| July–August | 534 | 532 | –1% |
| January | 306 | 238 | –22% |
| **2001 (Drought Year)** | | | |
| Annual | 398 | 321 | –19% |

| Modeled Year | Mean Flow (cfs) | Mean Flow (cfs) | Percentage Change |
|---|---|---|---|
| | *Alternative 1* Historic | *Alternative 1* Adverse | |
| July–August | 694 | 551 | –21% |
| January | 250 | 190 | –24% |

Predicted Easton reach seasonal flow exceedances for *Alternative 1* under the historic and adverse scenarios are summarized in Table 4-117. In the winter and spring, median flows in the Easton reach would be reduced by 17 and 22 percent, respectively, under the adverse scenario compared with the historic scenario. In the summer, median flows would increase by approximately 11 percent, likely because of increased reservoir releases to meet water supply demands and instream flow targets.

**Table 4-117. Easton Reach Seasonal Flow under *Alternative 1 – No Action***

| Season | Flow (cfs) | Flow (cfs) | Percentage Change |
|---|---|---|---|
| | *Alternative 1* Historic | *Alternative 1* Adverse | |
| **Winter (Nov 1–Mar 14)** | | | |
| Median (50% exceedance) | 305 | 252 | –17% |
| High (10% exceedance) | 712 | 821 | 15% |
| Low (90% exceedance) | 222 | 190 | –15% |
| **Spring (Mar 15–Jun 15)** | | | |
| Median (50% exceedance) | 393 | 305 | –22% |
| High (10% exceedance) | 1,100 | 786 | –29% |
| Low (90% exceedance) | 193 | 190 | –2% |
| **Summer (Jun 16–Oct 31)** | | | |
| Median (50% exceedance) | 310 | 344 | 11% |
| High (10% exceedance) | 735 | 821 | 12% |
| Low (90% exceedance) | 196 | 190 | –3% |

## Summary

Under *Alternative 1*, the effects of climate change on reservoir levels, water supply, and streamflow are likely to reduce the ability to meet 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 compared with the historic scenario. Because of predicted increased temperatures and decreased summer stream flow, adverse effects on water quality attributable to climate change are also likely under all alternatives.

#### *4.12.4.3 Other Climate Change Impacts*

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 substantially 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 an accompanying increase water temperatures, and more precipitation would fall as rain rather than snow (RMJOC, 2010). Other studies have shown that the Yakima River basin is likely to experience a 12 percent decrease in snowmelt volume given a 1°C (1.8°F) rise in air temperature, and a 27 percent decrease in snowmelt volume given a 2°C (3.6°F) rise (Vano et al., 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 an indirect impact on DO. 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°C(70°F) 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 because of climate change (Karl et al., 2009).

### 4.12.5 Alternative 2 – KDRPP East Shore Pumping Plant

#### *4.12.5.1 Greenhouse Gas Emission Impacts*

**Construction**

*KDRPP East Shore Pumping Plant Facilities*

The construction activities proposed under *Alternative 2* would generate approximately 8,780 metric tons of total $CO_2e$ emissions. This amount is below the 25,000-metric ton significance threshold established by Ecology.

*Volitional Bull Trout Passage Improvements*

The construction activities proposed for the Volitional Bull Trout Passage Improvements would generate approximately 250 metric tons of total $CO_2e$ emissions. This amount is well below the 25,000-metric ton significance threshold established by Ecology.

**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 2*, average pumping volume when the KDRPP is operated would increase by 28 percent from 87,000 acre-feet per year to 111,000 acre-feet per year under the adverse scenario compared with the historic 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).

*Volitional Bull Trout Passage Improvements*

Following construction, the Volitional Bull Trout Passage Improvements would not generate $CO_2e$ emissions because the actions included in the plan would consume no additional energy.

### *4.12.5.2 Climate Change Impacts on Operation*

**Reservoir Levels**

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 their water management approaches 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 and the need for the additional proratable water supply provided by *Alternative 2*. Table 4-118 and Figure 4-22 summarize the *Alternative 2* Kachess Reservoir level results under the adverse scenario. Compared with the historic scenario, Kachess Reservoir levels would be lower. The mean reservoir level would be approximately 35 feet lower over the period of record and 12 to 22 feet lower in drought years. Compared with *Alternative 1* under the adverse scenario, the mean reservoir level would be approximately 42 feet lower over the period of record and 20 to 90 feet lower in drought years (see Table 4-118).

**Table 4-118. Kachess Reservoir Pool Elevation under *Alternative 2 – KDRPP East Shore Pumping Plant***

| | Pool Elevation (feet) | Pool Elevation (feet) | | |
|---|---|---|---|---|
| **Modeled Year** | ***Alternative 2* Historic** | ***Alternative 2* Adverse** | **Percentage Change** | **Percentage Change Compared with *Alternative 1* Adverse** |
| **1925–2015** | | | | |
| Mean | 2,220 | 2,185 | –1.6% | –1.9% |
| Mean of annual maximum | 2,242 | 2,211 | –1.4% | –1.6% |
| Mean of annual minimum | 2,189 | 2,149 | –1.8% | –2.4% |
| **1994 (Drought Year)** | | | | |
| Mean | 2,151 | 2,129 | –1.1% | –4.1% |
| Maximum | 2,181 | 2,148 | –1.5% | –3.8% |
| Minimum | 2,111 | 2,111 | 0.0% | –4.1% |
| **2001 (Drought Year)** | | | | |
| Mean | 2,207 | 2,195 | –0.5% | –0.9% |
| Maximum | 2,234 | 2,222 | –0.5% | –0.4% |
| Minimum | 2,144 | 2,136 | –0.3% | –2.9% |

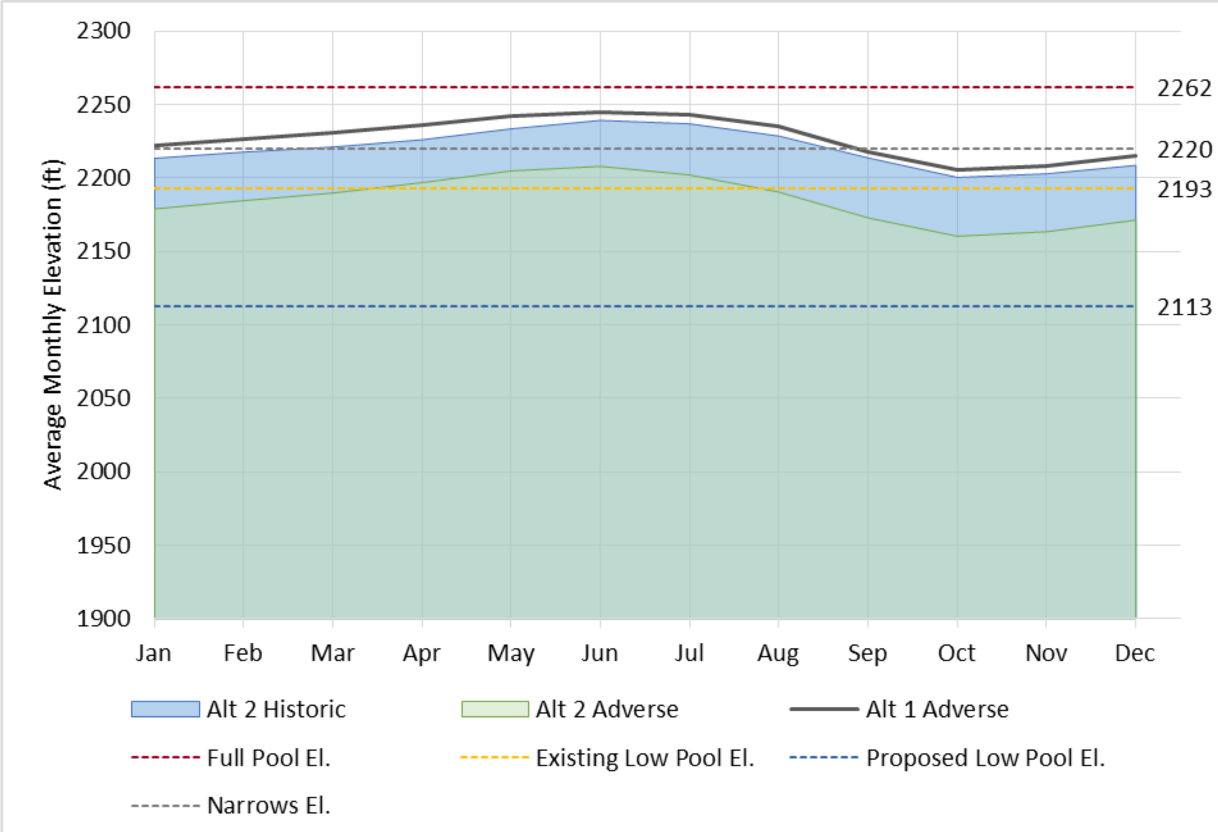



**Figure 4-22. Effect of Climate Change on Average Kachess Reservoir Water Surface Elevation – *Alternatives 2*, *3*, and *4***

Table 4-119 and Figure 4-23 summarize the *Alternative 2* Keechelus Reservoir level results under the adverse scenario. Compared with the historic scenario, Keechelus Reservoir levels would be lower. The mean reservoir level would be approximately 8 feet lower over the period of record. Compared with *Alternative 1* under the adverse scenario, Keechelus Reservoir levels would be essentially unchanged.

**Table 4-119. Keechelus Reservoir Pool Elevation under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Modeled Year | Pool Elevation (feet) *Alternative 2* Historic | Pool Elevation (feet) *Alternative 2* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| **1925–2015** | | | | |
| Mean | 2,479 | 2,471 | –0.3% | 0.1% |
| Mean of annual maximum | 2,508 | 2,502 | –0.2% | 0.0% |
| Mean of annual minimum | 2,445 | 2,435 | –0.4% | 0.1% |
| **1994 (Drought Year)** | | | | |
| Mean | 2,452 | 2,457 | 0.2% | 0.0% |
| Maximum | 2,484 | 2,480 | –0.2% | 0.0% |
| Minimum | 2,430 | 2,433 | 0.1% | 0.0% |
| **2001 (Drought Year)** | | | | |
| Mean | 2,456 | 2,442 | –0.6% | –0.2% |
| Maximum | 2,480 | 2,465 | –0.6% | –0.4% |
| Minimum | 2,431 | 2,429 | –0.1% | –0.1% |

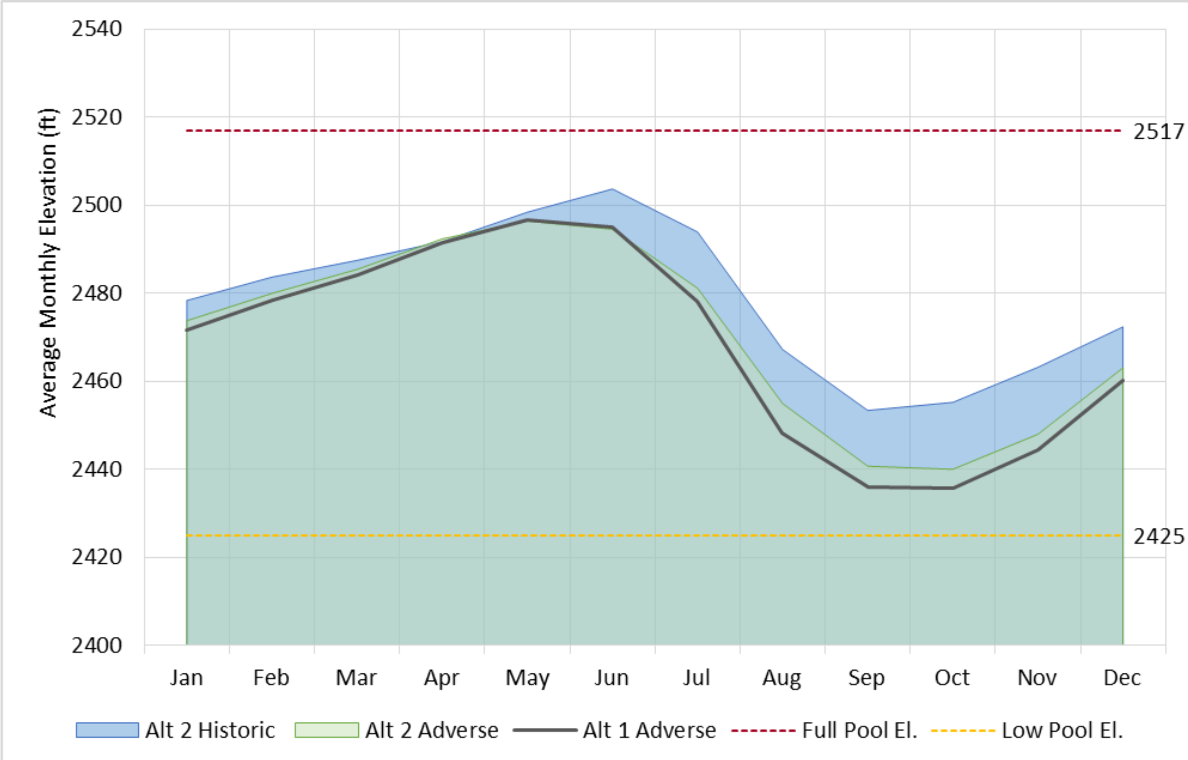



**Figure 4-23. Effect of Climate Change on Average Keechelus Reservoir Water Surface Elevation – *Alternatives 2, 3,* and *4***

### Water Supply

*Alternative 2* 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 2* would be used in 76 out of 90 years, as compared with 34 out of 90 years under historic scenario conditions.

The adverse scenario water supply results for *Alternative 2* are summarized in Table 4-120. Climate change would decrease the proratable water supply performance of *Alternative 2*. Under the adverse scenario, average September 30 water available for prorationing is reduced by 23 percent compared with the historic scenario. Average July 1 TWSA is reduced by 310,000 acre-feet, and average delivery to the major irrigation districts is reduced by 142,000 acre-feet.

However, climate change would increase the need for KDRPP because of higher agricultural water demands expected with the warmer temperatures and more severe proratable water supply shortages predicted under the adverse scenario. Compared with *Alternative 1* under the adverse scenario, *Alternative 2* would improve minimum September 30 prorationing by 3 percent, July 1 TWSA by 55,000 acre-feet, and deliveries by 73,000 acre-feet. Average and maximum water supply metrics would be essentially unchanged compared with *Alternative 1* under the adverse scenario.

**Table 4-120. Effects of Climate Change on *Alternatives 2, 3,* and *4* Water Supply Results**

| Condition | | Sept 30 Proration (Percentage) | July 1 TWSA (kaf) | April to Sept Diversions (kaf) |
|---|---|---|---|---|
| ***Alternatives 2, 3*, and *4*** | | | | |
| Historic | Min | 33% | 944 | 1,145 |
| | Average | 90% | 1,519 | 1,655 |
| | Max | 100% | 2,225 | 1,744 |
| Adverse | Min | 3% | 750 | 726 |
| | Average | 67% | 1,209 | 1,513 |
| | Max | 100% | 1,846 | 1,890 |
| Change | Min | –31% | –194 | –419 |
| | Average | –23% | –310 | –142 |
| | Max | 0% | –379 | 146 |
| Change Compared with No Action Adverse | Min | 3% | 55 | 73 |
| | Average | –1% | 4 | –5 |
| | Max | 0% | 2 | 0 |

### Streamflow

Climate change would decrease the winter, spring, and fall attainment of instream flow targets for the Keechelus reach. However, it would improve the July and August attainment of target instream flows.

Table 4-121 summarizes the changes in average flows in the Keechelus reach under *Alternative 2*. Average annual flows over the period of record would be reduced by approximately 11 percent under the adverse scenario compared with the historic scenario. Average summer flows would be greatly reduced, while average winter flows would be greatly increased. Drought year flows would be reduced by approximately 22 percent. Compared with *Alternative 1* under the adverse scenario, average flows during the summer would be reduced under the *Alternative 2* adverse scenario. These changes are likely attributable to smaller proratable water supply deliveries from Keechelus during times of shortage and greater operational flexibility. This reduction in flows would contribute to the goal of reducing the artificially high summer Keechelus reach streamflows.

**Table 4-121. Mean Keechelus Reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Modeled Year | Mean Flow (cfs) *Alternative 2* Historic | Mean Flow (cfs) *Alternative 2* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| **1926–2015** | | | | |
| Annual | 337 | 301 | –11% | –0.1% |
| July–August | 856 | 144 | –83% | 9.7% |
| January | 151 | 702 | 365% | –5.3% |
| **1994 (Drought Year)** | | | | |
| Annual | 231 | 184 | –21% | 0.5% |
| July–August | 564 | 341 | –39% | –7.6% |
| January | 81 | 92 | 13% | 2.0% |
| **2001 (Drought Year)** | | | | |
| Annual | 264 | 204 | –23% | 0.6% |
| July–August | 534 | 355 | –34% | –28.7% |
| January | 132 | 115 | –13% | 0.5% |

Table 4-122 summarizes the modeled seasonal flow exceedances for the Keechelus reach under the adverse climate scenario for *Alternative 2*. Winter median flows would be unchanged, spring median flows would be about 4 percent lower, and summer median flows would be about 25 percent lower. Compared with *Alternative 1* under the adverse scenario, median flows would increase in spring and summer.

**Table 4-122. Keechelus Reach Seasonal Flow under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Season | Flow (cfs) *Alternative 2* Historic | Flow (cfs) *Alternative 2* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | | |
| Median (50% exceedance) | 100 | 100 | 0% | 0% |
| High (10% exceedance) | 153 | 159 | 4% | 25% |
| Low (90% exceedance) | 80 | 80 | 0% | 0% |
| **Spring (Mar 15–Jun 15)** | | | | |
| Median (50% exceedance) | 357 | 343 | –4% | 12% |

| Season | Flow (cfs) *Alternative 2* Historic | Flow (cfs) *Alternative 2* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| High (10% exceedance) | 701 | 733 | 5% | 5% |
| Low (90% exceedance) | 100 | 80 | –20% | 0% |
| **Summer (Jun 16–Oct 31)** | | | | |
| Median (50% exceedance) | 490 | 367 | –25% | 18% |
| High (10% exceedance) | 1,073 | 936 | –13% | –8% |
| Low (90% exceedance) | 80 | 80 | 0% | 0% |

Climate change would decrease attainment of instream flow targets for the Easton reach in all seasons. Table 4-123 summarizes the changes in average flows in the Easton reach under *Alternative 2*. Average annual flows over the period of record would be reduced approximately 7 percent under the adverse scenario compared with the historic scenario. Average summer flows would decrease while average winter flows would increase. Drought year flows would be reduced by approximately 9 to 20 percent. Compared with *Alternative 1* under the adverse scenario, average flows over the period of record would be essentially unchanged, while drought year summer flows would increase because of drought relief water provided by KDRPP to meet irrigation water supply demands.

**Table 4-123. Mean Easton reach Flow under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Modeled Year | Mean Flow (cfs) *Alternative 2* Historic | Mean Flow (cfs) *Alternative 2* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| **1926–2015** | | | | |
| Annual | 456 | 423 | –7% | –0.6% |
| July–August | 522 | 488 | –6% | 2.4% |
| January | 440 | 487 | 11% | –12.5% |
| **1994 (Drought Year)** | | | | |
| Annual | 420 | 383 | –9% | –1.0% |
| July–August | 784 | 569 | –27% | 7.1% |
| January | 305 | 238 | –22% | 0.0% |
| **2001 (Drought Year)** | | | | |
| Annual | 518 | 415 | –20% | 29.3% |
| July–August | 918 | 771 | –16% | 40.1% |
| January | 250 | 190 | –24% | 0.0% |

Table 4-124 summarizes the modeled seasonal flow exceedances for the Easton reach under the adverse climate scenario for *Alternative 2*. Winter median flows would be about 17 percent lower, spring median flows would be about 25 percent lower, and summer median flows would increase by about 4 percent. Compared with *Alternative 1* under the adverse scenario, median flows would be essentially unchanged in winter and spring, and would be about 17 percent lower in summer.

**Table 4-124. Easton reach Seasonal Flow under *Alternative 2 – KDRPP East Shore Pumping Plant***

| Season | Flow (cfs)<br>*Alternative 2* Historic | Flow (cfs)<br>*Alternative 2* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | | |
| Median (50% exceedance) | 305 | 254 | –17% | 1% |
| High (10% exceedance) | 698 | 836 | 20% | 2% |
| Low (90% exceedance) | 231 | 190 | –18% | 0% |
| **Spring (Mar 15–Jun 15)** | | | | |
| Median (50% exceedance) | 406 | 306 | –25% | 0% |
| High (10% exceedance) | 1,094 | 799 | –27% | 2% |
| Low (90% exceedance) | 250 | 190 | –24% | 0% |
| **Summer (Jun 16–Oct 31)** | | | | |
| Median (50% exceedance) | 274 | 285 | 4% | –17% |
| High (10% exceedance) | 772 | 756 | –2% | –8% |
| Low (90% exceedance) | 196 | 190 | –3% | 0% |

### Summary

In general, *Alternative 2* 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. Climate change could decrease the effectiveness of *Alternative 2*. However, the predicted changes in snowpack and runoff associated with climate change would increase proratable water supply shortages, thereby increasing the need for the KDRPP during drought years when water supply falls below 70 percent of proratable water rights. These changes could result in greater and more frequent drawdowns, up to the KDRPP maximum design drawdown of 80 feet. This could potentially increase the number of years when the reservoir would fail to fully refill. KDRPP would help reduce potential water quality effects caused by increased temperatures and decreased summer flows by providing additional proratable water supply releases during drought years.

*Volitional Bull Trout Passage Improvements*

Volitional Bull Trout Passage Improvements at the Narrows 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 Volitional Bull Trout Passage Improvements were developed to improve bull trout populations' passage through the Narrows during drought relief pumping and refill and would provide that benefit regardless of the effect of climate change on reservoir operations.

## 4.12.6 Alternative 3 – KDRPP South Pumping Plant

### *4.12.6.1 Greenhouse Gas Emission Impacts*

**Construction**

*KDRPP South Pumping Plant Facilities*

The construction activities proposed under *Alternative 3* would generate approximately 4,020 metric tons of total $CO_2$e emissions. This amount is below the 25,000-metric ton significance threshold established by Ecology.

*Volitional Bull Trout Passage Improvements*

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.12.5.1).

**Operations**

*KDRPP South Pumping Plant Facilities*

Impacts under *Alternative 3* would be the same as those under *Alternative 2.* Reclamation would operate KDRPP the same regardless of the location of the facilities.

*Volitional Bull Trout Passage Improvements*

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.12.5.1).

### *4.12.6.2 Climate Change Impacts on Operation*

**KDRPP South Pumping Plant Facilities**

The impacts of climate change on *Alternative 3* would be the same as those under *Alternative 2.* Reclamation would operate KDRPP the same regardless of the location of the facilities.

**Volitional Bull Trout Passage Improvements**

The impacts of climate change on Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.12.5.2).

## 4.12.7 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.12.7.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

The construction activities proposed under *Alternative 4 (Preferred Alternative)* would generate approximately 1,500 metric tons of total CO2e emissions. This amount is below the 25,000-metric ton significance threshold established by Ecology.

**Volitional Bull Trout Passage Improvements**

The construction activities proposed for the Volitional Bull Trout Passage Improvements would generate approximately 250 metric tons of total CO2e emissions. This amount is well below the 25,000-metric ton significance threshold established by Ecology.

### *4.12.7.2 Operation*

**KDRPP Floating Pumping Plant Facilities**

Impacts under *Alternative 4 (Preferred Alternative)* would be the same as those under *Alternative 2*. Reclamation would operate KDRPP the same regardless of the location of the facilities.

**Volitional Bull Trout Passage Improvements**

Following construction, the Volitional Bull Trout Passage Improvements would not generate CO2e emissions because the actions included in the plan would consume no additional energy.

### *4.12.7.3 Climate Change Impacts on Operation*

**KDRPP Floating Pumping Plant Facilities**

The impacts of climate change on Alternative 4 (Preferred Alternative) would be the same as those under *Alternative 2*. Reclamation would operate KDRPP the same regardless of the location of the facilities.

**Volitional Bull Trout Passage Improvements**

The impacts of climate change on Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.12.5.2).

### 4.12.8 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

*Alternative 5A* would include construction of the KDRPP East Shore Pumping Plant (*Alternative 2*). The impacts from construction and operation of these components of *Alternative 5A* would be the same as described in Section 4.12.5. *Alternative 5A* would also include construction and operation of the KKC North Tunnel. The impacts of the KKC North Tunnel are described below.

#### *4.12.8.1 Greenhouse Gas Emission Impacts*

**Construction**

*KKC North Tunnel Alignment Facilities*

The construction activities proposed under *Alternative 5A* would generate approximately 5,030 metric tons of total CO2e emissions. This amount is below the 25,000-metric ton significance threshold established by Ecology.

**Operations**

*KKC North Tunnel Alignment Facilities*

Operation of *Alternative 5A* would generate negligible emissions because KKC would operate by gravity and would consume no additional energy.

#### *4.12.8.2 Climate Change Impacts on Operation*

**Reservoir Levels**

Table 4-125 and Figure 4-24 summarize the impact of climate change on Kachess Reservoir levels. Compared with the historic scenario, mean Kachess Reservoir levels would be approximately 10 feet lower over the period of record and 0 to 13 feet lower in drought years. Compared with *Alternative 1* under the adverse scenario, mean reservoir level would be essentially unchanged over the period of record and in drought years (see Table 4-125).

**Table 4-125. Kachess Reservoir Pool Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Modeled Year | Pool Elevation (feet) *Alternative 5A* Historic | Pool Elevation (feet) *Alternative 5A* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| **1925–2015** | | | | |
| Mean | 2,238 | 2,228 | –0.4% | 0.0% |
| Mean of annual maximum | 2,257 | 2,251 | –0.3% | 0.2% |
| Mean of annual minimum | 2,211 | 2,200 | –0.5% | –0.1% |
| **1994 (Drought Year)** | | | | |
| Mean | 2,214 | 2,215 | 0.0% | –0.2% |
| Maximum | 2,238 | 2,232 | –0.3% | 0.0% |
| Minimum | 2,197 | 2,198 | 0.1% | –0.2% |
| **2001 (Drought Year)** | | | | |
| Mean | 2,225 | 2,212 | –0.6% | –0.2% |
| Maximum | 2,246 | 2,229 | –0.8% | –0.1% |
| Minimum | 2,201 | 2,195 | –0.3% | –0.3% |

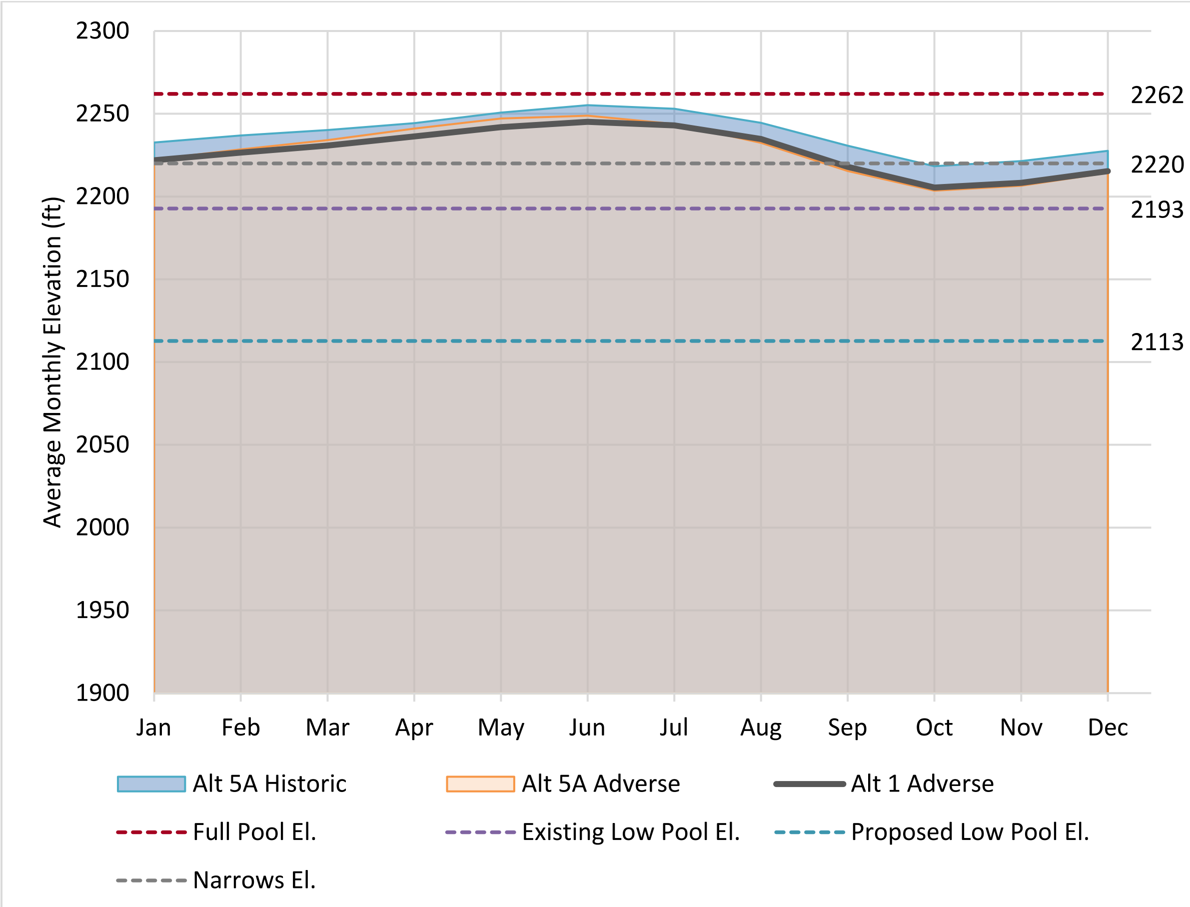



**Figure 4-24. Effect of Climate Change on Average Kachess Reservoir Water Surface Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

Table 4-126 and Figure 4-25 summarize the impact of climate change on Keechelus Reservoir levels. Compared with the historic scenario, mean Keechelus Reservoir levels would be approximately 10 feet lower over the period of record and either slightly increased or up to 19 feet lower in drought years. Compared with *Alternative 1* under the adverse scenario, mean reservoir level would be slightly higher over the period of record and in drought years (see Table 4-126).

**Table 4-126. Keechelus Reservoir Pool Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Modeled Year | Pool Elevation (feet) *Alternative 5A* Historic | Pool Elevation (feet) *Alternative 5A* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| **1925–2015** | | | | |
| Mean | 2,482 | 2,471 | –0.4% | 0.1% |
| Mean of annual maximum | 2,507 | 2,496 | –0.4% | –0.2% |
| Mean of annual minimum | 2,454 | 2,439 | –0.6% | 0.3% |
| **1994 (Drought Year)** | | | | |
| Mean | 2,464 | 2,467 | 0.1% | 0.3% |
| Maximum | 2,485 | 2,482 | –0.1% | 0.1% |
| Minimum | 2,444 | 2,444 | 0.0% | 0.4% |
| **2001 (Drought Year)** | | | | |
| Mean | 2,474 | 2,455 | –0.8% | 0.3% |
| Maximum | 2,489 | 2,480 | –0.4% | 0.2% |
| Minimum | 2,445 | 2,438 | –0.3% | 0.3% |

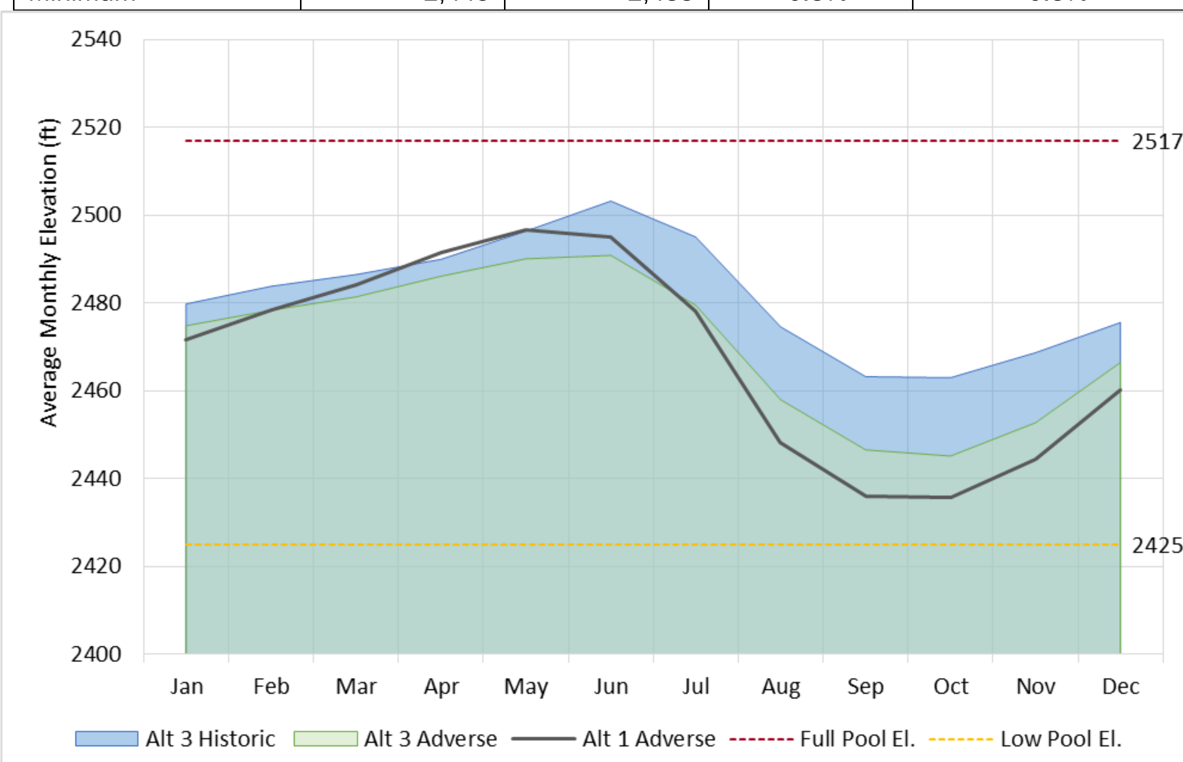



**Figure 4-25. Effect of Climate Change on Average Keechelus Reservoir Water Surface Elevation under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

### Water Supply

The adverse scenario water supply results for *Alternative 5A* are summarized in Table 4-127. Climate change would decrease the proratable water supply performance of *Alternative 5A*. Under the adverse scenario, average September 30 water available for prorationing is reduced by 19 percent compared with the historic scenario. Average July 1 TWSA is reduced by 313,000 acre-feet, and average delivery to the major irrigation districts is reduced by 121,000 acre-feet. Compared with *Alternative 1* under the adverse scenario, water supply conditions would be essentially unchanged.

Compared with *Alternative 5A* under the historic scenario, simulated July 1 TWSA values decrease by an average of 313,000 acre-feet under the adverse scenario. Simulated deliveries would decrease by an average of 121,000 acre-feet under the adverse scenario.

**Table 4-127. Effects of Climate Change on *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* Water Supply Results**

| Condition | | Sept 30 Proration (Percentage) | July 1 TWSA (kaf) | April to Sept Diversions (kaf) |
|---|---|---|---|---|
| | | ***Alternatives 5A*, *5B*, and *5C*** | ***Alternatives 5A*, *5B*, and *5C*** | |
| Historic | Min | 19% | 858 | 999 |
| | Average | 89% | 1,524 | 1,643 |
| | Max | 100% | 2,225 | 1,742 |
| Adverse | Min | 0% | 697 | 654 |
| | Average | 68% | 1,211 | 1,522 |
| | Max | 100% | 1,858 | 1,890 |
| Change | Min | –19% | –161 | –345 |
| | Average | –21% | –313 | –121 |
| | Max | 0% | –367 | 148 |
| Change Compared with No Action Adverse | Min | 0% | 1 | 1 |
| | Average | 1% | 6 | 3 |
| | Max | 0% | 15 | 0 |

### Streamflow

July and August instream flow targets in the Keechelus reach would be met nearly 100 percent of the time under *Alternative 5A*. 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 essentially unchanged under the effects of climate change. Therefore, climate change is not expected to have a significant impact on *Alternative 5A*.

Table 4-128 summarizes the changes in average flows in the Keechelus reach under *Alternative 5A*. Average annual flows over the period of record would be reduced approximately 8 percent under the adverse scenario compared with the historic scenario. Average summer flows would be greatly decreased while average winter flows would be greatly increased. Drought year flows would be reduced by approximately 10 percent. This reduction in flows would contribute to the goal of reducing the artificially high summer Keechelus reach stream flows. Compared with *Alternative 1* under the adverse scenario, average flows would be greatly reduced under the *Alternative 5A* adverse scenario because of operation of the KKC.

**Table 4-128. Mean Keechelus reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| | Mean Flow (cfs) | Mean Flow (cfs) | | |
|---|---|---|---|---|
| **Modeled Year** | ***Alternative 5A* Historic** | ***Alternative 5A* Adverse** | **Percentage Change** | **Percentage Change Compared with *Alternative 1* Adverse** |
| **1926–2015** | | | | |
| Annual | 221 | 204 | –8% | –32.4% |
| July–August | 393 | 99 | –75% | –24.2% |
| January | 150 | 364 | 143% | –50.9% |
| **1994 (Drought Year)** | | | | |
| Annual | 160 | 146 | –9% | –20.3% |
| July–August | 324 | 282 | –13% | –23.5% |
| January | 80 | 80 | 0% | –10.9% |
| **2001 (Drought Year)** | | | | |
| Annual | 165 | 149 | –10% | –26.7% |
| July–August | 332 | 296 | –11% | –40.5% |
| January | 80 | 80 | 0% | –30.1% |

Table 4-129 summarizes the modeled *Alternative 5A* seasonal flow exceedances for the Keechelus reach. Under the adverse climate scenario, winter median flow exceedances would be about 20 percent lower. Spring and summer median flows would be about 10 percent lower compared with the historic scenario. Compared with *Alternative 1* under the adverse scenario, median flow exceedances would be lower in all seasons.

**Table 4-129. Keechelus reach Seasonal Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Season | Flow (cfs) *Alternative 5A* Historic | Flow (cfs) *Alternative 5A* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | | |
| Median (50% exceedance) | 100 | 80 | –20% | –20% |
| High (10% exceedance) | 120 | 120 | 0% | –6% |
| Low (90% exceedance) | 80 | 80 | 0% | 0% |
| **Spring (Mar 15–Jun 15)** | | | | |
| Median (50% exceedance) | 271 | 245 | –10% | –21% |
| High (10% exceedance) | 570 | 559 | –2% | –20% |
| Low (90% exceedance) | 100 | 80 | –20% | 0% |
| **Summer (Jun 16–Oct 31)** | | | | |
| Median (50% exceedance) | 206 | 186 | –10% | –40% |
| High (10% exceedance) | 500 | 500 | 0% | –51% |
| Low (90% exceedance) | 80 | 80 | 0% | 0% |

Table 4-130 summarizes the changes in average flows in the Easton reach under *Alternative 5A*. Average annual flows over the period of record would be reduced approximately 7 percent under the adverse scenario compared with the historic scenario. Average summer flows would slightly decrease while average winter flows would increase. Drought year average flows could increase by 7 percent, or decrease. Compared with *Alternative 1* under the adverse scenario, average flows would be essentially unchanged under the *Alternative 5A* adverse scenario. However, summer flows would increase in the Easton reach as the KKC transfers water to Kachess Reservoir to meet summer flow targets in the Keechelus reach.

**Table 4-130. Mean Easton reach Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Modeled Year | Mean Flow (cfs) *Alternative 5A* Historic | Mean Flow (cfs) *Alternative 5A* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| **1926–2015** | | | | |
| Annual | 459 | 426 | –7% | 0.2% |
| July–August | 483 | 472 | –2% | –1.0% |
| January | 453 | 552 | 22% | –1.0% |
| **1994 (Drought Year)** | | | | |
| Annual | 363 | 389 | 7% | 0.5% |
| July–August | 551 | 561 | 2% | 5.6% |
| January | 306 | 238 | –22% | 0.0% |
| **2001 (Drought Year)** | | | | |
| Annual | 431 | 322 | –25% | 0.2% |
| July–August | 717 | 600 | –16% | 9.0% |
| January | 250 | 190 | –24% | 0.0% |

Table 4-131 summarizes the modeled *Alternative 5A* seasonal flow exceedances for the Easton reach. Under the adverse climate scenario, winter median flows would be about 17 percent lower, spring median flows would be about 25 percent lower, and summer median flows would increase by about 27 percent compared with the historic scenario. Compared with *Alternative 1* under the adverse scenario, median flow exceedances would be essentially unchanged in winter and spring, and would increase by about 14 percent in summer.

**Table 4-131. Easton reach Seasonal Flow under *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment***

| Season | Flow (cfs) *Alternative 5A* Historic | Flow (cfs) *Alternative 5A* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| **Winter (Nov 1–Mar 14)** | | | | |
| Median (50% exceedance) | 305 | 252 | –17% | 0% |
| High (10% exceedance) | 707 | 820 | 16% | 0% |
| Low (90% exceedance) | 222 | 190 | –15% | 0% |
| **Spring (Mar 15–Jun 15)** | | | | |
| Median (50% exceedance) | 408 | 307 | –25% | 1% |
| High (10% exceedance) | 1176 | 770 | –34% | –2% |

| Season | Flow (cfs)<br>*Alternative 5A* Historic | Flow (cfs)<br>*Alternative 5A* Adverse | Percentage Change | Percentage Change Compared with *Alternative 1* Adverse |
|---|---|---|---|---|
| Low (90% exceedance) | 206 | 190 | –8% | 0% |
| **Summer (Jun 16–Oct 31)** | | | | |
| Median (50% exceedance) | 308 | 391 | 27% | 14% |
| High (10% exceedance) | 681 | 757 | 11% | –8% |
| Low (90% exceedance) | 196 | 190 | –3% | 0% |

**Summary**

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 North Tunnel. However, 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.

*Alternative 5A* would have a positive impact on the ability of water agencies 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 5A* operations by reducing the duration of water transfer to Kachess Reservoir. 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 the 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, thus increasing the need for the operational flexibility provided by KKC that is not provided in *Alternatives 2, 3* or *4*.

### 4.12.9 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation of *Alternative 5B* would be the same as described in Section 4.12.8 (*Alternative 5A*) for the North Tunnel; however, KDRPP would be constructed at the south shore location as described in Section 4.12.6 (*Alternative 3*) rather than the east shore location. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.12.8 (*Alternative 5A*).

### 4.12.10 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation of *Alternative 5C* would be the same as described in Section 4.12.8 (*Alternative 5A*) for the KCC North Tunnel; however, the KDRPP floating pumping plant would be constructed as described in Section 4.12.7 (*Alternative 4 [Preferred Alternative]*) rather than the east shore location. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.12.8 (*Alternative 5A*).

### 4.12.11 Avoidance, Minimization and Mitigation Measures

None of the alternatives would generate carbon emissions impacts at a level above Ecology and EPA's threshold for significance, therefore no mitigation measures are required.

Changes associated with climate change would worsen proratable water supply shortages and thereby increase the need for the extra storage provided by KDRPP. Climate change would alter the timing and volume of inflow to Keechelus Reservoir, slightly decreasing the need to bypass water through the KKC North Tunnel. However, a significant impact is not anticipated under *Alternatives 5A, 5B,* or *5C* because KKC is expected to continue to help reduce instream flows in the Keechelus reach of the Yakima River. These changes could increase the need for this alternative, but could also decrease its effectiveness. Overall, the proposed alternatives would have a positive impact on the ability of water agencies, the economy's agriculture sector, and fish and wildlife to better withstand and adapt to changing conditions, including those associated with climate change. Because no significant impacts are anticipated from the effects of climate change on the proposed alternatives, no mitigation measures are proposed.

## 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 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) in accordance with WAC 173-60-050 and because 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 of Washington 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 environmental noise levels are established. The noise levels detailed in Table 4-132 are measured at the edge of the receiving property. Construction noise (including blasting) and traffic noise (including use of roads by heavy construction vehicles) is exempt from maximum permissible environmental noise level limits in accordance with WAC 173-60-050. Anticipated construction noise levels are shown in Table 4-132. Reclamation used noise levels of typical construction equipment to analyze the potential noise generated during construction.

Disturbance to wildlife species from noise impacts generated by construction activities is discussed in Sections 4.8 and 4.9.

**Table 4-132. Construction Equipment Average Maximum Noise Level ($L_{max}$)**

| Equipment Type | Examples | Actual Measured Average $L_{max}$[1] at 50 feet |
|---|---|---|
| Earth moving | Compactors<br>Front end loader<br>Backhoe<br>Tractors<br>Graders<br>Pavers | 83<br>79<br>78<br>84<br>89<br>77 |
| Materials handling | Concrete mixer truck<br>Concrete pump truck<br>Crane | 79<br>81<br>81 |
| Stationary | Pumps<br>Compressors<br>Generators | 81<br>78<br>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 4-132 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. For this reason, noise received farther from construction activities would be lower than that listed in Table 4-132. 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 for determining impacts are shown in Table 4-133. Impacts are assessed relative to *Alternative 1 – No Action*. This section describes potential noise impacts on humans. Sections 4.6, 4.8, and 4.9 describe potential noise impacts on fish and wildlife. The impact indicators for noise are increases in noise above ambient noise levels or exceedance of maximum permissible environmental noise levels.

**Table 4-133. Impact Indicators for Noise**

| Issues | Impact Indicators |
|---|---|
| Operation noise exceeding maximum permissible environmental noise levels | Increase in noise above maximum permissible environmental noise levels for residential and recreational uses (55 dBA) (WAC 173-60) |

## 4.13.2 Summary of Impacts

The noise environment in the primary and expanded study areas under *Alternative 1* would remain the same as it exists today.

For *Alternative 2 – KDRPP East Shore Pumping Plant, Alternative 3 – KDRPP South Pumping Plant,* and *Alternative 4 (Preferred Alternative),* construction noise would not occur during daytime hours consistent with the WAC 173-60-050 exemption (see Section 3.13.1).

Construction activities associated with *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment, Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment,* and *Alternative 5C– KDRPP Floating Pumping Plant with KKC North Tunnel Alignment* (truck hauling along Kachess Lake Road) would be intermittent and would occur during daytime hours. Construction would cause loud noise immediately surrounding primary construction sites and along tunneling routes, but these areas are isolated from existing noise- sensitive receptors.

None of the alternatives would generate noise exceeding maximum permissible environmental noise levels during operations (Table 4-134). Alternative 4 (Preferred Alternative) would have the least noise impacts overall due to the shorter duration of the construction period as compared to all other alternatives.

**Table 4-134. Summary of Impacts for Noise**

| Impact Indicator | Summary of Impacts |
|---|---|
| Increase in noise above maximum permissible environmental noise levels for residential and recreational uses (55 dBA) (WAC 173-60) | 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. |

## 4.13.3 Alternative 1 – No Action

Under *Alternative 1*, Reclamation and Ecology would not implement either KDRPP or KKC. No new noise sources are anticipated under *Alternative 1*; therefore, noise conditions would remain generally consistent with existing conditions.

### 4.13.4 Alternative 2 – KDRPP East Shore Pumping Plant

#### *4.13.4.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**

Construction noise associated with *Alternative 2* would be primarily associated with excavation for the intake tunnel and pumping plant shaft. These activities would require 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 2*, 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.

The nearest anticipated sensitive receptor is located 1.4 miles south of the proposed pumping plant site and 0.4 mile 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 impacts. Under the worst-case scenario—all construction equipment (e.g., excavator, backhoe, and 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 from this worst-case scenario would be reduced to approximately 56 dBA. For context, 56 dBA is equivalent to sound levels associated with conversational speech.

Truck trips would also cause noise during construction. Mining and excavation required as part of *Alternative 2* 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 would be the large majority of machinery- and vehicle-derived noise associated with *Alternative 2* construction. Under *Alternative 2*, 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 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 (the existing noise condition is assumed to have a daytime equivalent continuous noise level well above 55 dBA), and the temporary and intermittent nature of passing construction trucks, no noise impacts associated with spoils hauling are anticipated.

Construction noise generated by *Alternative 2* activities would occur within a localized area surrounding the construction site and would occur between 7:00 a.m. and 10:00 p.m. on weekdays, with no anticipated impacts on 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 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 would occur only during normal daytime construction hours.

**Volitional Bull Trout Passage Improvements**

Construction of the Volitional Bull Trout Passage Improvements would result in localized generation of noise, primarily from heavy equipment and truck trips required to move fill material. Construction activity would occur during daylight hours. It is assumed that approximately 10 residences or cabins are located within the area where construction noise could be a nuisance (Figure 4-26 and Section 4.15). Periodically, daytime construction noise levels could be elevated, but construction noise is exempt from the county and state noise regulations; therefore, no impact is anticipated. Construction noise would be mitigated via BMPs such as use of functional mufflers and restriction of construction noise to daytime hours only.

### *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 environmental noise levels for surrounding recreational uses. All regularly operated noise generating equipment would be housed within the pumping plant structure. Final facility design of operational equipment would use insulation strategies and technologies to reduce noise to levels below threshold levels. Therefore, operation of *Alternative 2* would not cause noise impacts.

**Volitional Bull Trout Passage Improvements**

The Volitional Bull Trout Passage Improvements would not have an operational impact on the noise environment because no noise would be generated by the improvements.

## 4.13.5 Alternative 3 – KDRPP South Pumping Plant

### *4.13.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

Construction impacts under *Alternative 3* would be similar to those under *Alternative 2*, as described in Section 4.13.4.1, except that less overall excavation would be involved. Construction of the intake tunnel under *Alternative 3* would require use of a TBM. TBMs are generally not audible at the surface, even in areas immediately surrounding tunnel portal sites (SFMTA, 2008). Because construction activities would take place closer to Kachess Dam, where recreational activities are more limited, temporary noise effects associated with *Alternative 3* would affect fewer recreational users

Reclamation is evaluating the same spoils disposal options for *Alternatives 2* and *3*. 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 2 trips per hour; see Section 4.17.5.1). This is approximately 30 percent of the total truck trips required for *Alternative 2*. Reduced truck trips for spoils disposal would further limit noise impacts from *Alternative 3.* As with *Alternative 2*, *Alternative 3* construction would not result in noise impacts.

**Volitional Bull Trout Passage Improvements**

Construction noise impacts for the Volitional Bull Trout Passage Improvements would be the same as those for *Alternative 2* (Section 4.13.4.1).

### *4.13.5.2 Operation*

**KDRPP South Pumping Plant Facilities**

Operation impacts under *Alternative 3* would be similar to those described for *Alternative 2* (Section 4.13.4.2).

**Volitional Bull Trout Passage Improvements**

The Volitional Bull Trout Passage Improvements would not have an operational impact on the noise environment because no noise would be generated by the improvements.

## 4.13.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.13.6.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

Construction noise (including blasting, although none is planned for *Alternative 4 [Preferred Alternative]*) and traffic noise (including use of roads by heavy construction vehicles for

*Alternative 4*) is exempt from maximum permissible environmental noise level limits in accordance with WAC 173-60-050, but nearby noise-sensitive receptors may nonetheless experience temporary disturbance. Construction noise comes primarily from use of equipment and trucks. Construction noise impacts for *Alternative 4 (Preferred Alternative)* would be similar to those for *Alternative 3,* but would be less overall due to the shorter 1 year construction period. Because construction activities would take place close to Kachess Dam, where recreational activities are more limited, temporary noise effects associated with *Alternative 4 (Preferred Alternative)* would affect fewer recreational users. Volitional Bull Trout Passage Improvements

Construction noise impacts for the Volitional Bull Trout Passage Improvements would be the same as those for *Alternative 2* (Section 4.13.4.1).

#### *4.13.6.2 Operation*

**KDRPP Floating Pumping Plant Facilities**

Operation of *Alternative 4 (Preferred Alternative)* would produce noise that may exceed ambient levels because of operation of pumps. Datakustic's acoustic modeling program Computer Aided Noise Abatement was used to model noise levels from the pumps. The sound sources modeled include four 1,000-horsepower 900 rpm water pumps with a sound power level ($L_W$) of 102 dBA for each and 87.4 dBA $L_W$ for the energy dissipation area. The water pump sound power level was obtained from acoustical engineering literature, specifically the Encyclopedia of Acoustics (Wiley and Sons, Inc., 1997) for water pumps. Additionally, the pumps would be enclosed on the floating barge.

Semi-reflective ground conditions were applied for the on-land portions of the acoustic model, and hard or reflective ground conditions were assumed for the on or near water sound sources. Additional modeling parameters included a digital elevation model with 10-meter (33-foot) resolution from the United States Geologic Survey to account for terrain effects.

Using these acoustic modeling inputs, sound levels were calculated at noise sensitive receptors located closest to Alternative 4 (Preferred Alternative) implementing the International Standards Organization's Standard 9613-2, Acoustics – *Attenuation of Sound during Propagation Outdoors* (ISO, 1996). *Alternative 4 (Preferred Alternative)* would operate 24 hours a day and 7 days per week during the drought-and refill pumping operations. Therefore, impacts were determined by comparing predicted operational sound levels from Alternative 4 (Preferred Alternative) against the sound level thresholds in the WAC 173-60-040. The most restrictive WAC threshold would be noise at Class A receptors from a Class C source at nighttime, which is 50 dBA $L_{eq}$.

Operational noise levels from all noise generated during operations of Alternative 4 (Preferred Alternative) at the closest noise sensitive receptors would range from 26 dBA $L_{eq}$ to 33 dBA $L_{eq}$. No exceedances of the EDNA Class A nighttime noise level limit would occur as a result of Alternative 4 (Preferred Alternative), and no perceptible change in sound level is anticipated with *Alternative 4 (Preferred Alternative)*. Therefore, no impact is anticipated from operation of *Alternative 4 (Preferred Alternative)* at the closest noise sensitive receptors.

For recreational uses on the reservoir, or at areas on the shore closer to the on or near water facilities, sound levels may be higher than those predicted at the noise sensitive receptors. Although there are no formal campgrounds or trails in this area, it is possible that informal camping or recreational use happens throughout noise analysis area. The operation of Alternative 4 (Preferred Alternative) would generate noise levels that could be disruptive to the enjoyment of the reservoir by recreationists.

Some traffic noise would result from *Alternative 4 (Preferred Alternative)* as a result of two employee trips per day. However, as with construction of *Alternative 4 (Preferred Alternative)*, these traffic volumes are too low to result in a perceptible change in traffic noise. Therefore, no traffic noise impacts would occur as a result of Alternative 4 (Preferred Alternative).

**Volitional Bull Trout Passage Improvements**

The Volitional Bull Trout Passage Improvements would not have an operational impact on the noise environment because no noise would be generated by the improvements.

## 4.13.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

### *4.13.7.1 Construction*

*Alternative 5A* would include construction of the KDRPP East Shore Pumping Plant (*Alternative 2*). The impacts from construction and operation of these components of *Alternative 5A* would be the same as described for *Alternative 2* (Section 4.13.4). *Alternative 5A* would also include construction and operation of the KKC North Tunnel. The impacts of KKC North Tunnel are described below.

**KKC North Tunnel Alignment Facilities**

Construction noise associated with *Alternative 5A* would be associated primarily 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). KKC would be constructed concurrent with KDRPP. Truck trips would be a primary noise source during construction of *Alternative 5A*.

Although Reclamation has not yet identified the soils disposal areas, it is assumed that the location would be within 12 miles of the reservoir. Two primary options are available for disposal: 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 are 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 5A* 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 a.m. and 10 p.m. (see Section 4.13.1), which would be the case for this construction. The noise levels would be noticeable but would be intermittent. Therefore, *Alternative 5A* noise would not result in a noise 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 4-132, is generally the source of most surface-audible noise associated with underground tunneling.

**Volitional Bull Trout Passage Improvements**

Construction noise impacts for the Volitional Bull Trout Passage Improvements would be the same as those for *Alternative 2* (Section 4.13.4.1).

#### *4.13.7.2 Operation*

**KKC North Tunnel Alignment Facilities**

Operation of KKC under *Alternative 5A* could cause minor increases in noise at the Keechelus inlet facility and at the Kachess outfall. The increase attributable 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 Kachess Reservoir. No noise-sensitive receptors are located within 2,000 feet of the outfall location. Minor increases in noise from operation of *Alternative 5A* facilities would not increase noise above maximum permissible environmental noise levels; for this reason, no impact on sensitive receptors is expected.

**Volitional Bull Trout Passage Improvements**

The Volitional Bull Trout Passage Improvements would not have an operational impact on the noise environment because no noise would be generated by the improvements.

### 4.13.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 3* (Section 4.13.5). Impacts would be the same as those associated with the KCC North Tunnel discussed in *Alternative 5A* (Section 4.13.7.1). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.13.7 (*Alternative 5A*).

### 4.13.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 4 (Preferred Alternative)* (Section 4.13.6). Impacts would be the same as those associated with the KCC North Tunnel discussed in *Alternative 5A* (Section 4.13.7). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.13.7 (*Alternative 5A*).

### 4.13.10 Avoidance, Minimization and Mitigation Measures

The proposed construction work would comply with applicable noise regulations by restricting construction activities to daytime hours. Although not required for construction noise during normal daytime hours, project proponents 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 would minor and temporary, no mitigation is proposed.

# 4.14 Recreation

## 4.14.1 Methods and Impact Indicators

**Methods.** Reclamation and Ecology 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 directly and 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 Reservoir to determine whether the new reservoir levels would limit, disrupt, or eliminate recreational uses.

## 4.14.2 Summary of Impacts

**Table 4-135. Summary of Impacts for Recreation**

| Impact Indicator | Summary of Impacts |
|---|---|
| Loss of fishing access or reduction of fishing opportunities that exceeds current seasonal loss of use due to existing drawdown conditions | All alternatives would have impacts due to the effects of reservoir drawdown on fish in Kachess Reservoir and to the temporary loss of boating access during construction and increased distance from the shore for shore fishing at both reservoirs during drought and recovery years. |
| Reduction of usability of recreation 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 | All alternatives would have impacts on developed recreation at Kachess Reservoir because drawdown in drought years would reduce access to water and aesthetic quality. |

## 4.14.3 Alternative 1 – No Action

Under *Alternative 1*, 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 existing drawdown operations. 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 *Alternative 1*, the reservoir pool would below elevation 2,235 during the recreation season (June to September) in approximately 79 percent of years modeled, for an average of 34 days in those years. Existing drawdown at Keechelus Reservoir in summer would continue to interfere with the 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.

## 4.14.4 Alternative 2 – 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. Put in and take out of the barge would reduce recreational use of the launch for two days out of the 122 day recreational season (June – September). Movement of the barge to

Kachess Dam would displace boaters on the Reservoir for another two days. The majority of the reservoir would remain open to recreational boating. Impacts would be minor because boat launches would not become unusable, and boating uses would not be displaced during construction.

No developed recreation facilities are located in the vicinity of construction activities. Construction traffic, as described in Section 4.17, could briefly delay access to 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 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 activities. Construction traffic could delay access to undeveloped recreation areas for short periods. These impacts would occur over the 3-year duration of construction, and recreationists 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.

**Volitional Bull Trout Passage Improvements**

Construction of Volitional Bull Trout Passage Improvements would have temporary impacts on recreation sites and activities from the construction activities, particularly at Kachess Campground on the west side of Kachess Reservoir, near the location of the proposed Volitional Bull Trout Passage Improvements.

#### *4.14.4.2 Operation*

**KDRPP East Shore Pumping Plant Facilities**

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 fully refilled to its previous pool level. Kachess Reservoir would not be drawn down 80 feet in every drought year. As shown in Figure 4-6, drought conditions in 2001 and 2005 would have required drawdowns of only 40 feet below the existing gravity outlet rather than 80 feet below the existing gravity outlet.

Kachess Reservoir levels would be lower than those under *Alternative 1* 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 impacts on recreation as described below for each impact indicator.

Under existing conditions the boat launch at Kachess Campground become unusable in late summer.  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 existing boat launches unusable earlier in the summer and for longer duration during portions of the subsequent 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* and would typically occur during the limited season for boating.  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 would increase.  To enhance recreational opportunities, a new east shore boat launch would be constructed.  The boat launch and dock on the east shore would be made available for public use once construction is completed.  The east shore boat launch would provide recreational access for boating at all future water surface elevations.

Kachess Campground and the East Kachess Group Site would not 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 portions of the subsequent 2 to 5 years as the reservoir refills.

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.  However, as shown in Figure 4-6, maximum drawdown would occur infrequently and only for short periods.

As with construction, operation of KDRPP would require that access roads, including FS-4818, be plowed, which could 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. These impacts would occur in drought years and for the next 2 to 5 years as the reservoir refills. 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.

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. 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.

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 2*, the minimum level of Keechelus Reservoir would be 15 feet lower than under *Alternative 1*. Keechelus Reservoir levels would be lower than under *Alternative 1* 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 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.

Changes to boating and fishing opportunities and on the quality of recreation at Kachess Reservoir could increase recreational pressure at other recreation sites, particularly Cle Elum Reservoir and other reservoirs, in the Yakima River basin and central Washington.

### Volitional Bull Trout Passage Improvements

Operations of Volitional Bull Trout Passage Improvements would occur during drought relief pumping and refill years, but would not impact recreation uses or facilities.

## 4.14.5 Alternative 3 – KDRPP South Pumping Plant

### *4.14.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

Construction impacts under *Alternative 3 – KDRPP South Pumping Plant* would be similar to those under *Alternative 2*, as described in Section 4.14.4.1. However, fewer recreational users would be affected than with *Alternative 2* because construction activities would take place closer to Kachess Dam, where recreational activities are more limited.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (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 2*, as described in Section 4.14.4.2. Reclamation would operate KDRPP the same regardless of the location of the facilities.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.14.4.2).

## 4.14.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.14.6.1 Construction*

Construction impacts would be limited to the primary study area. The launch and transportation of the proposed floating pumping plant barge could have a minor impact on boating by temporarily limiting access to boat launch areas and disrupting boating uses in areas through which the barge passes. During construction, an 800 by 600 foot area would be closed to boating to the north of the channel barrier; however, the majority of the reservoir would remain open to recreational boating. Impacts would be minor because access to boat launches would not be permanently impacted and because boating uses would not be permanently displaced. Overall impacts to recreation are less under Alternative 4 (Preferred Alternative) than all other alternatives due to the shorter construction duration of 1 year.

No developed recreational facilities are located in the vicinity of construction activities. Access to the operations yard would be provided by existing roads. Construction traffic could briefly delay access to the Kachess Campground and the East Kachess Group Site; however, access would be maintained. Construction would not interfere with winter recreational activities because project construction would occur in the spring. Impacts would not be significant because no developed recreational sites would become unusable. However, construction workers could stay at campsites, which would displace some recreationists.

Dispersed camping and undeveloped recreational 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 recreational areas for short periods. These impacts would occur over the 1 year duration of construction and recreationists may avoid these areas during the construction period. Impacts would not be significant because recreationists could access Kachess Reservoir at many other sites.

The boat launches at Kachess Campground become unusable at elevation 2,235. In order to facilitate construction activities, reservoir would be drawn down making the boat launches unusable. However, the impact would not be significant, because the boat launches would be accessible again as the reservoir refills.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.14.4.1).

#### *4.14.6.2 Operation*

**KDRPP Floating Pumping Plant Facilities**

Operation impacts would be the same as those for *Alternative 2*, as described in Section 4.14.4.2. Reclamation would operate KDRPP the same regardless of the location of the facilities.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.14.4.2).

### 4.14.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

#### *4.14.7.1 Construction*

*Alternative 5A- KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* would include construction of the KDRPP East Shore Pumping Plant (*Alternative 2*) and the KCC North Tunnel. The impacts from construction and operation of these components would be the same as described for *Alternative 2* (Section 4.14.4.1). Impacts of the KKC North Tunnel are described below.

**KKC North Tunnel Alignment Facilities**

According to all impact indicators, recreation at Keechelus Reservoir would not be affected by construction of the 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 short delays 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. This realignment 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 be minor because other undeveloped recreation sites are available in the vicinity and no users would be displaced.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.14.4.1).

#### *4.14.7.2 Operations*

Operations of *Alternative 5A* would have the same impacts as described for *Alternative 2*.

### 4.14.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 3* (Section 4.14.5). Impacts associated with the KCC North Tunnel would be the same as those discussed in *Alternative 5A* (Section 4.14.7). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.14.7 (*Alternative 5A*).

### 4.14.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 4 (Preferred Alternative)* (Section 4.14.6). Impacts associated with the KCC North Tunnel would be the same as those discussed in *Alternative 5A* (Section 4.14.7). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.14.7 (*Alternative 5A*).

### 4.14.10 Avoidance, Minimization and Mitigation Measures

Reclamation would implement construction BMPs to minimize the impact on recreational facilities and their users from nuisance dust, noise, and conflicts with temporary construction traffic as described in Sections 4.13, 4.17, and 4.11.

A new east shore boat launch would be constructed, with parking and visitor facilities. The boat launch and dock on the east shore would be made available for public use once construction is completed. The east shore boat launch would provide recreational access for boating at all future water surface elevations, including elevations that cannot be accessed at any boat launch on Kachess Reservoir under existing conditions.

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 potential impacts of the action alternatives

## 4.15 Land and Shoreline Use

Land and shoreline use impact indicators are shown in Table 4-136. Reclamation assessed all criteria relative to *Alternative 1 – No Action*.

**Table 4-136. Impact Indicators for Land and Shoreline Use**

| Issues | Impact Indicators |
|---|---|
| Change in land ownership | Acres of lands acquired |
| Compatibility with applicable Federal, State, and local land use plans and regulations | Conflict or conformance with applicable land use plans or shoreline use designations |

### 4.15.1 Methods and Impact Indicators

Existing land use in the study area was mapped to determine ownership and use and to determine consistency with or conformance to land management plans. Data were obtained from Kittitas County and available aerial photography (Kittitas County Assessor, 2014). Potential impacts were analyzed by evaluating whether the action alternatives would change land and shoreline uses and would be compliant with applicable Federal, State, and local land use policies and regulations. All action alternatives would include real property acquisitions from private parties and permitting from the USFS. Per 1994 Public Law 103-434 as amended, Reclamation would acquire real property through the voluntary purchase or lease of land (YRBWEP, 1994). Reclamation verified that the proposed acquisitions of real property would not convert prime or unique farmland to nonagricultural uses (under the Farmland Protection Policy Act 7 USC 4201-4209).

Section 4.14, addresses changes in shoreline access. Effects on property values of private lands adjacent to the Kachess Reservoir attributable to drawdowns are addressed in Section 4.21.

**Impact Indicators.** The impact indicators relate to a qualitative assessment of whether and how construction activities or 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 availability or reliability of irrigation water supply.

### 4.15.2 Summary of Impacts

*Alternative 1* would not change land use or conflict with applicable plans and regulations. Under all alternatives (*Alternative 1, Alternative 2 – KDRPP East Shore Pumping Plant, Alternative 3 – KDRPP South Pumping Plant, Alternative 4 (Preferred Alternative), Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment, Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment,* and *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment*), lower reservoir levels in drought and refill years would affect recreation and visual quality at Kachess Reservoir, with indirect potential impacts on land uses (Section 3.14, and Section 3.10). Under *Alternatives 2, 3, 4, 5A, 5B,* and *5C*, the acquisition of property not owned by the United States would be necessary (see Figure 4-26). Under *Alternatives 5A, 5B,* and *5C,* the acquisition of property for the construction of the tunnel, portals, and connecting facilities would also be necessary where the United States currently does not hold title to the land (see Figure 4-27). Access to the Volitional Bull Trout Passage Improvements at the Narrows may require acquisition of property not owned by the United States. 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 would be 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 actions in implementing the proposal.

Under *Alternative 1*, 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 because of climate change. Long-term changes in land use could potentially result from these indirect impacts on water reliability. Under *Alternatives 2, 3, 4, 5A, 5B,* and *5C,* the improved reliability of proratable water supply to existing irrigated land would help to ensure continued agriculture use. The alternatives would not increase the amount of irrigated land, but would help to maintain current levels of production while not ensuring them. These impacts are summarized in Table 4-137.

**Table 4-137. Impact Indicators for Land and Shoreline Use**

| Impact Indicator | Summary of Impacts |
|---|---|
| Lands acquired | Acquisition of private property could be necessary for the following action alternatives:<br>• *Alternative 2*: Construction of the pumping plant on the east shore of the Kachess Reservoir.<br>• *Alternative 3*: Construction of a small portion of the boat launch on the east shore of the Kachess Reservoir.<br>• *Alternative 4*: No or very minor acquisition of land.<br>Easements of land could be required for constructing the North Tunnel, portals, and connecting facilities for *Alternatives 5A, 5B,* and *5C*.<br>Additional acquisition of private real property or easements may be needed for access to the Volitional Bull Trout Passage Improvements at the Narrows. Reclamation would follow Federal guidelines for property acquisition. |
| Conflict or conformance with applicable land use plans or shoreline use designations | All alternatives would be compatible with applicable Federal, State, and local land use plans and regulations. |

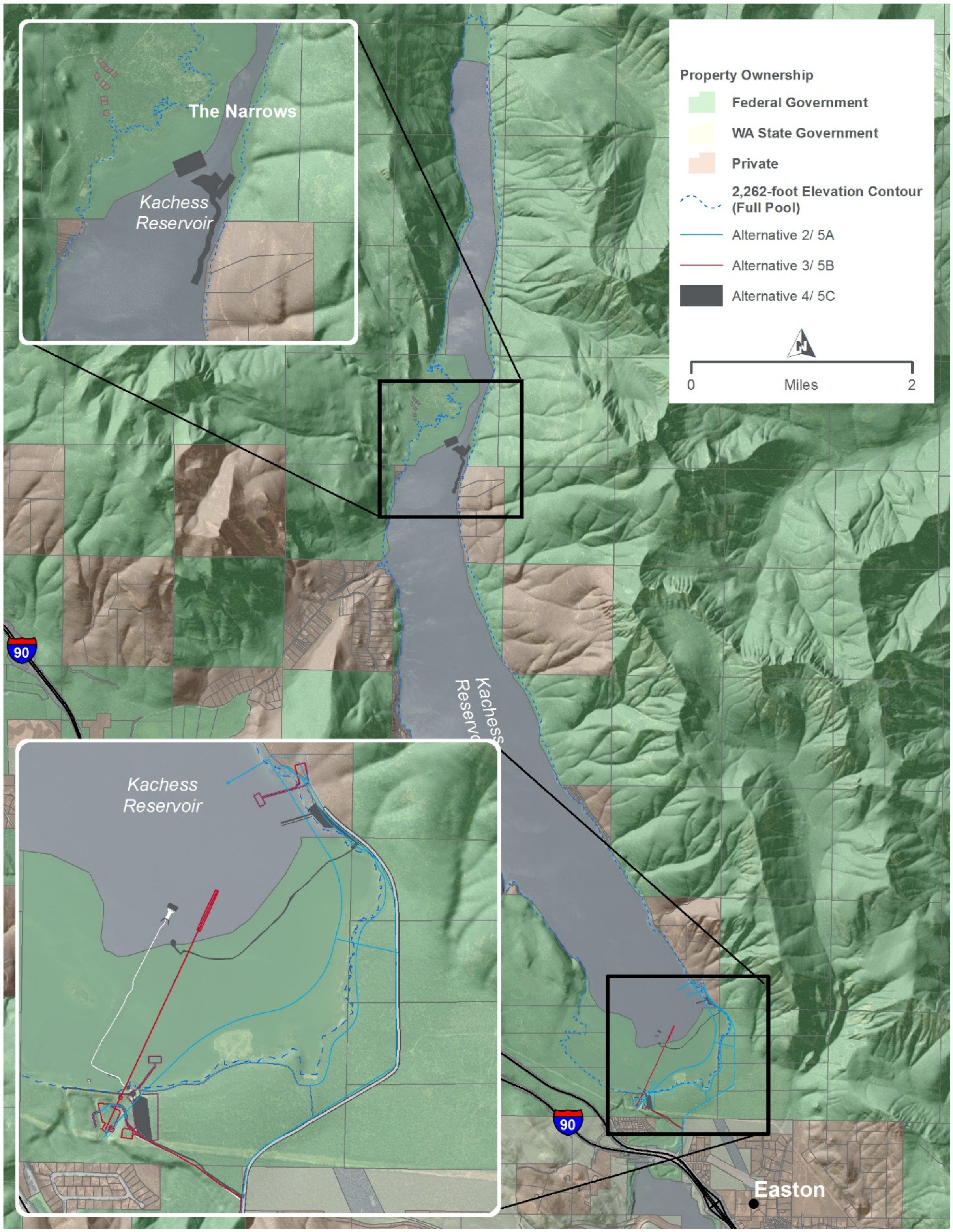



**Figure 4-26. Land Ownership in the Kachess Reservoir Area for All Alternatives**

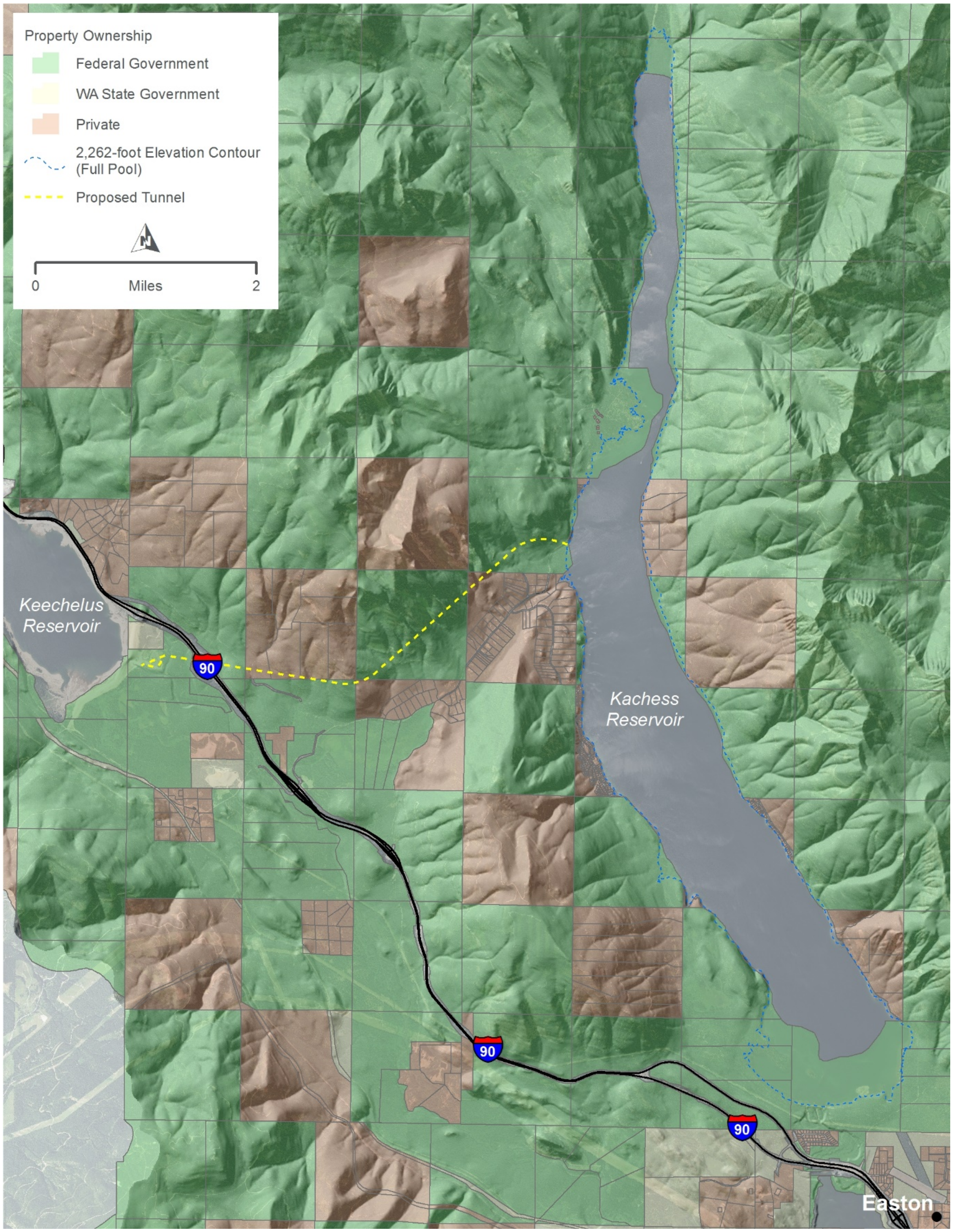



**Figure 4-27. Land Ownership in the North Tunnel Construction Area**

### 4.15.3 Alternative 1 – No Action

Under *Alternative 1*, existing land use patterns and development trends will continue, however long-term land use changes could occur 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 2 – KDRPP East Shore Pumping Plant

#### *4.15.4.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**

*Alternative 2* would require acquisition of real property interests related to the pumping plant site, and additional easements for the transmission line interconnect needed to supply power to the pumping plant (Figure 4-26). Reclamation would comply with Federal land 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 2003 Reclamation Manual Directives and Standards LND 06-01 for any property or easement acquisition.

*Alternative 2* would result in temporary traffic impacts because of truck traffic during construction (see Section 4.17). Traffic impacts 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 permanent changes to land use.

**Volitional Bull Trout Passage Improvements**

The construction of the Volitional Bull Trout Passage Improvements would occur on federally managed land. There would be some temporary access restrictions to this public land during construction. Construction would be compatible with existing Federal, State, and local policies.

#### *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 land (Section 3.15). Reclamation and USFS manage Federal lands and resources in the primary study area. Reclamation manages Keechelus and Kachess reservoirs, which are located in a USFS- managed national forest. If Reclamation receives authority as delegated by Congress to implement KDRPP, Reclamation would exercise its authority and would adhere to all applicable laws and regulations that govern its actions in implementing the Proposed Action.

*Alternative 2* would result in the construction of new permanent facilities (i.e., pumping plant and associated infrastructure) and in reservoir levels as much as 80 feet lower than current levels during drought years. This change would affect recreation and visual quality, but would not cause long-term change in land or shoreline use or Federal management of land around the lake. Refer to Section 4.10, Visual Quality, and Section 4.14, Recreation, for additional discussion of these impacts.

*Alternative 2* would provide Reclamation with access to 200,000 acre-feet of water for use during drought, thereby improving the reliability of water supply for irrigators. This would be a beneficial effect. KDRPP would not support an increase in the amount of irrigated land but rather would support existing agricultural properties. The improved reliability of water supply could encourage irrigators to retain or invest in permanent crops and maintain existing agricultural land uses.

**Volitional Bull Trout Passage Improvements**

The Volitional Bull Trout Passage Improvements 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 3 – KDRPP South Pumping Plant

#### *4.15.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

Impacts would be the same as those for *Alternative 2* (Section 4.15.4.1). Construction of a small portion of the boat launch is located on private property on the east shore of Kachess Reservoir (Figure 4-26). Reclamation would comply with Federal property acquisition policies.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.15.4.1).

#### *4.15.5.2 Operation*

**KDRPP South Pumping Plant Facilities**

Impacts would be the same as those for *Alternative 2* (Section 4.15.4.2). Reclamation would operate KDRPP the same regardless of the location of facilities.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.15.4.2).

## 4.15.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.15.6.1 Construction*

Impacts would be the similar to those for *Alternative 2* (Section 4.15.4.1); however duration of those impacts would be shorter because construction would occur over a shorter period for *Alternative 4 (Preferred Alternative)* than for *Alternatives 2* or *3.* Based on the current design, *Alternative 4 (Preferred Alternative)* would require no or very minor acquisition of real property interests. *Alternative 4 (Preferred Alternative)* may require acquisition of real property interests on the east shore of Kachess Reservoir for the paved, public parking area and property needed for enlarging the existing East Shore Access Road.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.15.4.1).

### *4.15.6.2 Operation*

Impacts would be the same as those for *Alternative 2* (Section 4.15.4.2). Operations would be the same regardless of the location of facilities.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.15.4.2).

## 4.15.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

### *4.15.7.1 Construction*

*Alternative 5A* would include construction of the KDRPP East Shore Pumping Plant (*Alternative 2*). The impacts from construction and operation of these components of *Alternative 5A* would be the same as described for *Alternative 2* (Section 4.15.4). *Alternative 5A* would also include construction and operation of the KKC North Tunnel. The impacts of the KKC North Tunnel are described below.

**KKC North Tunnel Alignment Facilities**

Constructing the North Tunnel would cause temporary traffic impacts because of construction truck trips (see Section 4.17,), which could delay access to land uses in and near the construction area. The temporary relocation of a portion of Lake Kachess Road for construction of the North Tunnel would allow continued access to properties along the road. Both local residents and recreational users of the area would be affected, but access to all properties would be maintained. The relocation of Lake Kachess Road would occur on

Federal lands. Section 4.14 describes impacts on recreation. Construction impacts would be limited to a 3-year period, and are not expected to result in permanent changes to land use.

*Alternative 5A* could result in the permanent or temporary acquisition of property easements needed for the construction of the tunnel or portals (see Figure 4-27). 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), as amended; 49 CFR Part 24, and other applicable laws and regulations. Some facilities may be located on USFS-managed property. Reclamation would coordinate with the USFS on any project needs and obtain a legislative withdrawal through the BLM if access to Federal lands is required.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.15.4.1).

#### *4.15.7.2 Operation*

**KDRPP East Shore and 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 Keechelus and Kachess reservoirs and their surrounding lands. Reclamation receives authority as delegated by Congress to implement KKC. Therefore, Reclamation would adhere to the laws and regulations that govern its actions in implementing KKC.

*Alternative 5A* 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 would be a beneficial effect. This alternative would support existing agricultural uses only and would not increase the amount of irrigated land.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.15.4.2).

### 4.15.8 Alternative 5B – KDRPP South with Pumping Plant KKC North Tunnel Alignment

The impacts from construction and operation would be the same as those for *Alternative 3* (Section 4.15.5) and the North Tunnel as described in Section 4.15.7 (*Alternative 5A*). *Alternative 5B* could result in the permanent and/or temporary acquisition of property easements needed for the construction of the boat launch associated with *Alternative 3* and tunnel or portals associated with the North Tunnel. Reclamation would follow all applicable land acquisition laws and regulations described above for *Alternative 5B.* Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.15.7 (*Alternative 5A*).

### 4.15.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts from construction and operation would be the same as those for *Alternative 4 (Preferred Alternative)* (Section 4.15.6) and impacts associated with the North Tunnel as discussed for *Alternative 5A* (Section 4.15.7). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.15.7 (*Alternative 5A*).

### 4.15.10 Avoidance, Minimization, and Mitigation Measures

For alternatives requiring acquisition of real property interest, as per 1994 Public Law 103-434 as amended, Reclamation would acquire real property through the voluntary purchase or lease of land (YRBWEP, 1994). Reclamation would continue to coordinate with potentially affected property owners regarding acquisition of real property interests and would comply with all applicable Federal regulations. Reclamation would address real property acquisition impacts as provided by the application of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 USC 4601), as amended, 49 CFR Part 24, and other applicable laws and regulations.

All appropriate inquiry (for example, Phase 1 Environmental Site Assessment ASTM E-1527-13) would be conducted prior to the acquisition of any real property. Reclamation would continue to coordinate with the USFS for plan compliance and mitigation of potential impacts on USFS-managed land. Continued coordination would ensure that access impacts during and following construction are minimized.

## 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 the utility requirements of the proposed alternatives. 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 the KKC North Tunnel Alignment, Reclamation also evaluated the potential for hydropower generation as discussed in general in Section 4.16.7.

**Impact Indicators**. Impact indicators are based on changes in demand and service interruptions. Impact indicators for utilities are shown in Table 4-138. Reclamation assessed all criteria against *Alternative 1 – No Action*.

**Table 4-138. Impact Indicators for Utilities**

| Issues | Impact Indicators |
|---|---|
| Delivery of project electrical service | Total demand for pumping plant operations (up to approximately 30 MW) |
| Interruption of existing utilities | Likely or anticipated interruption of any utility service during construction or operation |

## 4.16.2 Summary of Impacts

Reclamation does not anticipate construction or operation impacts on electrical services, wastewater, or telecommunications under any alternative. Table 4-139 includes a summary of impacts for utilities.

**Table 4-139. Summary of Impacts for Utilities**

| Impact Indicator | Summary of Impacts |
|---|---|
| Total demand for pumping plant operations (up to approximately 30 MW) | Alternatives 2, 3, 4, 5A, 5B, and 5C would require approximately 30 MW of electrical power for operation of the pumping plant. For all alternatives, a transmission interconnection to the Puget Sound Energy (PSE) supply would be required to provide electric power for KDRPP pump operations. The power supply system would consist of four primary features: (1) an interconnection from the existing Puget Sound Energy transmission line near Easton, WA; (2) installation of a substation on Reclamation property adjacent to the Lake Easton outlet; (3) twin, buried, 34.5 kV transmission lines from the new Lake Easton substation to the Kachess Dam area; and (4) a new on-site Kachess Reservoir substation. This would not result in a substantial change to PSE's overall electrical power demand. Existing electrical systems are sufficient to supply the required electricity. The KKC North Tunnel with Alternatives 5A, 5B, and 5C would operate by gravity flow and would require no new power supply. Overhead PSE transmission lines and poles may need to be relocated for construction. |
| Likely or anticipated interruption of any utility service during construction or operation | Interruption of services during construction is not anticipated for *Alternatives 2, 3, 4, 5A, 5B,* and *5C*. There would be no impacts on wastewater or telecommunications because construction and operation would not increase the demand for these utilities.<br>Construction of the KKC North Tunnel with *Alternatives 5A, 5B,* and *5C* would require temporarily relocating telecommunication lines in the Palouse to Cascades State Park Trail. This relocation would be temporary, short-term, and unlikely to interrupt or impact services. Any transmission line or pole relocation would be temporary, short-term, and unlikely to impact services. |

## 4.16.3 Alternative 1 – No Action

Reclamation would continue existing operations at Kachess and Keechelus reservoirs under *Alternative 1*. No changes to utilities would be needed.

## 4.16.4 Alternative 2 – KDRPP East Shore Pumping Plant

### *4.16.4.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**

The construction of the transmission line interconnect would not lead to any disruptions to electricity supply. 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. The existing PSE Easton switchyard would be expanded to contain new 115 kV transformers. The expansion would occur on vacant, cleared, land located immediately adjacent to the existing PSE switch yard in Easton, Washington.

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.

**Volitional Bull Trout Passage Improvements**

The construction of the Volitional Bull Trout Passage Improvements at the Narrows would not result in impacts on any utility services. Electrical needs for construction would be minimal and would likely require the use of onsite generators. There would be no telecommunications, water, or wastewater impacts from construction of these improvements.

### *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 via interconnection to the existing PSE 115kV transmission line near Lake Easton, through a proposed new Lake Easton substation and buried power line to a new Kachess Reservoir substation, and from there to the East Shore Pumping Plant. In drought years, when the Kachess Reservoir is below the existing gravity outlet and Reclamation operates KDRPP, the *Alternative 2* would increase electrical demand. However, this anticipated increase falls within normal ratings for bulk electrical systems under normal operating conditions (Reclamation and Ecology, 2014i). In the event of a power failure, a 3,000 kilowatts diesel-powered generator would likely provide backup power supply for fish flow pumps and for essential station loads fed from the Essential Motor Control Center. Reclamation would require a 500 kilowatt standby generator set to provide a second back up for the Essential Motor Control Center when the primary generator is down for maintenance. 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 2* because operation would not increase the demand for these utilities.

**Volitional Bull Trout Passage Improvements**

Following construction, the Volitional Bull Trout Passage Improvements at the Narrows would not result in impacts on any utility services. The improvements would not require access to any utilities.

## 4.16.5 Alternative 3 – KDRPP South Pumping Plant

### *4.16.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

Impacts from construction of *Alternative 3* would generally be the same as those described for *Alternative 2*.

**Volitional Bull Trout Passage Improvements**

The construction of the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (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 3* would be the same as those described for *Alternative 2*.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.16.4.2).

## 4.16.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.16.6.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

Impacts from construction of *Alternative 4 (Preferred Alternative)* would generally be the same as those described for *Alternative 2*.

A new control building, approximately 3,200 square feet, would be located on the shoreline of Kachess Reservoir near the left abutment of Kachess Dam. The control building would house switchgear, instrumentation, and variable-frequency drives for the pump motors, as well as appurtenant instrumentation, control and communication equipment.

Four buried power cables running from the new switchyard to the control building would be installed beneath the existing Kachess Dam Access Road. These cables would transmit 6600-V power from the step-down transformers to the control building, for a distance of about 200 linear feet.

**Volitional Bull Trout Passage Improvements**

The construction of the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.16.4.1).

#### *4.16.6.2 Operation*

Operation impacts from *Alternative 4 (Preferred Alternative)* would be the same as those described for *Alternative 2*.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.16.4.2)

### 4.16.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

#### *4.16.7.1 Construction*

**KKC North Tunnel Alignment Facilities**

Construction impacts from *Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* for the KDRPP East Shore Pumping Plant and Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2*.

For KKC facilities, overhead transmission lines to Keechelus Dam would 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 as power and communications would be maintained. No onsite sewage systems are located in areas that would be impacted by construction. The power demand for construction of both KDRPP and KKC is small and within the capacity of the power system.

**Volitional Bull Trout Passage Improvements**

The construction of the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.16.4.1).

### *4.16.7.2 Operation*

**KKC North Tunnel Alignment Facilities**

Impacts from *Alternative 5A* for the KDRPP East Shore Pumping Plant, and Volitional Bull Trout Improvements at the Narrows would be the same as described for *Alternative 2*.

For KKC facilities, a substantial additional power source would not be needed for operation of *Alternative 5A* because the KKC would operate by gravity flow. Power requirements for operating KKC are limited to lighting and instrumentation. PSE three phase power serves the Keechelus Dam area facilities intake, screening, and deep tunnel portal shaft. These existing power lines would be extended to provide power to the proposed electrical and mechanical systems building as well as to the motorized gates at the intake.

In the event of a power failure, the control system would maintain the flow settings in place before the power failure occurred. The system would automatically issue an alarm to operational staff. Operators would then respond to the site to make manual adjustments to flow control gates, if needed and then take steps to restore power to the site. Battery backup would provide standby power to alarm, telemetry, and control systems during that period.

The existing Keechelus Dam area facilities include a small propane fueled standby generator to power essential instrumentation and control systems and some emergency lighting. This generator would need to be replaced with a larger (approximately 150 kW) generator to be located in a fenced enclosure adjacent to the existing operations building. It is expected that this generator would also use propane fuel.

Reclamation does not anticipate operation impacts on electrical services, wastewater, or telecommunications from *Alternative 5A*.

During early planning, Reclamation considered the feasibility of hydropower generation from the flow of water in the KKC North Tunnel (Reclamation and Ecology, 2014i). The feasibility study showed that the cost of a hydropower facility would be approximately 2 to 3 times higher than economically feasible based on 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 KKC. However, Reclamation would construct KKC so that the future addition of power recovery facilities would not be precluded. Power demands for operating KKC are limited to lighting and instrumentation.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements at the Narrows would be the same as those described for *Alternative 2* (Section 4.16.4.2).

### 4.16.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 3* (Section 4.16.5). Impacts would be the same as those associated with the KCC North Tunnel discussed for *Alternative 5A* (Section 4.16.7). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.16.7 (*Alternative 5A*).

### 4.16.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 4 (Preferred Alternative)* (Section 4.16.6). Impacts would be the same as those associated with the KCC North Tunnel discussed for *Alternative 5A* (Section 4.16.7). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.16.7 (*Alternative 5A*).

### 4.16.10 Avoidance, Minimization and Mitigation Measures

During final design, project proponents would conduct utility surveys and take appropriate measures to minimize conflicts with utilities in construction areas. Project proponents would coordinate with the affected utility company to relocate or replace affected utilities, as appropriate. Project proponents would use 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, and 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 are shown in Table 4-140. Reclamation assessed all criteria relative to *Alternative 1 – No Action*.

**Table 4-140. Impact Indicators for Transportation**

| Issues | Impact Indicators |
|---|---|
| Increase in vehicle traffic levels or traffic flow disruptions | Increase of peak-period (a.m., p.m., or both) construction roundtrips that could result in the delay or interruption of traffic or increase safety risks. |
| Construction vehicle traffic | Roadway deterioration |

### 4.17.2 Summary of Impacts

The condition of transportation systems in the primary and the expanded study areas under *Alternative 1* would remain the same as exists today. Table 4-141 summarizes construction traffic trips associated with each of the alternatives.

**Table 4-141. Summary of Construction Round Trips**

| Alternative | Total Construction Materials Haul Trips (round trips [one-way trips])[1] | Average Hourly Construction Materials Haul Trips during Construction (round trips [one-way trips]) | Maximum Hourly Worker Trips during Construction (round trips [one-way trips]) | Maximum Hourly Trips for Construction and Workers (round trips [one-way trips]) |
|---|---|---|---|---|
| *2* | 28,870 (57,740) | 7 (14) | 25 (50) | 32 (64) |
| *3* | 8,809 (17,618) | 2 (4) | 25 (50) | 27 (54) |
| *4* | 3,444 (6,888) | 1 (2) | 25 (50) | 26 (52) |
| *5A* | 40,270 (80,540) | 9 (18) | 50 (100) | 59 (118) |
| *5B* | 20,209 (40,419) | 5 (10) | 50 (100) | 55 (110) |
| *5C* | 14,844 (29,688) | 4 (8) | 50 (100) | 54 (108) |

[1] *Estimates do not include potential trips associated with volitional bull trout passage improvements.*

The types of impacts on transportation from *Alternatives 2, 3, 4, 5A, 5B*, and *5C* would be similar, whereas the duration and extent of impacts would differ, with Alternative 4

(Preferred Alternative) having the least impacts of all alternatives. With the exception of I-90, the roads in the primary study area generally have light traffic and are rural in nature. However, construction under all action alternatives would result in an increase in vehicle travel time and could increase the response time of emergency vehicles using the same routes as construction traffic. The increase could have a noticeable effect on traffic and/or safety. The increase in vehicle traffic would be the greatest under *Alternatives 5A*, *5B,* and *5C*, as shown in Table 4-142. This increase in construction vehicle roundtrips would result in greater impacts (increased traffic levels and flow disruptions) under *Alternative 5A, 5B,* and *5C* than under *Alternatives 2, 3,* and *4*. Alternative 4 (Preferred Alternative) would be expected to have the least transportation impacts when compared to the other action alternatives due to the shorter construction duration and because it would result in fewer trips during construction.

The increased traffic levels during construction could increase emergency vehicle response time. 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 action alternatives 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 upgrades to existing roadways would be required to facilitate construction vehicle access. The overall increase in vehicle traffic would likely result in minor deterioration of local roads; however, the project proponents 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 4.17.10). Once construction is complete, the actions would require infrequent trips for maintenance or operation; therefore, no impacts are expected.

**Table 4-142. Summary of Impacts for Transportation**

| Impact Indicator | Summary of Impacts |
|---|---|
| Increase of peak-period (am, pm, or both) construction roundtrips that could result in the delay or interruption of traffic or increase safety risks. | *Alternatives 2, 3, 4, 5A, 5B*, and *5C* – Impacts anticipated due to increased construction traffic; potential delay but no interruption to emergency service vehicle access; and minor increase in safety risk due to additional traffic |
| Roadway deterioration | *Alternatives 2, 3, 4, 5A, 5B*, and *5C* – Potential deterioration of local roadways from construction traffic, restored following construction activities |

### 4.17.3 Alternative 1 – No Action

The condition of transportation systems in the primary and the expanded study areas under *Alternative 1* would remain the same as exists today. No impacts are anticipated.

### 4.17.4 Alternative 2 – KDRPP East Shore Pumping Plant

#### *4.17.4.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**

Construction for *Alternative 2 – 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. An approximately 26-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. If the spoils disposal site identified in Chapter 2 is used, trucks transporting spoils materials would not require access to local roadways. However, because the use of the spoils disposal site has not been confirmed, this analysis assumes that spoils disposal could occur up to 12 miles away from the construction site and that local roadways would be used.

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 Feasibility-Level Design Report, Kachess Drought Relief Pumping Plant (Reclamation and Ecology, 2017d). Approximately 28,870 truck roundtrips (or 57,740 one-way trips to or from the construction site) are anticipated over the life of the project, or an average of 48 roundtrips (or 96 one-way trips] during each day of construction (or 7 roundtrips [or 14 one-way trips) per hour). A maximum of 100 vehicle roundtrips (or 200 one-way trips to or from the construction site) per day are expected for construction workers access to and from the construction sites. Because most workers would arrive in the morning and depart in the evening, 50 vehicles per hour were assumed to arrive between 7 and 9 a.m. and then 50 vehicles per hour would depart between 4 and 6 p.m.

Together, construction worker trips and delivery of materials would result in a maximum of 32 roundtrips (or 64 one-way trips) per hour during the peak travel periods; however, during the nonpeak hours of the day, traffic would be much lower because 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. An increase in vehicle travel time is anticipated. The increased peak period construction traffic would cause an increase in delays for traffic along local roadways. This increase in peak period construction traffic would not interrupt emergency service vehicle access to any roadways since no road closures are planned; however, emergency vehicle response time would increase because of the increased traffic on roadways at certain times. The increased traffic would result in delays for school buses along school bus routes; however, these impacts would be minor since there would only be short-term, intermittent delays due to construction activities.

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 64 vehicles per peak period hour would increase peak period traffic on I-90 by approximately 3 percent of all construction-related workers and equipment used I-90 (which is not anticipated to occur). This small increase is not anticipated to noticeably change the existing traffic conditions or peak hour delay on I-90.

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 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. 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 deterioration of local roads; however, the project proponents 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).

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 4.17.10).

The offshore drilling and intake installation in the reservoir would be supported by a barge or semi-permanent 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 restriction 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.

**Volitional Bull Trout Passage Improvements**

The Narrows would be accessed for construction via NF-4948 to Bakers Lane. From Bakers Lane, existing roads that run to the shore of the reservoir south of Washington State's Kachess Campground would be used to gain access to the bed of the reservoir. From the shoreline, a temporary road on the reservoir bed (approximately 0.4 miles) would be used to gain access to the Narrows for construction. A second option to access the Narrows would be via Forest Service Road NF-4948 to Bakers Lane. From Bakers Lane, existing roads that run to the shore of the reservoir north of Washington State's Kachess Campground would be used to gain access to the bed of the reservoir. From the shoreline, a temporary road on the reservoir bed (approximately 0.8 miles) would be used. The number of construction worker trips and construction deliveries is unknown at this time.

#### *4.17.4.2 Operation*

**KDRPP East Shore Pumping Plant Facilities**

No transportation impacts are anticipated during operation and maintenance because *Alternative 2* would not result in additional traffic on local or regional roadways. Therefore, there would be no operational 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 2*. The proposed transmission line could lie within the zone that would require notification of the Federal Aviation Administration (FAA). Under 49 CFR 77, 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 would 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 were located 3,000 feet from the airport and exceeded 60 feet in height. FAA would be notified as necessary.

**Volitional Bull Trout Passage Improvements**

Following construction of the Volitional Bull Trout Passage Improvements, there would be no impacts on transportation.

### 4.17.5 Alternative 3 – KDRPP South Pumping Plant

#### *4.17.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

The potential transportation impacts from construction of *Alternative 3 – KDRPP South Pumping Plant* would be less than those described for *Alternative 2* because fewer vehicle trips would be needed. *Alternative 3* would 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 2*. Kachess Dam Road would provide local access to the site of the proposed pumping plant.

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 8,809 truck roundtrips (or 17,618 one-way trips) over the life of the project, or approximately 15 truck roundtrips (or 30 one-way trips) during each day of construction (approximately 2 roundtrips [or 4 one-way trips] per hour). A maximum of 100 vehicle roundtrips (or 200 one-way trips to or from the construction site) per day are 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 7 and 9 a.m. and depart between 4 and 6 p.m. Together, construction worker trips and delivery of construction materials would require a maximum of 27 roundtrips (or 54 one-way trips) per hour; however, during the day, traffic would be much lower since there would be much less construction worker traffic. Although this number of truck trips is lower than described for *Alternative 2*, the impacts from this increase in traffic would be generally the same.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.17.4.2).

#### *4.17.5.2 Operation*

**KDRPP South Pumping Plant Facilities**

The transportation impacts from operation of *Alternative 3* would be the same as those described for *Alternative 2*.

**Volitional Bull Trout Passage Improvements**

The transportation impacts associated with operation of the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.17.4.2).

### 4.17.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

#### *4.17.6.1 Construction*

The potential types of transportation impacts from construction of *Alternative 4 (Preferred Alternative)* would be similar but the extent of the impacts would be less than those described for the other action alternatives because fewer vehicle trips would be needed and the construction duration would be shorter. Kachess Dam Road would provide local access to the proposed construction sites.

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 3,444 truck roundtrips (or 6,888 one-way to or from the construction site) over the life of the project, or approximately 6 truck roundtrips (or 12 one-way trips) during each day of construction (approximately 1 roundtrips [2 one-way trips] per hour). A maximum of 100 vehicle roundtrips (or 200 one-way trips to or from the construction site) per day are 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 7 and 9 a.m. and depart between 4 and 6 p.m. Together, construction worker trips and delivery of construction materials would require a maximum of 26 roundtrips (or 52 one-way trips) per hour; however, during the day, traffic would be much lower since there would be much less construction worker traffic. Overall the transportation impacts under Alternative 4 (Preferred Alternative) would be expected to be less than the impacts of the other action alternatives due to the decrease in construction duration and the decrease in vehicles trips required for construction activities.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.17.4.2).

#### *4.17.6.2 Operation*

The transportation impacts from operation of *Alternative 4 (Preferred Alternative)* would be the same as those described for *Alternative 2*.

**Volitional Bull Trout Passage Improvements**

The transportation impacts associated with operation of the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.17.4.2).

### 4.17.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

*Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* would include construction of the KDRPP East Shore Pumping Plant (*Alternative 2*). The impacts from construction and operation of these components of *Alternative 5A* would be the same as described in Section 4.17.4. *Alternative 5A* would also include construction and operation of the KKC North Tunnel. The impacts of KKC North Tunnel are described below.

#### *4.17.7.1 Construction*

**KKC North Tunnel Alignment Facilities**

Construction of the components for *Alternative 5A* 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 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 on the amount of materials anticipated to be hauled to and from construction sites reported in the Feasibility-Level Design Report, Keechelus-to-Kachess Conveyance (Reclamation and Ecology, 2015e). Approximately 11,400 truck roundtrips (22,800 one-way trips) are anticipated over the life of the project, or approximately 19 truck roundtrips (or 38 one-way trips) during each day of construction (approximately 3 roundtrips [or 6 one-way] trucks per hour). A maximum of 100 vehicle roundtrips (or 200 one-way trips to or from the construction site) per day are 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 7 and 9 a.m. and depart between 4 and 6 p.m.

Together, construction worker trips and delivery of construction materials would require a maximum of 28 roundtrips (or 56 one-way trips) per hour; however, during the day, traffic would be much lower since 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. An increase in vehicle travel time is anticipated. The increased peak period traffic could increase delay 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 56 vehicles per peak period hour would increase peak period traffic on I-90 by approximately 3 percent if all construction-related vehicles used I-90 (which is not anticipated to occur). This small increase is not anticipated to noticeably change the existing traffic conditions sinceI-90 is generally already congested during the peak period.

The increased peak period construction traffic would increase delays for all traffic along local roadways. This increase in traffic delays would not interrupt emergency service vehicle access to any roadways since no road closures are planned; however, emergency vehicle response time would increase because of the increased traffic on roadways. The increased traffic would result in delays for school buses along school bus routes; however, these impacts would be minor since there would only be short-term, intermittent delays due to construction activities.

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 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 are anticipated.

No upgrades to existing roadways would be required to facilitate construction vehicle access. Reclamation expects that the overall increase in construction vehicle traffic would result in minor to moderate deterioration of local roads; however, the project proponents would require contractors to repair damage and restore roadways to a condition similar to or better than that prior to construction (see Section 4.17.10). 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 4.17.10).

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.17.4.1).

**Alternative 5A Summary**

Construction of *Alternative 5A* would result in approximately 40,270 roundtrips (or 80,540 one-way trips) over the life of the construction activities. This would result in approximately 68 truck roundtrips (136 one-way trips) during each day of construction or approximately 9 roundtrips (or 18 one-way trips) per hour. With construction worker trips, there would be a maximum of 61 roundtrips (or 122 one-way trips) per hour during the peak travel periods; however, during the nonpeak hours of the day, traffic would be much lower since there would be much less construction worker traffic.

#### *4.17.7.2 Operation*

**KKC North Tunnel Alignment Facilities**

Reclamation does not expect operation transportation impacts, because operation of *Alternative 5A* 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 deterioration of local roadways leading to increased maintenance requirements.

**Volitional Bull Trout Passage Improvements**

The transportation impacts associated with operation of the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.17.4.2).

### 4.17.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation of *Alternative 5B* would be similar to those described for *Alternative 3* (Section 4.17.5). Impacts would be the same as those associated with the North Tunnel discussed in *Alternative 5A* (Section 4.17.7). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.17.7 (*Alternative 5A*).

Construction of *Alternative 5B* would result in approximately 20,209 roundtrips (or 40,419 one-way trips) over the life of the construction activities. This would result in approximately 34 truck roundtrips (68 one-way trips) during each day of construction or approximately 5 roundtrips (or 10 one-way trips) per hour. With construction worker trips, there would be a maximum of 55 roundtrips (or 110 one-way trips) per hour during the peak travel periods; however, during the nonpeak hours of the day, traffic would be much lower since there would be much less construction worker traffic.

### 4.17.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation of *Alternative 5C* would be the same as those for *Alternative 4 (Preferred Alternative)* (Section 4.17.6). Impacts would be the same as those associated with the North Tunnel discussed in *Alternative 5A* (Section 4.17.7). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.17.7 (*Alternative 5A*).

Construction of *Alternative 5C* would result in approximately 14,844 roundtrips (or 29,688 one-way trips) over the life of the construction activities. This would result in approximately 25 truck roundtrips (50 one-way trips) during each day of construction or approximately 4 roundtrips (or 8 one-way trips) per hour. With construction worker trips, there would be a maximum of 55 roundtrips (or 110 one-way trips) per hour during the peak travel periods; however, during the nonpeak hours of the day, traffic would be much lower since there would be much less construction worker traffic.

### 4.17.10 Avoidance, Minimization and Mitigation Measures

A temporary increase in vehicle traffic levels or traffic flow disruptions including travel time is anticipated during construction. To mitigate this potential impact, the project proponents would implement a construction traffic management plan with specific traffic management measures and procedures that construction contractors would be required to follow.

This would include requiring the contractor(s) 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. If road deterioration merits repair, project proponents would coordinate with local jurisdictions, USFS, WSDOT, or others as needed.

# 4.18 Cultural Resources

## 4.18.1 Methods and Impact Indicators

**Methods.** Reclamation analyzed impacts on cultural and historic resources by conducting a literature review and on-the-ground cultural resource surveys to identify historic properties within the APE; and consulted with Indian Tribes to identify properties of religious and cultural significance. Chapter 3, Section 3.18 provides examples of the types of resources and the types of impacts that could result from the action alternatives.

The cultural resources surveys and investigations conducted by the YCRP (2014, 2015, 2017, and 2018) assessed the relative impacts of the action alternatives on historic properties by applying the criteria of adverse effect (36 CFR 800.5). Additional surveys and consultation would be required pending finalization of design of the selected alternative.

Consultation with Indian Tribes was conducted to identify cultural resources and will continue throughout the implementation of the project.

**Impact Indicators.** An adverse effect would occur when an alternative would alter, directly or indirectly, any of the characteristics of a historic property that qualifies it for inclusion in the NRHP. An adverse effect would occur when a cultural item protected under the Native American Grave Protection and Repatriation Act (NAGPRA) is disturbed (Table 4-143)

**Table 4-143. Impact Indicators for Cultural Resources**

| Issues | Impact Indicators |
|---|---|
| Loss of integrity to historic property | An adverse effect would occur when an alternative would alter, directly or indirectly, any of the characteristics of a historic property that qualifies it for inclusion in the NRHP. Impacts are due to construction or operation. |
| Disturbance to a NAGPRA cultural item | An adverse effect would occur when a NAGPRA cultural item is displaced or removed. |
| Prevent use of Indian Sacred Site by tribal members (discussed in Section 4.19) | An adverse effect would occur when an alternative would destroy or prevent access to an Indian Sacred Site |

### 4.18.2 Summary of Impacts

*Alternative 1 – No Action* would have no additional impact on cultural resources beyond those occurring due to current reservoir operations. Agents such as inundation and shoreline fluctuation, and recreational activities at the reservoirs, have impacted cultural resources, and would continue to occur under the No Action alternative.

Each of the action alternatives would affect cultural resources to varying degrees. Table 4-144 summarizes and compares the potential impacts of the action alternatives and shows that Alternative 4 (Preferred Alternative) would have the least impacts.

**Table 4-144. Summary of Indicators and Impacts for Cultural Resources**

| Indicator | Summary of Impacts (Issue) |
|---|---|
| Physical impact on an historic property, sacred site, or cultural resource through agents such as changes in shoreline drawdown and reservoir fluctuation (operation). | Additional 80-foot drawdown of Kachess Reservoir under *Alternatives 2, 3,* and *4* would expose portions of shoreline that are currently inundated, potentially exposing cultural resources to degradation, looting, or vandalism.<br>Under *Alternatives 5A, 5B,* and *5C* which results in additional drawdown at Keechelus Reservoir, additional shoreline impacts would be incurred. |
| 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 improvement activity (construction). | Construction at Kachess Reservoir under Alternatives 2, 3, and 4 could damage or alter one identified NRHP-eligible site and potentially additional sites.<br>Under Alternatives 5A, 5B, and 5C which adds construction at Keechelus Reservoir, additional impacts may be incurred to one identified NRHP-eligible site and potentially additional sites.<br>All of the Action Alternatives include construction of a volitional fish passage at the Kachess Narrows which has the potential to incur impacts to several historic properties. |
| An adverse effect would occur when a NAGPRA cultural item is displaced or removed.<br>An adverse effect would occur when an alternative would destroy or prevent access to an Indian Sacred Site. | No NAGPRA Items have been identified for any of the Alternatives.<br>No Indian Sacred Sites have been identified for any of the Alternatives. |

| Indicator | Summary of Impacts (Issue) |
|---|---|
| Relative combined impacts by Action Alternative. | All of the Action Alternatives would incur impacts to Cultural Resources, to varying degrees. *Alternative 4 (Preferred Alternative)* would be the least impacting, whereas *Alternative 5B* would incur the greatest impacts.<br>Impacts to Cultural Resources:<br>Least<br>*Alternative 4 (Preferred Alternative)*<br>*Alternative 2*<br>*Alternative 3*<br>*Alternative 5C*<br>*Alternative 5A*<br>*Alternative 5B*<br>Most |

Construction of Alternatives 2, 3, and 4 could disturb, damage, or alter historic features and artifacts associated with site 45KT1014 (a fishing and dam construction camp) and Kachess Dam, which is considered eligible for inclusion on the NRHP. The design and placement of a proposed intake structure, pumping plant, and spillway (*Alternative 3*) or control building *(Alternative 4 [Preferred Alternative])* close to Kachess Dam would require evaluation to determine whether these features would affect any of the qualities which make the dam eligible for inclusion in the NRHP. It is possible that subsequent surveys would identify additional cultural resources that could be impacted by construction. Per consultation with the SHPO, while the preferred alternative (*Alternative 4 (Preferred Alternative)*), would be the least impacting of the action alternatives it nevertheless constitutes an "Adverse Effect" to cultural resources.

Operation-related impacts would result from the additional drawdown at Kachess Reservoir. Drawing the reservoir down an additional 80 feet would expose reservoir bed for the first time since Kachess Dam Pas constructed in 1912. The drawdown could expose previously inundated cultural resources. Such exposure could lead to site degradation and increase the potential for looting or vandalism. Appropriate mitigation for these potential impacts would be developed if consultation with the State Historic Preservation Officer (SHPO) and Indian Tribes determines that historic properties are present and being adversely affected (see Section 4.18.10).

Construction for the KKC North Tunnel Alignment under *Alternatives 5A*, *5B*, and *5C* would cause impacts on an NRHP-eligible site, WF303 (an extensive multicomponent site with numerous features and artifacts, some of which are associated with construction of Keechelus Dam). 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 under action alternatives. Further, the proposed diversion close to the Keechelus Dam outlet would require evaluation to determine whether it would affect any of the qualities (e.g., the historic fabric) that make the dam eligible to the NRHP. Keechelus

Reservoir could have additional draw down during drought years, exposing reservoir bed that would be exposed for the first time since Keechelus Dam was constructed.

Another common element to all of the action alternatives is the proposed Volitional Bull Trout Passage Improvements at the Narrows. As described in Section 3.18, the Narrows is very sensitive, archaeologically and culturally. Several cultural resource sites are potentially adversely affected by the installation of the volitional fish passage. Additional surveys and consultation would be required pending finalization of design.

## 4.18.3 Alternative 1 – No Action

*Alternative 1* would have no additional impact on cultural resources beyond those occurring under current operations; this alternative involves no change in reservoir drawdown patterns. Agents such as inundation and shoreline fluctuation, and recreational activities at the reservoirs, have impacted cultural resources, and would continue to occur under the No Action alternative.

## 4.18.4 Alternative 2 – KDRPP East Shore Pumping Plant

### *4.18.4.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**

Construction of the East Shore Pumping Plant would adversely impact site 45KT1014, one NHRP-eligible historic property. It is possible that future surveys would identify additional cultural resources and historic properties that could be impacted by construction of the *Alternative 2* facilities. Section 4.18.10 describes the process to resolve adverse effects on cultural resources.

**Volitional Bull Trout Passage Improvements**

The proposed Volitional Bull Trout Passage Improvements at the Narrows have the potential to cause effects on cultural resources. As described in Section 3.18, the Narrows is very sensitive, archaeologically and culturally. Evaluation of the design of the fish passage has determined it would potentially adversely affect several historic properties. If so, mitigation measures described in Section 4.18.10 would need to be implemented.

### *4.18.4.2 Operation*

**KDRPP East Shore Pumping Plant Facilities**

Operational impacts would result from the additional drawdown at Kachess Reservoir. The cultural resources survey (YCRP, 2014 and 2017; Central Washington University, 2014) identified 10 known sites around the immediate shoreline or drawdown area of the reservoir and at the Narrows. 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 reservoir bed would be exposed for the first time since Kachess

Dam was constructed in 1912. The drawdown could expose previously inundated cultural resources. In consultation with the SHPO and Indian Tribes, if eligible historic properties exist and are determined to be adversely affected due to increased exposure, site degradation over time, and increased visitation and potential looting or vandalism, then the additional steps in the 36 CFR 800 process that are described in Section 4.18.10 would be taken. Exposure of these resources would physically impact cultural resources.

**Volitional Bull Trout Passage Improvements**

There would be no identified impacts on cultural resources from operation of Volitional Bull Trout Passage Improvement at the Narrows.

## 4.18.5 Alternative 3 – KDRPP South Pumping Plant

### *4.18.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

Construction impacts would adversely affect site 45KT1014, and Kachess Dam. It is possible that subsequent surveys would identify additional cultural resources that could be impacted by construction of the south pumping plant. Section 4.18.10 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.

The design and placement of the proposed intake tunnel, pumping plant and spillway close to Kachess Dam could affect the qualities that make the dam eligible for inclusion in the NRHP.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.18.4.1).

### *4.18.5.2 Operation*

**KDRPP East Shore Pumping Plant Facilities**

Operation impacts would be the same as those described for *Alternative 2* (Section 4.18.4.2).

**Volitional Bull Trout Passage Improvements**

Operation impacts would be the same as described for *Alternative 2* (Section 4.18.4.2).

## 4.18.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.18.6.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

Construction of this alternative would adversely impact two historic properties: site 45KT1014 and Kachess Dam. It is possible that subsequent cultural resource surveys would identify additional cultural resources that could be impacted by construction of the floating pumping plant. Section 4.18.10 describes the process to resolve adverse effects on cultural resources.

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.18.4.1).

### *4.18.6.2 Operation*

**KDRPP Floating Pumping Plant Facilities**

Operation impacts would be the same as those described for *Alternative 2* (Section 4.18.4.2).

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.18.4.2).

## 4.18.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

### *4.18.7.1 Construction*

**KKC North Tunnel Alignment Facilities**

Construction impacts associated with *Alternative 5A* would include site 45KT1014 plus impacts on the NRHP-eligible site WF303 (an extensive multicomponent site with numerous features and artifacts, with some associated with construction of Keechelus Dam). In addition, depending on final design, construction might affect Keechelus Dam itself, which is considered eligible for inclusion in the NRHP.

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 4.18.10 describes the process to resolve adverse effects on cultural resources.

No impacts on cultural resources are anticipated from tunneling.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.18.4.2).

#### *4.18.7.2 Operation*

**KKC North Tunnel Alignment Facilities**

Operation impacts associated with KDRPP and KKC combined would adversely impact Site 45KT1014. In addition, KKC operation impacts would result from the additional drawdown at Keechelus Reservoir. The survey (YCRP, 2014 and 2017; Central Washington University, 2014) identified one site around the immediate reservoir bed 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 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. Increased exposure would lead to site degradation over time and would invite increased visitation and potential looting or vandalism. If eligible resources exist and are determined to be adversely affected, Reclamation, in consultation with the SHPO and Indian Tribes, would develop Cultural Resource Management Plan to address operational impacts.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.18.4.2).

### 4.18.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would adversely impact site 45KT1014, Kachess Dam, and the Narrows. Impacts associated with the North Tunnel would be the same as those discussed in *Alternative 5A* (Section 4.18.7).

### 4.18.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would adversely impact site 45KT1014, Kachess Dam, and the Narrows. Impacts associated with the North Tunnel would be the same as those discussed in *Alternative 5A* (Section 4.18.7).

### 4.18.10 Avoidance, Minimization and Mitigation Measures

Reclamation will complete additional field surveys and continue to identify cultural resources as project designs are refined. Prior to construction, Reclamation would complete all necessary consultations with the SHPO, USFS, Washington State Parks, interested Tribes, and other stakeholders. It is Reclamation's policy to prevent impacts on historic resources whenever possible. If avoidance is not possible, Reclamation would develop protective or mitigation measures.

Reclamation has determined the Proposed Action will have an *Adverse Effect* on historic properties and the SHPO has concurred with that finding. For those cultural resources immediately and unavoidably affected by the selected alternative, Reclamation would develop and implement a Memorandum of Agreement (MOA) and treatment plan in consultation with the SHPO, USFS, interested Indian Tribes, the Federal Advisory Council on Historic Preservation and other stakeholders, as necessary. If historic facilities are 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. During construction archaeological monitoring of construction activities will be conducted as necessary.

As part of Section 110 responsibilities, Reclamation will develop and implement a Cultural Resources Management Plan (CRMP) appropriate to the selected alternative to address ongoing and future operational and land management implications to cultural resources.

As the Yakama Nation Cultural Resources Program (YCRP) indicates in its survey of cultural resources (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. As part of the CRMP, Reclamation will consult with the Yakama Nation and the Colville Confederated Tribes regarding identification of the natural Kachess (and Keechelus Lake if included as a part of the selected alternative) Lake and associated pre-contact archaeological resources as Traditional Cultural Properties (TCPs). 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

The impact indicators for Indian sacred sites is the disturbance of, or limiting access to, such sites.

## 4.19.2 Summary of Impacts

Through consultation with Indian Tribes, no Indian sacred sites have been identified in the primary study area.

### 4.19.3 Mitigation Measures

No mitigation measures are needed.

## 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

No impacts on ITAs would occur because none have been identified in the project area at this time.

### 4.20.3 Alternatives 2– KDRPP East Shore Pumping Plant, 3– KDRPP South Pumping Plant and 4 – KDRPP Floating Pumping Plant

Because consultation has not identified ITAs in the primary study area for KDRPP facilities, Reclamation anticipates no impacts on ITAs under any of the action alternatives.

### 4.20.4 Alternatives 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment, 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment, and 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts would be the same as for KDRPP (Section 4.20.3).

### 4.20.5 Mitigation Measures

If Reclamation identifies ITAs during future consultation, Reclamation would comply with its Indian Trust Assets Policy (July 2, 1993) and avoid impacts on ITAs whenever possible.

## 4.21 Socioeconomics

### 4.21.1 Methods and Impact Indicators

**Methods.** Due to the regional extent of potential socioeconomic effects on output, personal income, and employment arising from project construction and project operation, the geographic area for this analysis is the extended or regional study area, which includes four counties within the Yakima River watershed (Kittitas, Benton, Yakima, and Franklin).

IMPLAN (IMpact Analysis for PLANning) software was used to understand the regional distribution and extent of direct, indirect, and induced impacts associated with construction and operation expenditures (IMPLAN, 2014). IMPLAN is an input-output model that works by tracing how spending associated with a specific project circulates through the defined impact area. Effects were modeled for spending in the four county regional study area, and for spending in the rest of the state of Washington. Model inputs for construction and operations expenditures came from the Feasibility Planning Reports for KDRPP (alternatives 2 and 3) and KKC (Reclamation and Ecology 2016b; 2016c). Construction and operations expenditures for *Alternative 4 (Preferred Alternative)* were estimated for this FEIS based on appraisal-level project design, and reflect a higher degree of uncertainty than the costs for *Alternatives 2, 3, 5A,* and *5B*. Table 4-145 shows the assumptions for how construction costs would be allocated across labor and capital resources in the primary study area and in the state of Washington.

**Table 4-145. Assumptions for IMPLAN Analysis of Construction Impacts**

| Assumption | *Alternative 2* | *Alternative 3* | *Alternative 4* | *Alternative 5* |
|---|---|---|---|---|
| Construction Expenditures: % Labor | 8% | 6% | 25% | 6% |
| Percent of Labor Construction Expenditures in Regional Study Area | 50% | 50% | 50% | 50% |
| Percent of Non-Labor Construction Expenditures in Regional Study Area | 10% | 10% | 30% | 10% |
| Percent of Non-Labor Construction Expenditures in Rest of Washington | 60% | 60% | 40% | 60% |

Reclamation also assessed the changes in economic activity associated with changes in water availability during project operation. This assessment relied on two models: the first model of irrigated agriculture in the Yakima River 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 *Alternative 1 -* . Estimates of increased water supply reliability were derived directly from RiverWare modeling outputs, as described in other sections of this FEIS. Using outputs of the agriculture model, Reclamation analyzed economic impacts of agricultural activity attributable to the alternatives and associated costs using the IMPLAN software as described above. 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. See the technical economic reports on KKC and KDRPP for more detail on the methods used to conduct the IMPLAN analysis (Reclamation and Ecology, 2015b; 2015c).

Reclamation evaluated potential impacts on temporary housing by surveying the temporary lodging supply within commuting distance to the project site. Commuting distance is defined as within approximately 1-hour driving time or approximately 75 miles of Easton, Washington. The analysis focused the communities of Cle Elum, Ellensburg, and Yakima within this area. The survey of temporary lodging options relied on Census data and business listings on Google maps and yellowpages.com (U.S. Census, 2012; Google Maps, 2016; Yellowpages.com, 2016). Follow-up telephone calls to hotel/motels, campgrounds, and RV facilities were conducted to determine seasonal availability and use patterns. To assess potential impacts on available temporary lodging, the available supply is compared with the additional demand for temporary lodging that the action alternatives would generate from workers.

In response to comments raised during scoping for the EIS, Reclamation qualitatively assessed the effects on property values for property surrounding Kachess Reservoir, effects potentially arising from disrupted access during construction and lowered reservoir water levels. For this FEIS, Reclamation identified the parcels immediately surrounding Kachess Reservoir and their value, assessed the literature on property values and reservoir operations, and compared impacts found in the literature with the changes in pool levels expected for each alternative. This approach yielded a qualitative description of the pathways through which the action alternatives could affect property values, and identified variables that may influence whether impacts on property values are likely to materialize.

Among the sources reviewed for this qualitative assessment was a study prepared for WDFW and Ecology (Dean Potter & Associates, 2015). These agencies engaged an independent Real Estate Appraiser to conduct this study to provide decision makers with a professional opinion regarding the general range and probable limits of property value impacts on real property surrounding Kachess Reservoir arising from KDRPP. The findings of the report are based on the management and operations of the reservoirs and impacts on values as of the date of the study (2015) and provided no supported information regarding the influence on value due to operation of the reservoirs during severe drought conditions. The study found that because of current operations and the significant draw down at Cle Elum, that this influence had a five to ten percent impact on value at Cle Elum when compared to Kachess. The study then interpreted this to be a potential indication that might result from change in management at Kachess and therefore it was “projected to the Lake Kachess location relative to the After Condition.”

Reclamation summarized the results of this study and updated the discussion presented in this FEIS. Reclamation did not identify an impact indicator and did not quantitatively assess impacts on property values because the relevant literature and the Potter study indicates that multiple factors and uncertainties culminate to potentially affect the value of properties surrounding Kachess Reservoir. Many of these factors are unrelated to the action alternatives evaluated in this FEIS. Reclamation determined there was no way to reliably assign or assess impact or significance to the specific effects of the alternatives, and thus, the property value assessment remains qualitative and general.

**Impact Indicators.** Issues and impact indicators are summarized in Table 4-146. All criteria are assessed relative to *Alternative 1 – No Action*. The indicators align with categories of benefits, costs and market impacts identified and analyzed. Based on 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.

**Table 4-146. Impact Indicators for Socioeconomics**

| Issues | Impact Indicators |
|---|---|
| Changes in output (the value of production) | Increase or decrease in sector output by 1% of overall economic activity |
| Changes in personal income | Increase or decrease in sector personal income by 1% of regional activity |
| Changes in employment | Increase or decrease in jobs in sector by 1% of regional activity |
| Changes in demand or supply of temporary lodging | Availability of sufficient housing |

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 action alternatives. Reclamation analyzes all impacts on an annual basis, and does not sum market (industry) impacts over multiple years for evaluation.

Indicators include the following types of economic impacts:

- ***Direct Impacts***. These impacts describe changes in economic activity directly tied to spending associated with the 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 action alternatives (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

Under *Alternative 1,* prevailing global, national, and regional economic trends and conditions would continue to influence the economy of the primary study area. Shifting local climate conditions arising from global climate trends may increase the frequency and severity of droughts and water available for crop production. This may reduce the size and influence of the agricultural sector over time, causing changes in other economic sectors that supply inputs to the agricultural sector and the population it supports. Shifting climate patterns, including reduced snowpack, may also adversely affect aspects of the service economy dependent on recreational visitors, especially during the winter months. Responses to these long-term trends may offset some adverse effects, for example if the traditional summer recreation season expands. Highway construction in the primary study area would increase demand for local services in the short run and may temporarily affect traffic and visitation patterns.

Short-run socioeconomic impacts arising from construction activities for all action alternatives are expected to be positive. Local spending and demand for temporary lodging are expected to temporarily increase. At the peak of construction, construction workers may displace some customary visitors, but the net effect on demand for lodging likely would be positive. The socioeconomic impacts of the action alternatives in the long-run, arising from changes in water supply available for agriculture, are expected to be positive, resulting in a net gain in regional economic activity relative to *Alternative 1*. Regional trends in real estate market value are likely to continue to be the overwhelming source of variation in property values surrounding Kachess Reservoir, but interactions between broader market trends and extreme drought conditions may increase the likelihood of short-term reductions in value for some properties.

Table 4-147 summarizes impacts for each impact indicator.

**Table 4-147. Summary of Impacts for Socioeconomics**

| Impact Indicator | Summary of Impacts |
|---|---|
| Increase or decrease in sector output by 1% of overall economic activity | Improved water supply and agricultural output during drought years. |
| Increase or decrease in sector personal income by 1% of regional activity | For all action alternatives, impacts on income from construction and operation would be generally positive, but not significant. |
| Increase or decrease in jobs in sector by 1% of regional activity | For all action alternatives, impacts on employment from construction and operation would be generally positive, but not significant. |
| Availability of sufficient housing | For all action alternatives, sufficient housing is available. |

### 4.21.3 Alternative 1 – No Action

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.

With *Alternative 1*, 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 example, during 2015, a record drought year in Washington, growers in the Yakima Valley reported both reduced yields and quality across all crop types. Kittitas Reclamation District specifically reported a 50 percent reduction of alfalfa and grass hay cuttings and pasture value, among other impacts. Based on interviews with growers, the Washington State Department of Agriculture estimated total impacts from the 2015 drought and associated water rationing in the Kittitas Reclamation District alone at about $11.4 million (Washington Department of Agriculture 2015).

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.

The current economic factors and trends that influence the value of private property at the reservoirs, including regional and national market conditions, demand for recreational properties, and other economic and environmental conditions, would continue to influence property values.

## 4.21.4 Alternative 2 – KDRPP East Shore Pumping Plant

### *4.21.4.1 Income and Employment*

**Construction**

*KDRPP East Shore Pumping Plant Facilities*

Construction of *Alternative 2* 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 who would likely be hired by the contractor from the communities in the primary study area.

Total direct construction labor expenditures would be about $24 million (Table 4-148) with direct regional job-years of 150 and total regional job-years of 241 (Table 4-149). These estimates represent the average annual impact during construction on output, personal income, and employment these estimates are well below a 1 percent threshold for the impact indicators in the four-county regional study area.

**Table 4-148.** ***Alternative 2 – KDRPP East Shore Pumping Plant* Construction Expenditures**

| Expenditure Category | Total Construction Spending | Spending in the 4-county Region | Spending in the Rest of Washington |
|---|---|---|---|
| Construction Labor ($Millions) | $23.7 | $11.9 | $11.9 |
| Contractor, Equipment & Material Costs ($Millions) | $263.3 | $26.3 | $158.0 |
| Taxes and other costs ($ Millions) | $97.9 | $11.2 | $86.7 |
| **Total** | **$384.9** | **$49.4** | **$256.6** |

**Table 4-149.** ***Alternative 2 – KDRPP East Shore Pumping Plant* Construction Impacts, by Type**

| Region /Impact Measure | Direct[1] | Indirect[1] | Induced[1] | Total Impacts[a] |
|---|---|---|---|---|
| **4 County Region** | | | | |
| Output ($ Millions) | $49.35 | $7.8 | $7.0 | $64.1 |
| Personal Income ($ Millions) | $11.9 | $3.0 | $3.0 | $17.9 |
| Job Years | 150 | 46 | 45 | 241 |
| **Rest of Washington** | | | | |
| Output ($ Millions) | $256.6 | $72 | $89 | $417 |
| Personal Income ($ Millions) | $11.9 | $9.3 | $12.4 | $33.6 |
| Job Years | 150 | 163 | 259 | 572 |
| **Total Washington State** | | | | |
| Output ($ Millions) | $305.9 | $79.6 | $95.5 | $481.0 |
| Personal Income ($ Millions) | $23.7 | $12.4 | $15.4 | $51.4 |
| Job Years | 300 | 209 | 304 | 813 |

Totals may not sum because of rounding.

*Volitional Bull Trout Passage Improvements*

Construction associated with the Volitional Bull Trout Passage Improvements at the Narrows is estimated to involve additional construction expenditures, which would employ additional people, somewhat increasing total job years of employment under Alternative 2, as described above. Information is not available at this time to describe these impacts in detail, but they are expected to be positive.

### Operation

The long-term operation and maintenance of *Alternative 2* would require labor in addition to the ongoing management of the existing facilities. Typical annual labor expenditures would total $212,000 (Table 4-150), with 7 direct jobs and 14 total jobs annually in the 4-county regional study area (Table 4-151). The average annual impacts during operation on output, personal income, and employment are well below the 1 percent threshold for the impact indicators at the four-county regional level.

**Table 4-150. *Alternative 2 – KDRPP East Shore Pumping Plant* Operating Expenditures**

| Expenditure Category | Total Expenditures of Average Year |
|---|---|
| Labor | $212,400 |
| Materials and equipment | $1,572,880 |
| **Total** | **$1,785,280** |

**Table 4-151. *Alternative 2 – KDRPP East Shore Pumping Plant* Operating Impacts, by Type, Rounded**

| Region/Impact Measure | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| **Four County Region** | | | | |
| Output | $1,785,280 | $941,131 | $444,377 | $3,170,788 |
| Personal income | $522,113 | $135,898 | $129,380 | $787,391 |
| Job years | 7 | 2 | 4 | 14 |
| **Rest of Washington** | | | | |
| Output | $0 | $277,495 | $107,835 | $385,330 |
| Personal income | $0 | $78,693 | $29,923 | $108,616 |
| Job years | 0 | 1 | 1 | 2 |
| **Total Washington State** | | | | |
| Output | $1,785,280 | $1,218,626 | $552,212 | $3,556,118 |
| Personal income | $522,113 | $214,591 | $159,303 | $896,007 |
| Job years | 7 | 4 | 5 | 16 |

The tables above describe the gross contributions of spending associated directly with operating *Alternative 2*. Section 4.14 describes potential impacts to recreational access during periods when the lake is drawn down below historic levels. To the extent that people choose not to travel to the region and spend money related to recreation at the reservoirs, local businesses that serve these customers may experience losses in revenue. These revenue losses could translate into losses in economic activity. Data are not available to estimate the reduction in visitors during these periods, or the associated reduction in spending and economic contribution to the region. Several factors may mitigate the loss in economic activity somewhat during these periods:

- Some people may continue to participate in certain activities, such as camping, despite the low pool elevations. Their spending patterns may differ, but the money they spend in the region would continue to generate economic activity and support jobs at local businesses.

- Some people may choose to go elsewhere to recreate, either engaging in the same activity or something different. A quarter of respondents to the 2006-2007 survey indicated that Cle Elum Reservoir is the alternate location where they would go to find their desired experience. Almost 40 percent said another reservoir in the Yakima River basin would satisfy their recreational interest (Reclamation, 2008b). Thus, it is likely that many visitors would seek substitute recreational experiences elsewhere in the basin, so their travel and other expenditures on these activities likely would remain in the region.

#### *4.21.4.2 Temporary Lodging Supply and Demand*

**Construction**

At the peak of construction, *Alternative 2* would increase demand for temporary lodging requirements in the primary study area. Approximately 50 workers would need temporary lodging for some period 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 and likely stay in hotels, motels, RV parks, and campgrounds near the construction site. There are 9 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 farther from the construction site, in 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 when vacancy rates are low, this alternative may 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 2* would not 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. These rentals would have a positive impact on local businesses since workers would pay for temporary lodging services that might otherwise remain vacant.

**Operation**

Operation of *Alternative 2* would require minimal additional workforce and would not 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 2* would have no impact on temporary lodging or housing in the long term.

#### *4.21.4.3 Property Values*

Variation in the property market over time makes it difficult to establish specific impact indicators for property values. The potential for changes in reservoir elevation to affect property values was raised during EIS scoping, so this discussion is included here, in general terms. Property value effects are borne by property owners and local jurisdictions as property tax revenue could eventually change if assessed values are adjusted to reflect changes in property value. Thus, while effects on property value would most directly impact property owners, the wider community could also experience effects.

**Construction**

While construction is likely to disrupt some access and use of property, the disruption would be temporary and would be minimized to the extent possible. No impacts on property values are anticipated from construction.

**Operation**

*Alternative 2* would increase the frequency, magnitude, and duration of lower pool elevations relative to baseline conditions. These lower pool elevations would modify the appearance of the shoreline, increase relative distance from current recreational facilities and the water's edge, and may create less desirable views. Comments received during scoping for this EIS indicate that residents of areas near Kachess Reservoir are concerned about potential impacts on property values from these changes. 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 reservoir shoreline has been subject to fluctuating water levels since development has occurred. While the proposed fluctuations would add to those which now occur, they would take place only during drawdowns as the result of drought conditions.

Hydrologic modeling results indicates that the *Alternative 2* pool elevation in Kachess Reservoir would be lower than under *Alternative 1* 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. 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.

Property values are affected by numerous factors, many of which are based on the potential buyer's preferences. The specific 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 because they are already factored into the market, but transactions that occur in years during drought conditions, when the pool level may be drawn below historical lows, may be reflected in lower prices or slower sales. In the absence of clear verifiable information about how buyers and sellers respond to greater fluctuations in reservoir levels at Kachess Reservoir, it may be possible to use data from similar locations that have influences identical or similar to those at Kachess Reservoir. Studies of the changes in property values at other reservoirs subsequent to changes in pool levels suggest that lake levels can influence property transactions and values, and that sustained or significant decreases in water levels have negative effects (Lansford and Jones, 1995; Hanson and Hatch, 1998; Hanson et al., 2002).

Locally, Cle Elum Reservoir has a history of more severe drawdowns than Kachess Reservoir. Taking advantage of this close proximity and similar market conditions otherwise, a study compared property sales in the vicinity of Cle Elum Reservoir, to property sales in the vicinity of Kachess Reservoir. After controlling for other factors that influence value, including property characteristics, location, and other amenities, such as views, researchers concluded that a difference in market value of property of between 5 and 10 percent may be attributable to greater drawdowns at Cle Elum Reservoir (Dean Potter and Associates, Inc. 2015). There are many uncertainties associated with applying the results of this study to the potential future conditions at Kachess Reservoir under the alternatives, including whether the conditions at Cle Elum Reservoir accurately reflect what may occur under future conditions, and whether market differences between properties in the vicinity of Cle Elum Reservoir and properties in the vicinity of Kachess Reservoir were fully addressed in the study.

Property values are influenced by a number of different variables, and many of these variables would not be affected by the Proposed Action. Variables that are relatively universal include: fluctuating market prices for housing due to changes in the economy; the availability of substitute properties for potential purchasers; the age and type of improvements; quality and features of the improvements; and transportation access and convenience; just to name a few elements. Variables specific to vacation and retirement housing in the central Cascade Range include but are not limited to: access to terrestrial and aquatic recreational activities such as hiking, skiing, snowmobiling, boating, and fishing; the health, quality and character of local forests; wildland fire issues; and scenic qualities.

For the SDEIS, Reclamation and Ecology reviewed the property value study prepared for the WDFW and Ecology (Dean Potter & Associates, 2015). Reclamation summarized the results of this study and updated the discussion presented in Section 4.21 of the SDEIS, concluding that there are multiple factors affecting the value of properties surrounding Kachess Reservoir that are unrelated to the action alternatives evaluated in this FEIS. The proposed changes in temporary fluctuations in water levels do not necessarily have a causal relationship to property values or market perceptions.

#### 4.21.4.4 Irrigation Impacts

*Alternative 2* would provide additional water for irrigation, compared with *Alternative 1*. To estimate the economic impact of this additional water, Reclamation used a model that allocated irrigation water supplies to crop production. The model accounted for allocation of water supply among proratable users during droughts and the range of drought frequency and severity, but did not incorporate any conservation or water trading activity beyond what is already occurring in the Yakima River basin. It then calculated gross farm earnings, and assigned the revenue to corresponding agricultural industry sectors in the IMPLAN model (discussed in Section 4.21.1). To calculate the indirect and induced impacts of this change in agricultural production, the direct impacts were run through IMPLAN. The impacts do not include downstream impacts tied to value-added agricultural production, such as food processing and restaurant sales. 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 4.12. The following analysis of alternative impacts is provided for both sets of conditions.

Under historic climate conditions, *Alternative 2* would provide a 23 percent increase in the water supply for proratable irrigation districts during drought years. Any given year would have a 17 percent probability of experiencing a drought. Although in some years, the increased water supply would not fully meet the 70 percent goal, it would be an increase in water supply compared with *Alternative 1*. With the improved water supply, *Alternative 2* would increase agricultural output during drought years, relative to *Alternative 1*.

Table 4-152 summarizes the economic impacts under historical climate conditions associated with the change in agricultural production attributed to the additional water provided by

Alternative 2 compared with the amount of water provided by *Alternative 1*. The impact on agricultural production of *Alternative 2* during an average (weighted) drought year under historic climate conditions would generate about $172 million in total output within the four-county study area. Of that output, about $44 million would go toward personal income that supports 1,293 job-years. This represents about 0.47 percent of total employment in the four-county region, below a 1 percent threshold for significance at the four-county regional level.

**Table 4-152. Summary of Economic Impacts from Agricultural Production Associated with *Alternative 2 - KDRPP East Shore Pumping Plant* (Historical Climate Conditions)[a,b]**

| Region/Impact Measure | Direct | Indirect | Induced | Total | Multiplier |
|---|---|---|---|---|---|
| Four 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 |

a Model assumes historical climate conditions as opposed to adverse climate change

b 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, which is why no direct impacts are reported for the rest of Washington.

Note: Calculated using the spreadsheet model of direct irrigation benefits and 2012 IMPLAN base data. Based on measurement relative to baseline conditions, and the net present value of 100 years of operation.

Table 4-153 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: roughly 65 percent of the total change in output, 66 percent of the increase in personal income, and 69 percent of job-years 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: roughly 20 percent of the total increase in output, personal incomes, and jobs-years is observed in this sector.

**Table 4-153. Distribution of Economic Impacts Associated with *Alternative 2 - KDRPP East Shore Pumping Plant*, by Industry Sector (Historical Climate Conditions)[a]**

| Aggregate Industry Sector | Output | Personal Income | Job Years | 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** |

[a] 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.

Table 4-154 summarizes the economic impacts under adverse climate change conditions associated with the change in agricultural production attributed to the additional water provided by Alternative 2 compared with the amount of water provided by *Alternative 1*. The adverse climate change scenario is expected to increase the probability of experiencing a drought from 17 percent in any given year to 49 percent, and when droughts occur, they are expected to be more severe. With this increase in both frequency and severity, water deliveries are expected to decline under both *Alternative 1* and *Alternative 2*, relative to historic climate conditions. However, relative to *Alternative 1*, *Alternative 2* would increase water deliveries and generate net output of $162 million, net personal income of about $42 million, and 1,223 additional job years. Relative to *Alternative 1*, this increase is a smaller change than *Alternative 2* would generate under historic climate conditions (Table 4-154), but, even under adverse climate conditions, *Alternative 2*is capable of generating net economic impacts.

**Table 4-154. Summary of Economic Impacts from Agricultural Production Associated with *Alternative 2 - KDRPP East Shore Pumping Plant* (Adverse Climate Conditions)[a]**

| Region/Impact Measure | Direct | Indirect | Induced | Total | Multiplier |
|---|---|---|---|---|---|
| **Four 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 |

[a] Modeled with adverse climate change conditions
Note: Calculated using the spreadsheet model of direct irrigation benefits and 2012 IMPLAN base data.

Table 4-154 shows how the impacts (direct, indirect, and induced) of *Alternative 2* under adverse climate change conditions would be distributed across different industry sectors in the four-county study area. The results are similar to those shown in Table 4-155, and mirror the overall lower level of impacts described in the results above.

**Table 4-155 Distribution of Economic Impacts Associated with Increased Agricultural Production, by Industry Sector, Four-County Study Area (Adverse Climate Conditions)[a]**

| Aggregate Industry Sector | Output | Personal Income | Job-Years | 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** |

[a] Modeled with adverse climate change conditions
Note: Calculated using the spreadsheet model of direct irrigation benefits and 2012 IMPLAN base data.

### 4.21.5 Alternative 3 – 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 3* would be similar in magnitude and timing to those from *Alternative 2.* Construction would generate 263 job-years under *Alternative 3* in total across the four-county region (Table 4-156 and Table 4-157). The average annual impact during construction on output, personal income, and employment these estimates represent is well below a 1 percent threshold for the impact indicators at the four-county regional level.

| **Table 4-156. *Alternative 3 – KDRPP South Pumping Plant* Construction Expenditures**<br>**Expenditure Category** | **Total Construction Spending** | **Spending in the Four-county Region** | **Spending in the Rest of Washington** |
|---|---|---|---|
| Construction Labor ($Millions) | $17.7 | $8.8 | $8.8 |
| Contractor, Equipment & Material Costs ($Millions) | $267.9 | $26.8 | $160.7 |
| Taxes and other costs ($Millions) | $97.7 | $20.0 | $77.7 |
| **Total** | **$383.3** | **$55.6** | **$247.3** |

**Table 4-157. *Alternative 3 – KDRPP South Pumping Plant* Construction Impacts, by Type**

| Region /Impact Measure | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| **4 County Region** | | | | |
| Output ($ Millions) | $55.6 | $9.5 | $17.0 | $82.1 |
| Personal Income ($ Millions) | $8.8 | $2.9 | $5.3 | $17.1 |
| Job Years | 112 | 51 | 101 | 263 |
| **Rest of Washington** | | | | |
| Output ($ Millions) | $247.3 | $70.3 | $84.1 | $401.7 |
| Personal Income ($ Millions) | $8.8 | $7.5 | $10.0 | $26.3 |
| Job Years | 112 | 134 | 212 | 457 |
| **Total Washington State** | | | | |
| Output ($ Millions) | $302.9 | $79.8 | $101.0 | $483.7 |
| Personal Income ($ Millions) | $17.7 | $10.4 | $15.3 | $43.4 |
| Job Years | 223 | 185 | 313 | 721 |

*Volitional Bull Trout Passage Improvements*

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.21.4.1).

### Operation

Long-term impacts on water supply, income, and employment of KDRPP operation under *Alternative 3* would be similar to those from *Alternative 2*. Typical annual total job impacts in the four-county region would be approximately 15, 8 of which would be direct jobs (Table 4-158 and Table 4-159). The average annual impact during operation on output, personal income, and employment these estimates represent is well below a 1 percent threshold for the impact indicators at the four-county regional level.

**Table 4-158. *Alternative 3 – KDRPP South Pumping Plant* Operating Expenditures**

| Expenditure Category | Total Expenditures of Average Year |
|---|---|
| Labor | $212,400 |
| Materials and equipment | $1,338,156 |
| **Total** | **$1,550,556** |

**Table 4-159. *Alternative 3 – KDRPP South Pumping Plant* Operating Impacts, by Type**

| Region/Impact Measure | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| **Four County Region** | | | | |
| Output | $1,550,556 | $676,475 | $436,914 | $2,663,945 |
| Personal income | $541,691 | $111,849 | $127,210 | $780,750 |
| Job years | 8 | 3 | 4 | 15 |
| **Rest of Washington** | | | | |
| Output | $0 | $257,884 | $104,264 | $362,148 |
| Personal income | $0 | $74,809 | $28,887 | $103,696 |
| Job years | 0 | 1 | 1 | 3 |
| **Total Washington State** | | | | |
| Output | $1,550,556 | $934,359 | $541,179 | $3,026,093 |
| Personal income | $541,691 | $186,657 | $156,097 | $884,445 |
| Job years | 8 | 4 | 5 | 17 |

Impacts on economic activity related to recreation participation and spending under Alternative 3 would be similar in nature and timing to Alternative 2. See Section 4.21.4.1 for discussion.

#### 4.21.5.2 Temporary Lodging Supply and Demand

Impacts on lodging under *Alternative 3* would be similar in nature and timing to those under *Alternative 2*. See Section 4.21.4.2 for discussion.

#### 4.21.5.3 Property Values

Impacts on property values under *Alternative 3* would be similar in nature and timing to those under *Alternative 2*. See Section 4.21.4.3 for discussion.

#### 4.21.5.4 Irrigation Impacts

Effects on irrigation and the resulting economic impacts under *Alternative 3* would be similar in nature and timing to those under *Alternative 2*. See Section 4.21.4.4 for discussion.

### 4.21.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

#### 4.21.6.1 Income and Employment

**Construction**

*KDRPP Floating Pumping Plant Facilities*

Construction of *Alternative 4 (Preferred Alternative)* would require approximately 80 workers during the peak construction period, lasting less than a year, from March 1 to September 31. At any given time, approximately 50 percent of the workers (40 workers) would require specialized marine construction expertise, so these workers would come from outside the primary study area. The remaining 50 percent of workers would be laborers and truck drivers who would likely be hired by the contractor from the communities in the primary study area.

Total direct construction labor expenditures would be about $31 million (Table 4-160) with direct regional job-years of 196 and total regional job-years of 305 (Table 4-161). 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 4-160. *Alternative 4 (Preferred Alternative)* Construction Expenditures**

| Expenditure Category | Total Construction Spending | Spending in the 4-county Region | Spending in the Rest of Washington |
|---|---|---|---|
| Construction Labor ($Millions) | $31.0 | $15.5 | $15.5 |
| Contractor, Equipment & Material Costs ($Millions) | $80.5 | $24.2 | $32.2 |
| Taxes and other costs ($Millions) | $57.4 | $6.3 | $51.1 |

| Expenditure Category | Total Construction Spending | Spending in the 4-county Region | Spending in the Rest of Washington |
|---|---|---|---|
| **Total** | **$168.9** | **$45.9** | **$98.8** |

**Table 4-161. *Alternative 4 (Preferred Alternative)* Construction Impacts, by Type**

| Region /Impact Measure | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| **4 County Region** | | | | |
| Output ($ Millions) | $45.9 | $6.9 | $6.3 | $59.1 |
| Personal Income ($ Millions) | $15.5 | $3.7 | $3.8 | $23.0 |
| Job Years | 196 | 53 | 56 | 305 |
| **Rest of Washington** | | | | |
| Output ($ Millions) | $98.8 | $22.7 | $30.3 | $151.8 |
| Personal Income ($ Millions) | $15.5 | $8.8 | $11.3 | $35.7 |
| Job Years | 196 | 140 | 220 | 556 |
| **Total Washington State** | | | | |
| Output ($ Millions) | $144.8 | $29.6 | $36.6 | $210.9 |
| Personal Income ($ Millions) | $31.0 | $12.5 | $15.1 | $58.7 |
| Job Years | 392 | 193 | 276 | 861 |

[1] Totals may not sum because of rounding.

*Volitional Bull Trout Passage Improvements*

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.21.4.1).

## Operation

Typical annual total job impacts associated with operation of *Alternative 4 (Preferred Alternative)* in the four-county region would be approximately eight, four of which are direct jobs (Table 4-162 and Table 4-163). The average annual impact during operation on output, personal income, and employment these estimates represent is well below a 1 percent threshold for the impact indicators at the four-county regional level.

**Table 4-162. *Alternative 4 (Preferred Alternative)* Operating Expenditures**

| Expenditure Category | Total Expenditures of Average Year |
|---|---|
| Labor | $291,127 |
| Materials and equipment | $542,206 |

| Expenditure Category | Total Expenditures of Average Year |
|---|---|
| **Total** | **$833,333** |

**Table 4-163.** ***Alternative 4 (Preferred Alternative)*** **Operating Impacts by Type, Rounded**

| Region/Impact Measure | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| **Four County Region** | | | | |
| Output | $833,333 | $363,566 | $234,816 | $1,431,715 |
| Personal income | $291,127 | $60,112 | $68,368 | $419,607 |
| Job years | 4 | 1 | 2 | 8 |
| **Rest of Washington** | | | | |
| Output | $0 | $138,598 | $56,036 | $194,634 |
| Personal income | $0 | $40,205 | $15,525 | $55,730 |
| Job years | 0 | 1 | 1 | 1 |
| **Total Washington State** | | | | |
| Output | $833,333 | $502,163 | $290,852 | $1,626,349 |
| Personal income | $291,127 | $100,317 | $83,893 | $475,338 |
| Job years | 4 | 2 | 3 | 9 |

Impacts on economic activity related to recreation participation and spending under *Alternative 4 (Preferred Alternative)* would be similar in nature and timing to *Alternative 2*. See Section 4.21.4.1 for discussion.

### *4.21.6.2 Temporary Lodging Supply and Demand*

#### Construction

At the peak of construction, *Alternative 4 (Preferred Alternative)* would increase demand for temporary lodging requirements in the primary study area. Approximately 40 workers would need temporary lodging at the peak of the approximately 7-month construction period. Impacts would be generally the same as those described for *Alternative 2*; however, the specific numbers of workers would be less, leading to a smaller increase in demand on temporary lodging. The construction duration would also be shorter, lasting through just one summer recreation season instead of three. When peak construction overlaps with peak recreation visitation, some customary lodging customers may be displaced by construction workers. The impact would likely be limited to a handful of nights during the summer, when lodging facilities are at traditionally at full capacity. Workers or recreational users could find housing farther away from the project site, in Ellensburg or Yakima, where lodging options are more available even during the peak recreation season.

**Operation**

Because the long-term operation of *Alternative 4 (Preferred Alternative)* would require minimal additional workforce, 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 4 (Preferred Alternative)* would not have an impact on temporary lodging or housing in the long term.

#### *4.21.6.3 Property Values*

Impacts on property values under *Alternative 4 (Preferred Alternative)* would be similar in nature and timing to those under *Alternative 2*. See Section 4.21.4.3 for discussion.

#### *4.21.6.4 Irrigation Impacts*

Effects on irrigation and the resulting economic impacts under *Alternative 4 (Preferred Alternative)* would be similar in nature and timing to those under *Alternative 2*. See Section 4.21.4.4 for discussion.

### 4.21.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

*Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* would include construction of the KDRPP East Shore Pumping Plant and Volitional Bull Trout Passage Improvements (*Alternative 2*). The impacts from construction and operation of these components of *Alternative 5A* would be the same as described in Section 4.21.4. *Alternative 5A* would also include construction and operation of the KKC North Tunnel Alignment. The impacts of KKC North Tunnel Alignment are described below.

#### *4.21.7.1 Income and Employment*

**Construction**

Construction of the KKC North Tunnel Alignment would require an additional 30 workers over the construction period of approximately 3 years. At the peak of labor demand, there would be a total of 40 additional 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 in the primary study area.

Total employment in the four-county region associated with the KKC North Tunnel Alignment would be approximately 120 job years, 60 of which would be based upon direct impacts (Table 4-164 and Table 4-165). 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 4-164. KKC North Tunnel Alignment with Option B Construction Expenditures**

| Expenditure Category | Total Construction Spending | Spending in the 4-county Region | Spending in the Rest of Washington |
|---|---|---|---|
| Construction Labor ($ Millions) | $13.0 | $6.5 | $6.5 |
| Contractor, Equipment & Material Costs ($ Millions) | $188.1 | $18.8 | $112.8 |
| Taxes and other costs ($ Millions) | $39.8 | $4.3 | $35.4 |
| **Total** | **$240.8** | **$29.6** | **$154.8** |

**Table 4-165. KKC North Tunnel Alignment with Option B Construction Impacts, by Type**

| Region /Impact Measure | Direct | Indirect | Induced | Total Impacts |
|---|---|---|---|---|
| **4 County Region** | | | | |
| Output ($ Millions) | $29.6 | $6.2 | $9.6 | $45.4 |
| Personal Income ($ Millions) | $6.5 | $1.8 | $3.2 | $11.5 |
| Job Years | 60 | 20 | 40 | 120 |
| **Rest of Washington** | | | | |
| Output ($ Millions) | $154.8 | $58.4 | $263.3 | $476.4 |
| Personal Income ($ Millions) | $6.5 | $6.8 | $18.8 | $32.1 |
| Job Years | 60 | 90 | 130 | 280 |
| **Total Washington State** | | | | |
| Output ($ Millions) | $184.4 | $64.5 | $272.9 | $521.8 |
| Personal Income ($ Millions) | $13.0 | $8.7 | $21.9 | $43.6 |
| Job Years | 120 | 110 | 170 | 400 |

Totals may not sum because of rounding.

*Volitional Bull Trout Passage Improvements*

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as those described for *Alternative 2* (Section 4.21.4.1).

### Operation

The long-term operation and maintenance of 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 4-166 and Table 4-167). The average annual impact during operation on output, personal income, and employment these estimates represent is well below a 1 percent threshold for the impact indicators at the four-county regional level.

**Table 4-166. KKC North Tunnel Alignment with Option B Operating Expenditures**

| Expenditure Category | Total Expenditures of Average Year |
|---|---|
| Labor | $115,200 |
| Materials and equipment | $103,380 |
| **Total** | **$218,580** |

**Table 4-167. KKC North Tunnel Alignment with Option B Average Annual Operating Impacts, by Type, Rounded**

| Region/Impact Measure | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| **Four County Region** | | | | |
| Output | $218,580 | $55,909.33 | $103,589.28 | $378,079 |
| Personal income | $138,271 | $17,916 | $27,348 | $183,535 |
| Job years | 1.5 | 0.4 | 0.8 | 2.6 |
| **Rest of Washington** | | | | |
| Output | $0 | $26,180 | $15,661 | $41,841 |
| Personal income | $0 | $7,175 | $3,712 | $10,887 |
| Job years | 0.0 | 0.1 | 0.1 | 0.2 |
| **Total Washington State** | | | | |
| Output | $218,580 | $82,089 | $119,250 | $419,919 |
| Personal income | $138,271 | $25,091 | $31,060 | $194,422 |
| Job years | 1.5 | 0.5 | 0.9 | 2.9 |

### *4.21.7.2 Temporary Lodging Supply and Demand*

#### Construction

Impacts would be generally the same as those described for *Alternative 2*. At the peak of construction, construction of the KKC North Tunnel Alignment would increase demand for temporary lodging requirements in the primary study area. Approximately 20 additional workers, in addition to KDRPP 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 it is 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 is not 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 5A* would not impact temporary lodging conditions.

**Operation**

Because the long-term operation of the 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, the KKC North Tunnel Alignment would not have an impact on temporary lodging or housing in the long term.

#### *4.21.7.3 Property Values*

**Construction**

Impacts would be similar to those described for *Alternative 2* in Section 4.21.4.3. Some construction-related disruption (noise and 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**

KKC North Tunnel Alignment would not change reservoir levels relative to *Alternative 1* enough to have a potential adverse impact on property values.

#### *4.21.7.4 Irrigation Impacts*

The KKC North Tunnel Alignment would increase the overall water supply from the baseline for prorationed irrigators; however, the volume of water benefit would be minor, less than 1 percent TWSA, 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.

### 4.21.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation of *Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment* would be the same as described in Section 4.21.7 (*Alternative 5A*) for the North Tunnel; however, KDRPP would be constructed at the south shore location as described in Section 4.21.5 (*Alternative 3*) rather than the east shore location. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.21.7 (*Alternative 5A*).

### 4.21.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

The impacts of construction and operation of *Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment* would be the same as described in Section 4.21.7 (*Alternative 5A*) for the North Tunnel; however, the KDRPP floating pumping plant would be constructed as described in Section 4.21.6 (*Alternative 4*) rather than the east shore location. Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.21.7 (*Alternative 5A*).

### 4.21.10 Avoidance, Minimization and Mitigation Measures

The action alternatives would not cause negative socioeconomic impacts; therefore, no mitigation measures are proposed.

## 4.22 Environmental Justice

### 4.22.1 Methods and Impact Indicators

**Methods.** The individual resources analyzed in this chapter were reviewed to identify whether the alternatives would have disproportionately high and adverse human health or environmental impacts on Franklin County's Hispanic population in comparison with Kittitas, Yakima, and Benton counties. Franklin County qualifies as an environmental justice population for purposes of compliance with EO 12898 and with the guidance for conducting an environmental justice analysis (Federal Interagency Working Group on Environmental Justice NEPA Committee 2016). The impact indicators for environmental justice are described in Table 4-168.

### 4.22.2 Summary of Impacts

Environmental justice impacts are summarized in Table 4-168.

**Table 4-168. Summary of Impacts for Environmental Justice**

| Impact Indicator | Summary of Impacts |
|---|---|
| Disproportionate human health or environmental impacts | For all action alternatives:<br>• Earth and air quality- No impact<br>• Water resources, groundwater and water quality – No impact<br>• Socioeconomics - No data specific to Franklin County<br>• Health and safety – No impact |

#### *4.22.2.1 Earth and Air Quality*

The potential for fugitive dust ($PM_{2.5}$) and CO emissions that could cause health effects is minor across all four counties, and would remain within the NAAQS. There would be no disproportionate effects on the health of minority residents of Franklin County compared to Kittitas, Yakima, and Benton counties,

#### *4.22.2.2 Water Resources, Groundwater and Water Quality*

In drought years, there would be a reduction of water deliveries under all alternatives, but the deliveries downstream to the Roza Diversion Dam and Canal would not disproportionality affect Franklin County versus the others.  Franklin County does not receive any Yakima Project water.  There would be no disproportionate adverse effects on environmental justice populations as a result of changes to water resources, groundwater or water quality.

#### *4.22.2.3 Socioeconomics*

The socioeconomic analysis combined Franklin County with the others (including Yakima County where the Yakama Indian Reservation is located), so it is not possible to differentiate socioeconomic impacts of the alternatives on the Hispanic population in Franklin County. However, the analysis indicated that the economic effects of implementing any of the action alternatives would be beneficial.  Regardless of county, no measurable impacts on property values are predicted.

#### *4.22.2.4 Health and Safety*

For health and safety concerns related to the action alternatives, the primary concern is whether construction activities or operation would expose the public to safety hazards, including hazardous substances.  No impacts on worker or public health or safety are predicted and Project proponents are committed to safety and implementing risk reduction measures.  There would be no disproportionate adverse impacts on the health and safety of environmental justice populations.

#### *4.22.2.5 Other Resources*

The analysis of other resources in this chapter demonstrates that there would be no disproportionate high and adverse effects on environmental justice populations.  These resources include vegetation, fish and wildlife, visual quality, noise, recreation, land use, utilities and energy, traffic and transportation and cultural resources.

### 4.22.3 Avoidance, Minimization and Mitigation Measures

The action alternatives would not cause disproportionately high or adverse health or environmental effects on minority populations, low income populations or Indian tribes; therefore no avoidance, minimization, or mitigation measures are proposed.

## 4.23 Health and Safety

### 4.23.1 Methods and Impact Indicators

Reclamation and Ecology are committed to keeping workers and the public safe and reducing risks.  This section considers the potential impacts of the proposed action and alternatives on worker and public safety, including fire risk. It also considers the use, storage, or release of a hazardous substance or petroleum product. The potential impacts from the action alternatives are compared to existing conditions and the No Action Alternative. Table 4-169 lists the issues and impact indicators.

**Table 4-169. Impact Indicators for Health and Safety**

| Issue | Impact Indicator |
|---|---|
| Use, storage, or release of a hazardous substance or petroleum product | Evidence of presence of a hazardous substance or petroleum product in, on, or at a property. |
| Safety during construction and operation | Risk of an accident |
| Impacts to forest fire risk and firefighting capabilities. | Reducing access to water for firefighting. |

**Methods.** Reclamation conducted database surveys to identify known hazardous sites. It also analyzed aerial photography and bathymetry to determine potential safety hazards.

**Impact Indicators**. Impact indicators for 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

Only one underground storage tank was identified in the study area and it is not necessarily a recognized environmental condition (REC). Reclamation anticipates an increased safety risk associated with steep slopes around Kachess Reservoir from all action alternatives. In addition, under all action alternatives, the lower pool elevation on both Kachess and Keechelus reservoirs would increase the risk to boaters on the reservoirs. Compared with current conditions, there may be more exposure of submerged or formerly submerged hazards (such as rocks, tree stumps, and shoals). Although much of the reservoirs would be inaccessible to boaters during the lowest drawdown periods, these submerged hazards would present a risk to boaters.

The Volitional Bull Trout Passage Improvements would be implemented as part of all the action alternatives; no construction or operation impacts are anticipated. Table 4-170 summarizes the potential impacts.

**Table 4-170. Summary of Impacts for Health and Safety**

| Impact Indicator | Summary of Impacts |
|---|---|
| Evidence of presence of a hazardous substance or petroleum product in, on, or at a property | *Alternative 2* and *5A*. There is one location of concern, an underground storage tank, in the extended study area. Prior to acquiring land, a Phase I Environmental Site Assessment would be conducted to determine whether this is a REC or if whether other RECs are present.<br>*Alternative 3*, *4, 5B*, and *5C*. There are no known locations of concerns or RECs within the primary study area. |
| Risk of an accident | With all action alternatives, full drawdown would expose areas with steep slopes (greater than 20 degrees around Kachess Reservoir), which would present a safety hazard to people attempting to access the reservoir in those areas.<br>Exposure of formerly submerged boating hazards would have minor safety impact because boat launches would be above the reservoir pool elevation making access to the reservoir by boat difficult during low water periods. |
| Reducing access to water for firefighting. | For all action alternatives, operation of KDRPP would not increase fire risk in the area around Kachess Reservoir. The proposed new east shore boat ramp would provide year-round access to water in Kachess Reservoir for firefighting. |

### 4.23.3 Alternative 1 – No Action

Under existing conditions, there would be no health and safety impacts. A risk of hazardous material spill is present during construction of projects occurring under *Alternative 1* as described in Section 2.2. 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, and high wildland fire risk in some areas. *Alternative 1* would not change existing access to water for firefighting.

### 4.23.4 Alternative 2 – KDRPP East Shore Pumping Plant

#### *4.23.4.1 Construction*

**KDRPP East Shore Pumping Plant Facilities**

There is one location of concern, an underground storage tank, within the extended study area. Prior to acquiring land, a Phase I Environmental Site Assessment would be conducted to determine whether this is a REC or whether other RECs are present.

Construction would result in an increased risk of release of hazardous substances or petroleum products. Under *Alternative 2,* workers would be required to comply with all appropriate Federal (e.g., OSHA) and state laws and regulations, including those for managing hazardous waste (e.g., RCRA), and petroleum products (e.g., SPCC). By adhering to applicable laws, regulations, and construction best management practices, risks would be minimized.

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.

**Volitional Bull Trout Passage Improvements**

There are no known NPL sites in the primary study area (EPA, 2014b). The hazardous substances site located in the extended study area would not be disturbed by the proposed activities. Construction BMPs would be implemented to minimize the risk of releases of fuel, oil, solvent, and other potentially hazardous substances. If a release were to occur, the release would be reported to Reclamation and measures would be taken to avoid contamination of surface waters. Additional analysis of potential health and safety impacts would be developed as the design of these actions progresses. If sites containing hazardous substances 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**

**Public Safety.** The vertical distance from the Kachess Reservoir shoreline to the water could increase substantially over current conditions during drought relief pumping operations under *Alternative 2*. This change could create a risk to the general public attempting to access 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. Farther south, near the Kachess Ridge residential area, the areas exposed by full drawdown would be relatively flat and thus would 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. Steep slopes of greater than 20 degrees would be a potential safety hazard to the public. Project proponents would coordinate with reservoir users and the public to provide notice of drawdown and communicate potential hazards and safety measures the public should take if they are planning to access the reservoir.

Keechelus Reservoir levels would be up to 25 feet lower than existing conditions in years following a drought while the reservoir refills. Keechelus Reservoir thus would experience drawdown in the years following a drought and would have more area of steep slope than under present conditions. Although 25 feet of drawdown would occur, the decreased levels would likely expose slopes of greater than 20 degrees. Steep slopes of greater than 20 degrees would be a potential safety hazard to the public.

The lower pool elevation on both Kachess and Keechelus reservoirs would increase the risk to boaters on the reservoirs. Compared with current conditions, there may be more exposure of submerged or formerly submerged hazards (such as rocks, tree stumps, and shoals). Although much of the reservoirs would be inaccessible to boaters during the lowest drawdown periods, these submerged hazards would present a risk to boaters. Working with Reclamation, project proponents would communicate risks and safety measures to the public in advance of drought relief pumping.

Operation of *Alternative 2* would not change existing fire risk in the area surrounding Kachess Reservoir. The primary coniferous trees in this area (Douglas fir, western hemlock, western red cedar, ponderosa pine) rely on soil moisture present in the unsaturated zone that is derived from precipitation and snowmelt, not groundwater from below the water table. On average, the water table lies approximately 60 feet below ground surface, which is much deeper than the roots of these trees. Therefore forest health and wildfire susceptibility would not be impacted by reservoir drawdown effects on the groundwater table.

The project proponents will construct a boat ramp on the east shore of Kachess Reservoir near Kachess Dam that would provide access to surface water year round, and would be available to aid in firefighting. The firefighters would also continue to have access to water from the Kachess River downstream of Kachess Dam.

Aircraft operated by the USFS, Washington State Department of Natural Resources, and supporting agencies can be enlisted to fight wildfires in the central Cascade Range. Under *Alternative 2* water stored in Kachess Reservoir will remain accessible to aircraft for firefighting purposes. Reclamation would continue to coordinate with the local fire departments.

**Worker Safety.** The same issues and indicators identified above for construction could occur during operations, but such risks would be minimize by following Federal, State, and industry standards and codes.

### Volitional Bull Trout Passage Improvements

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2.*

## 4.23.5 Alternative 3 – KDRPP South Pumping Plant

### *4.23.5.1 Construction*

**KDRPP South Pumping Plant Facilities**

There are no known locations of concerns or RECs in the primary study area for *Alternative 3 - KDRPP South Pumping Plant*. All appropriate inquiry would be conducted prior to acquiring land for constructing the alternatives. Construction impacts would be the same as for *Alternative 2 – KDRPP East Pumping Plant* (Section 4.23.4.1).

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.23.4.1).

### *4.23.5.2 Operation*

**KDRPP South Shore Pumping Plant Facilities**

Long-term impacts would be the same as for *Alternative 2* (Section 4.23.4.2) because the reservoirs would experience the same level of drawdown.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.23.4.2).

## 4.23.6 Alternative 4 – KDRPP Floating Pumping Plant (Preferred Alternative)

### *4.23.6.1 Construction*

**KDRPP Floating Pumping Plant Facilities**

There are no known locations of concerns or RECs in the primary study area for *Alternative 4 (Preferred Alternative)*. All appropriate inquiry would be conducted prior to acquiring land for constructing the alternatives. Construction impacts would be the same as for *Alternative 2* (Section 4.23.4.1).

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.23.4.1).

#### *4.23.6.2 Operation*

**KDRPP Floating Pumping Plant Facilities**

Long-term impacts would be the same as for *Alternative 2* (Section 4.23.4.2) because the reservoirs would experience the same level of drawdown. Operations of *Alternative 4 (Preferred Alternative)* would include permanent presence of the pump barge, catenary anchors, and conveyance structures within Kachess Reservoir that could be encountered by recreational boaters. Signage would be included to indicate locations of these structures.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.23.4.2).

### 4.23.7 Alternative 5A – KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment

*Alternative 5A- KDRPP East Shore Pumping Plant with KKC North Tunnel Alignment* would include construction of the KDRPP East Shore Pumping Plant. The impacts from construction and operation of these components of *Alternative 5A* would be the same as described in Section 4.23.4. *Alternative 5A* would also include construction and operation of the KKC North Tunnel Alignment. The impacts of KKC North Tunnel Alignment are described below.

#### *4.23.7.1 Construction*

**KKC North Tunnel Alignment Facilities**

There are no known locations of concerns or RECs in the primary study area for *Alternative 5A*. All appropriate inquiry would be conducted prior to acquiring land for constructing the alternatives. Construction impacts would be the same as for *Alternative 2* (Section 4.23.4.1).

**Volitional Bull Trout Passage Improvements**

Construction impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.23.4.1).

#### *4.23.7.2 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.

**Volitional Bull Trout Passage Improvements**

Operation impacts associated with the Volitional Bull Trout Passage Improvements would be the same as described for *Alternative 2* (Section 4.23.4.2).

### 4.23.8 Alternative 5B – KDRPP South Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 3* (Section 4.23.5). Impacts would be the same as those associated with the North Tunnel discussed in *Alternative 5A* (Section 4.23.7.1). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.23.7.1 (*Alternative 5A*).

### 4.23.9 Alternative 5C – KDRPP Floating Pumping Plant with KKC North Tunnel Alignment

Impacts of construction and operation would be the same as those for *Alternative 4 (Preferred Alternative)* (Section 4.23.6.1). Impacts would be the same as those associated with the North Tunnel discussed in *Alternative 5A* (Section 4.23.7.1). Impacts of construction and operation of the Volitional Bull Trout Passage Improvements would be the same as described in Section 4.23.7.1 (*Alternative 5A*).

### 4.23.10 Avoidance, Minimization and Mitigation Measures

Project proponents are committed to safety and implementing risk reduction measures. These measures include designing the facilities according to applicable standards and codes; having construction crews comply with all applicable guidelines and standards construction practices for installing facilities, and limiting access to authorized and trained personnel.

BMPs would be implemented to minimize the risk and impacts of releases of fuel, oil, solvent, and other potentially hazardous substances. These BMPs would include identifying emergency spill containment procedures, training employees in the proper handling and response procedures for potential hazardous substances, and having appropriate spill containment materials onsite during construction and operations.

If incision of the Kachess River occurs at the head of the Big Kachess Reservoir, Reclamation would install signage and/or fences to warn or prevent public access, as appropriate, by the public until side slopes are flattened.

## 4.24 Relationship of the Proposed Action to the Integrated Plan

This section is included for SEPA purposes to summarize how the action alternatives meet the goals of the Integrated Plan. As described in Chapter 1, Reclamation and Ecology identified the Kachess Reservoir Drought Pumping Plant as necessary to help address water needs in the Yakima River basin.

As described in the Integrated Plan PEIS, The KDRPP alternatives 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 the prorationing percentage close to the Integrated Plan's 70 percent goal. Alternatives that include KKC 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 diversion would improve habitat for salmonids, including the ESA-listed bull trout and MCR steelhead. Incorporating Volitional Bull Trout Passage Improvements into the action alternatives would improve fish passage between Little and Big Kachess reservoirs.

The following are the Integrated Plan's specific goals that the proposed project supports:

- Provide opportunities for comprehensive watershed protection, ecological restoration, and enhancement by 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 climate change effects
- Contribute to the vitality of the regional economy and sustain the riverine environment

KDRPP would improve water supply to proratable irrigators by up to 22 percent in the worst single-drought years, thereby raising the proration percentage to about 53 percent of entitlement. This would be a benefit to water supply.

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. If the milestone is met, the TCF would continue to be managed to meet the Integrated Plan's goals, including habitat protection and restoration.

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 the operation of the Yakima Project. Reducing the artificially high summer flows in the Keechelus reach of the Yakima River is a high priority. With the KKC, summer flow targets in the Keechelus reach would be met in most years and would increase the productivity and abundance of spring Chinook salmon.

# 4.25 Cumulative Impacts Analysis

This section discusses the cumulative effects (or impacts) of the alternatives in the context of other past, present, and reasonably foreseeable future actions occurring in the region.

## 4.25.1 Regulatory Framework

Cumulative impacts are defined by CEQ regulations 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 other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." [40 CFR 1508.7]

Following CEQ guidance, the cumulative impact study area for identifying effects is expanded beyond the immediate project area, and includes past present and reasonably foreseeable actions within the study area that might affect the same resources of the environment as those described in Chapters 3 and 4. The impacts of past actions are incorporated into the affected environment description of Chapter 3 for each resource and represent a baseline for the consideration of cumulative effects. Present actions or projects (i.e. those that are under construction that are not yet part of the affected environment) and reasonably foreseeable future actions potentially affecting the same resources are described below. The effects of the alternatives in this EIS taken together with past, present and reasonably foreseeable actions form the basis of the cumulative effects analysis.

### *4.25.1.1 Present and Reasonably Foreseeable Future Actions*

Past and reasonably foreseeable future actions that have the potential to affect the same resources impacted by the alternatives in this EIS are described below, and the cumulative effect of the alternatives on these resources is described.

**Reclamation and Ecology Cle Elum Pool Raise Project**

Reclamation and Ecology are currently implementing the Cle Elum Pool Raise Project (CEPR) which involves raising the maximum water level of Cle Elum Reservoir by 3 feet, from a current maximum elevation of 2,240 to 2,243. The 2015 PEIS analyzed this alternative in the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan). The selected alternative was "Additional Storage Capacity for Instream Flow with Hybrid Shoreline Protection." The goal of implementing this alternative was to provide additional storage (14,600 ac-ft) to be managed for instream flows improvements in the lower Cle Elum River and in downstream reaches of the Yakima—which is located in the cumulative impact study area for this FEIS. Short-term construction effects were projected to occur over the 5-year construction period. Since construction is ongoing, there is a potential for construction effects. The long-term action is an operational change that could create cumulative impacts with respect to additional instream flows in the Yakima River for fish. These flows were included in the water resource analyses in Chapters 3 and 4.

**Washington Department of Transportation I-90 Snoqualmie Pass East Project**

The intent of WSDOT's I-90 Snoqualmie Pass East Project is to reduce vehicle congestion and improve safety along the 15-mile corridor of I-90 between Hyak and Easton. WSDOT's 2008 FEIS evaluated potential project impacts associated with widening the highway to six lanes, stabilizing rock slopes, replacing concrete pavement, adding vehicle capacity, and building wildlife crossings. The project also reduces road closures due to avalanches and rock slides. WSDOT has planned the I-90 Snoqualmie Pass East Project in three phases. The first phase is scheduled to be complete in 2018; the second phase is scheduled to be complete in 2019; and the final phase is currently in the planning stages. Cumulative impacts on those resources that might also be affected by implementation of an alternative in this FEIS include stormwater runoff or turbidity that could affect bull trout. Ongoing construction from this project would create beneficial impacts for wildlife and listed-species by providing passage and connectivity. Listed species were included in the analysis, but they were not predicted to have long-term effects.

**YRBWEP Phase II**

Public Law 103-434 Title XII Yakima River Basin Water Enhancement Project, October 31, 1994, as amended (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 cost-effective structural and nonstructural measures to increase the reliability of the irrigation water supply and enhance stream flows and fish passage for anadromous fish in the Yakima River Basin. Facility modifications; implementation of diversion reduction measures, the purchase or lease of land, water, or water rights from willing sellers for habitat improvements, habitat restoration, and changes in operations, management, and administration may be implemented to reduce the demand on the available water supply. In exchange for 65 percent Federal cost share, two-thirds of the water conserved under the Basin Conservation Program, will remain instream and will be used to increase flow requirements for anadromous fish. The current plan also includes improvements to Tribal water supply systems, enhancement of the Toppenish Creek Corridor, and an irrigation demonstration project for the Yakama Nation to enhance Tribal economic, fish, wildlife, and cultural resources. The total quantity of conserved water from completed and on-going conservation projects is 69,066 acre-feet which nets approximately an additional 100 cfs at Sunnyside Diversion Dam.

The following YRBWEP Phase II projects are ongoing:

- Sunnyside Division Board of Control Phase II Enclosed Lateral Improvement projects, which would conserve 6,565 acre-feet annually when construction is completed and it is operational in 2032
- Kittitas Reclamation District YRBWEP Phase II activities, which would conserve 48,500 acre-feet annually
- Yakama Nation Wapato Irrigation Project System Improvements and Demonstration Project, which is in progress and will improve irrigation efficiencies

**Integrated Plan (YRBWEP Phase III)**

The Integrated Plan identifies a comprehensive and balanced 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 water market reallocation. Of the seven elements in the Integrated Plan, 14 projects associated with the Enhanced Water Conservation Element and 23 projects associated with the Habitat/Watershed Protection and Enhancement Element have been funded by Ecology since 2013. Over half of the projects have been implemented through contracts between Ecology and entities providing funding.

The Enhanced Water Conservation Element has and will continue to provide future instream water to increase flow for anadromous fish and a more sustainable irrigation supply for farmers.

The Habitat/Watershed Protection and Enhancement Element will continue to improve habitat to assist in recovery of listed species.

An updated status of project implementation is provided in the *Yakima River Basin Integrated Water Resource Management Plan Implementation Status Report* (Ecology, 2018).

### 4.25.2 Cumulative Impacts by Resource

This section analyzes the cumulative impacts of the action alternatives on resources described in Chapters 3 and 4 of this FEIS, added to the effects of the effects of the Present and Reasonably Foreseeable Future Actions described above. A cumulative impact is the incremental effect of an alternative when considered with past, present and reasonably foreseeable future actions. While the EIS addresses the effects of alternatives on the range of resources representative of the human and natural environment, not all of those resources need to be included in the cumulative effects analysis – just those that indicate a direct or indirect effect will occur.

#### *4.25.2.1 Surface Water Resources including Reservoir Storage, Reservoir Elevations, Water Quality, Allocations, Releases, and Diversions*

In order to accurately capture future conditions, the modeling of the effects of the action alternatives on water resources took into consideration present and future actions; therefore, there would be no additional cumulative effects on water resources. Implementation of the Integrated Plan PEIS will continue to improve the condition of water resources in the Yakima River basin.

#### *4.25.2.2 Vegetation Including Wetlands and Floodplains*

As described in Chapter 3, the existence of the reservoirs, combined with natural succession, has led to the present status of vegetation communities across the cumulative impact study area. The reservoir pool elevations would continue to fluctuate under all alternatives and these fluctuations would continue to affect individual plants. However given the low probabilities of the reservoir surface water remaining at one elevation for a prolonged period, it is unlikely that substantial areas of vegetation would be affected.

Surrounding the Yakima Project reservoirs, USFS manages native vegetation to improve wildlife habitat. There are ongoing beneficial effects due to their fire management and non-native plant control program. These beneficial effects are expected to continue into the future.

While there is some potential for the spreading of noxious weeds in the short-term, as a cumulative impact of management by both USFS and Reclamation, noxious weeds are managed under existing integrated pest management frameworks and implemented through BMPs during construction activities. As a result, no increase in cumulative impacts on weeds is expected.

The US Army Corps of Engineers (USACE) is the federal agency tasked with protecting the nation's waters, along with Ecology which protects the State's waters. The USACE regulatory wetland program was put in place to mitigate the loss of wetlands and other waters of the U.S. through avoidance, minimization, and creation or restoration of wetland resources. The resulting USACE policy is "no net loss of wetland acres and/or function."

To determine the amount of wetlands that could be lost with Alternative 1 - No Action in the impact study areas, Reclamation and Ecology used data from the National Wetlands Inventory, as well as data on water-related land use from both agencies, and other site-specific information about projects listed above. According to these data, no jurisdictional wetlands are present in the study area. There are patches of emergent marsh plants in the sediment delta inflow area to the reservoirs, but these patches are not expected to become jurisdictional wetlands due to the repeated cycles of wetting and drying: the fluctuations are unlikely to support the development of hydric soils.

For floodplains in the cumulative impact study region, between USFS's and Reclamation's ongoing actions, there would be no change in base floodplains and no construction proposed in the 100- or 500-year floodplains that has not undergone prior NEPA analysis.

#### *4.25.2.3 ESA-listed Fish Species*

Cumulative impacts under NEPA are not the same as the definition of cumulative impacts under the ESA. For NEPA purposes, the cumulative impact on bull trout and steelhead is best measured by the changes in flows in the Yakima River below the dams. As described in Section 4.25.1, the effects of all of these past, present, and reasonably foreseeable actions were included in the modeling and impact assessment. There would be no cumulative impacts on listed species that have not already been described. Implementation of BTE projects and KRD Tributary Supplementation will have beneficial effects for listed species.

#### *4.25.2.4 Land Use*

The cumulative effects study area for land use includes the area around the two reservoirs, plus the rights of way that would be acquired for other facilities. Land use proposed for the implementation of the action alternatives is located in Kittitas County, which has approximately 454,087 acres of private land and approximately 660,783 acres of Federal lands. Federal land makes up 44 percent of Kittitas County and 30 percent of the State of Washington. The Preferred Alternative would require no or minimal acquisition real property and would represent a negligible change in land ownership as measured at the State and county levels. For all action alternatives, real property acquisitions or easements would include USFS and private lands. As per 1994 Public Law 103-434, as amended, Reclamation would acquire real property through the voluntary purchase or lease of land (YRBWEP, 1994).

With respect to the USFS Northwest Forest Plan and because a majority of the alternatives would be built in previously disturbed areas, the action alternatives would not change land use from current management plans and desired future conditions.

#### *4.25.2.5 Transportation*

When the I-90 Snoqualmie Pass East Project, the Cle Elum pool raise project, and the action alternatives in this FEIS are considered together, cumulative but temporary impacts on traffic and transportation would take place during construction of these projects. These impacts would include detours, construction work zones, and reduced speed limits. All the project proponents envision maintaining access to recreation facilities and residential property.

#### *4.25.2.6 Socioeconomics*

One of the purposes of the Yakima Project is to maintain water supply for irrigated agriculture which would continue into the future under the cumulative actions and all the action alternatives. When the impacts of the reasonably foreseeable future actions are added to those in this FEIS, there are no anticipated changes to farmland in production.

Simulation and analysis of socioeconomic conditions resulting from the action alternatives shows positive economic benefits to Yakima Project water users. In addition, users of project water may be able to better adapt to the future under climate change.

## 4.26 Relationship between Short-term Uses and Long-term Productivity

Section 42 USC 4332(C)(iv) of NEPA requires that an EIS discuss “the relationship between local short-term uses of man’s environment and the maintenance and enhancement of long-term productivity.” *See also* 40 CFR 1502.16. This section will discuss whether the construction and operation of the proposed action will involve short-term uses, otherwise described as impacts, of the environment that would effect, either positively or negatively, the long-term productivity of the environment.

This FEIS is tiered off the Integrated Plan PEIS which identifies a comprehensive and balanced long-term approach to water resources and ecosystem restoration improvements in the Yakima River basin. Consistent with Reclamation’s 2013 ROD, the Integrated Plan is anticipated to be implemented in phases over the next 30 years and is designed to enhance long-term productivity in the Yakima River basin. The Initial Development Phase (first 10-year period) includes the site-specific projects studied in this FEIS. These site specific projects are associated with two of the seven elements identified in the Integrated Plan’s long-term approach to enhancing the productivity of the basin: Structural and Operational Changes and Surface Water Storage. In addition, included as a feature of the project design are actions that provide long-term benefits to fish and that relate to a third element of the Integrated Plan and to short term goals such as implementation of the action alternatives from this FEIS. This would result in attainment of both short-term and long-term productivity goals of the Integrated Plan.

Notwithstanding the overarching long-term environmental benefits of the proposed action and the Integrated Plan as described in the Integrated Plan PEIS, the site specific proposals analyzed in this FEIS have some short term impacts, discussed below, that have either a positive or negative effect on the long term productivity of the environment.

**Short-term impacts** would include: construction impacts such as noise and emissions of particulate matter, motor vehicle traffic delay, some minor loss of recreational opportunities due to construction, loss of up to 0.7 acre of wetlands (which could be replaced) near Kachess Dam, and drawdown of Kachess Reservoir in drought years and for 2 to 5 years after drought years as the reservoir fills. Some additional recreational impacts would be displacement of boaters and anglers on Kachess Reservoir during drought year operations and subsequent refill years

Notably, the action alternatives would drawdown 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 *Alternative 1 - No Action* in 51 percent of years.

**Short-term benefits** would include: increased jobs and regional economic performance, and revenue generated during construction, and possible use of private funds (Roza's) to construct a public facility. Thus, the short-term impacts to the environment are outweighed by the long-term beneficial effects to productivity of the environment throughout the region related to the enhanced water management options in times of drought resulting from the Preferred Alternative. Adoption of the action alternatives, including the Preferred Alternative, would contribute to the long-term productivity and predictability of water use in the Yakima River basin and fulfill part of the first phase of the Integrated Plan as set forth in the 2013 ROD.

## 4.27 Unavoidable Adverse Impacts

Long-term impacts and unavoidable adverse effects would include: removal or loss of up to 22 acres of forest habitat if Alternative 5Ais selected, conversion of property ownership or uses for the project facilities, and visual impacts from the presence of the new facilities under all alternatives.

## 4.28 Irreversible and Irretrievable Commitments of Resources

Irreversible commitments are decisions affecting non-renewable resources such as soils, fossil fuels, or minerals. Such decisions are considered irreversible because their implementation would destroy the resource or cause it to become extinct or removed. The term irreversible describes the loss of future options and applies to impacts of using non-renewable resources or resources to the point that renewal could occur only over an extremely long time or at great expense. Irretrievable commitments of resources refers to actions resulting in the loss of production or use of natural resources. It represents opportunities foregone for the period of time that a resource cannot be used.

Implementation of the Proposed Action or other action alternatives, alone or in combination, would involve a commitment of a range of natural, physical, biological, cultural, and fiscal resources. Land used or acquired for the construction of the proposed facilities would be considered an irreversible commitment during the period that the land is used for the Yakima Project facilities. However, if a greater need arises for use of the land or if the pumping plant and related facilities are no longer needed, the land could be converted to another use.

Construction of the facilities would consume fossil fuels, human labor, and construction materials such as steel, cement, aggregate. Additionally large amounts of land and natural resources are used in manufacturing the construction materials. These materials are generally not retrievable, however, project proponents would make every effort to reduce, reuse, and recycle construction materials.

Construction could also involve a considerable one-time expenditure of Federal and/or State funds, which are not retrievable. However, Roza (and potentially participating Proratable Entities) would design, build, and operate the Preferred Alternative, which would not involve direct Federal funding.

The commitment of these resources is based on the benefit that would be gained by implementing the action alternatives, which fulfills in part the intent of Reclamation's 2013 Yakima Integrated Plan ROD and improves the management of the Yakima River basin water supply.

## 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 would have negligible impacts on energy resources.  Each alternative would have similar energy expenditures and impacts.

Operation of a pumping plant under the action alternatives would require construction of an electrical substation and a transmission line.  The pumping plant would consume additional electricity, up to 30 MW (Section 4.16), when operating during drought years.  The anticipated increase in electrical load falls within normal ratings for bulk electrical systems under normal operating conditions and would not be a significant impact on energy (Reclamation and Ecology, 2014i).

*(This page intentionally left blank)*

# 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. Public information activities would continue through future development of this project.

## 5.2 Public Involvement

Public involvement is a process in which agencies consult and include interested and affected individuals, organizations, agencies, and governmental entities in the decision-making process. In addition to providing information to the public regarding the DEIS and the SDEIS, 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 an EIS and to identify the significant issues related to a proposal.

On October 30, 2013, Reclamation published a NOI to prepare an EIS for the KDRPP and KKC projects in the Federal Register. Reclamation and Ecology issued a joint press release to Washington State media 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 EIS scope. Ecology also notified all those registered on its Integrated Plan list-serve by email 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 proposals 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 Scoping 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 would 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 WDSOT I-90 Snoqualmie Pass East Project Phase 2, and construction impacts.

Reclamation and Ecology prepared a Scoping Summary Report that summarized the comments received (Reclamation and Ecology, 2014g). 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: https://www.usbr.gov/pn/programs/yrbwep/2011integratedplan/index.html.

### 5.2.3 Comments on the DEIS

The public comment period for the DEIS began January 9, 2015, and concluded June 15, 2015. Reclamation and Ecology conducted public hearings February 3, 2015, and February 5, 2015, in Cle Elum and Ellensburg, Washington, respectively. Reclamation accepted written public comments and compiled public comments provided at the public hearings. Based on comments received on the DEIS, a new alternative along with new information and an updated evaluation of environmental impacts were added and a Supplemental DEIS (SDEIS) was published in April 2018. This FEIS presents revisions and additions to the SDEIS based on public comments provided on both the DEIS and SDEIS, and is intended to support a Record of Decision (ROD) by Reclamation.

### 5.2.4 Comments on the SDEIS

The public comment period for the SDEIS began April 13, 2018 and concluded July 11, 2018. Reclamation and Ecology provided a 90-day comment period and distributed information about the availability of the SDEIS and encouraged public review and comment. Reclamation and Ecology held public meetings May 16 and 17, 2018 in Cle Elum and Ellensburg, Washington, respectively. Reclamation and Ecology have considered all public comments provided in response to the DEIS and the SDEIS in the development of this FEIS. This FEIS includes the public comments, responses to those comments, and modifications to the SDEIS made in response to those comments.

### 5.2.5 Stakeholder Engagement

In addition to the public involvement described above, Reclamation and Ecology have coordinated with local landowners and residents throughout the EIS development process to provide project information and understand concerns, including the following outreach since publication of the DEIS:

- Meeting with Senator Maria Cantwell's staff (Ellensburg, August 18, 2015)
- Community outreach on well monitoring (Kachess Reservoir, April 28, 2016)
- Wells/groundwater information update meeting (Cle Elum, July 30, 2016)
- YRBWEP Technical Listening Session (April 5, 2017)
- Kachess Homeowners' Association presentation at YRBWEP Public Perspective Session (Yakima, June 21, 2017)
- YRBWEP Technical Listening Session (Yakima, April 5, 2017)
- Informational meeting with Save Lake Kachess organization (Seattle, May 29, 2018)

Current project information has been made available on Reclamation's website at https://www.usbr.gov/pn/programs/eis/kdrpp/ (KDRPP) and https://www.usbr.gov/pn/programs/eis/kkc/index.html (KKC).

## 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 BPA, NMFS, USFS, Yakama Nation, and the Service participate as cooperating agencies in the EIS. BPA and the 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 it would participate as a cooperating agency based on its jurisdictional responsibilities under the National Forest Management Act, as well as its 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. With the changes in project proponent roles described in Chapter 1, Roza is a state RO with Ecology for the SDEIS and this FEIS under the state SEPA law.

## 5.4 Tribal Consultation and Coordination

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. 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 has been and will continue to consult with the Confederated Tribes of the Colville Reservation and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) regarding issues of tribal concerns. The tribes received copies of the DEIS and the SDEIS, and will receive copies of this FEIS.

## 5.5 Compliance with Federal and State Laws and Executive Orders

In addition to the agency and Tribal coordination and consultation laws, EOs, and regulations described above, Reclamation will comply with the following laws and EOs on the KDRPP project.

### 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 NMFS that identifies threatened and endangered species within or near the action area. The agency then must evaluate impacts on those species. If the action may impact any ESA-listed species, the agency must consult with the Service or NMFS, or both.

Reclamation initiated consultation with the Service and NMFS on the KDRPP project through preparation of a Biological Assessment. Following review of the Biological Assessment, the Service and NMFS would be expected to issue a determination that addresses the effect of the projects on listed species.

### 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 YRBWEP 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 the KDRPP project. The Service determined that all impacts for KDRPP 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 included in or eligible for 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 whether there are properties of 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). Public involvement requirements under Section 106 of the NHPA are being met through agency public review and comment processes under NEPA.

Reclamation has determined that the Proposed Action would have an adverse effect to historic properties (Section 4.18). Reclamation has initiated consultation with the SHPO and with Native American Tribes (Section 5.4). As necessary, Reclamation will conduct additional cultural resource surveys of the Proposed Action areas prior to construction. Reclamation will continue consultation regarding impacts on 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 will 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 U.S., 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 on the aquatic environment. The guidelines in Section 404(b)(1) of the CWA describe this sequence.

Section 4.4 describes potential impacts on water quality. Reclamation will implement BMPs and other techniques to minimize the potential for erosion and sedimentation and turbidity impacts during construction, the most likely impact on 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 on 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 on 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 EO 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 on 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 a 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 are 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 EO.

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 action would not cause additional flooding in the reservoirs because they would cause reduced reservoir levels. The proposed action 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.

*(This page intentionally left blank)*

# REFERENCES

*(This page intentionally left blank)*

# References


| In-text Citation | Full Reference Information |
|---|---|
| Ackerman et al., 2002 | Ackerman, N., S. Cramer, and J. Carlson. 2002. *Estimation of Production Potential for Anadromous Salmonids above Keechelus Dam in the Yakima Basin*. Prepared for Yakima Basin Joint Board. |
| Anderson, 2006 | Anderson, E. 2006. Personal communication about bull trout survey results in upper Yakima Basin and discussion of data. |
| Anderson, 2014 | __________. 2014. Area Fish Biologist, Washington Department of Fish and Wildlife, Yakima, WA. Personal communication. |
| AINW, 2002 | Archaeological Investigations Northwest (AINW). 2002. *Data Recovery Treatments for Portions of the Keechelus Construction Camp Site, Safety of Dams Modification Project, Kittitas County, WA. Prepared for the Bureau of Reclamation*. |
| Auble et al., 2007 | Auble, G.T., P.B. Shafroth, M.L. Scott, and J.E. Roelle. 2007. "Early vegetation development on an exposed reservoir: Implications for dam removal." *Environmental Management* 39:806–818. |
| Beauchamp, 2016 | Beauchamp, D.A. 2016. Personal Communication. Phone call between Joe Miller, Anchor QEA; and Dave Beauchamp, Chief, Ecology Section USGS, Western Fisheries Research Center Seattle, WA |
| Berg and Fast, 2001 | Berg, L. and D. Fast. 2001. *Yakima Subbasin Summary, Draft.* Prepared for NPPC by the Yakima River Subbasin Team and the Province Budget Work Group [of the Columbia Basin Fish and Wildlife Authority]. Portland, Oregon. August 3, 2001. |
| Berger and Wells, 2017 | Berger C., and S. Wells, 2017. Food Web Structure of Kachess and Keechelus Reservoirs: Factors Affecting Bull Trout Production Model Development and Calibration. Portland State University, February 2017. Report prepared for Washington State Department of Ecology. |
| Bevelhimer and Adams, 1993 | Bevelhimer, M.S. and Adams, S.M. 1993. "A bioenergetics analysis of diel vertical migration by kokanee salmon, Oncorhynchus nerka." *Canadian Journal of Fisheries and Aquatic Sciences*, 50(11), pp.2336-2349. |

| In-text Citation | Full Reference Information |
|---|---|
| BLM, 2011 | Bureau of Land Management. 2011. Survey and Manage Species List: Categories from January 2001 ROD, December 2003, and 2011 Settlement Agreement. http://www.blm.gov/or/plans/surveyandmanage/files/02-sm_species_list_categories.xls. |
| Bonar et al., 2000 | Bonar, S.A., L.G. Brown, P.E. Mongillo, and K. Williams. 2000. "Biology, distribution and management of burbot (*Lota lota*) in Washington State." *Northwest Science* 74: 87–96. |
| Bosch, 2009 | Bosch, B. 2009. Fish Biologist, Yakama Nation, Toppenish, WA. Personal communication. |
| BPA, 2018 | Bonneville Power Administration. 2018. Record of Decision for the Melvin R. Sampson Hatchery, Yakima Basin Coho Project. April 2018. |
| BPA et al., 2018 | Bonneville Power Administration, US Army Corps of Engineers, and Bureau of Reclamation. 2018. *Climate and Hydrology Datasets for RMJOC Long-Term Planning Studies: Second Edition [RMJOC-II] Part I: Hydroclimate Projections and Analysis*. May 2018. |
| Braatne et al., 2007 | Braatne, J.H., R. Jamieson, K.M. Gill, and S.B. Rood. 2007. "Instream flows and the decline of riparian cottonwoods along the Yakima River, Washington, USA." *River Research and Applications* 23:247–267. |
| Brenkman et al., 2008 | Brenkman, S.J., Mumford, S.L., House, M., Patterson, C. 2008. "Establishing Baseline Information on the Geographic Distribution of Fish Pathogens Endemic in Pacific Salmonids Prior to Dam Removal and Subsequent Recolonization by Anadromous Fish in the Elwha River, Washington." *Northwest Science* 82, 142–152. doi:10.3955/0029-344X-82.S.I.142. |
| Brook and Woodward, 1956 | Brook, A.J. and W.B. Woodward. 1956. "Some observations on the effects of water inflow and outflow on the plankton of small lakes." *Journal of Animal Ecology* 25:22-35. |
| Bruijin and Clark, 2003 | Bruijn, H., and Clark S. E. 2003. Research and Development of Effective Suspended Solids Removal from Storm Water Runoff in Collection Systems Using In-Line Lamella Plate Separators. Terrehill Concrete Products.<br>https://www1.villanova.edu/content/dam/villanova/engineering/vcase/sym-presentations/2003/2C4.pdf.<br>Accessed May 15, 2013. |

| In-text Citation | Full Reference Information |
|---|---|
| Bryant and Parkhurst, 1950 | Bryant, F.G. and Z.E. Parkhurst. 1950. *Survey of the Columbia River and its Tributaries, Part 4: Area III, Washington Streams from the Klickitat and Snake Rivers to Grand Coulee Dam, with Notes on the Columbia and its Tributaries above Grand Coulee Dam.* U.S. Fish and Wildlife Service Special Science Report: Fisheries. No. 37. |
| Burns and Honkala, 1990 | Burns, R.M., and B. H. Honkala, tech. coords. 1990. *Silvics of North America: 1. Conifers; 2. Hardwoods.* Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC. Volume 2. |
| Busch and Smith, 1995 | Busch, D. E., and S. D. Smith. 1995. "Mechanisms associated with decline of woody species in riparian ecosystems of the southwestern U.S." *Ecological Monographs* 65:347–370. |
| Carpenter et al., 1985 | Carpenter, S.R., J.F. Kitchell, and J.R. Hodgson. 1985. "Cascading trophic interactions and lake productivity." *BioScience* 35: 634–639. |
| Carter and Erickson, 1992 | Carter, H.R., and R.A. Erickson. 1992. Status and conservation of the marbled murrelet in California, 1982-1987. Pages 92-108 in *Status and conservation of the marbled murrelet in North America*, H.R. Carter and M.L. Morrison, eds. Proc. West Found. Vertebr. Zool. 5. |
| Central Washington University, 2014 | Central Washington Anthropological Society. 2014. *Pedestrian Survey and Limited Subsurface Testing of Proposed Drill Hole Sites for the Keechelus-to-Kachess Proposed Conveyance Project.* October 2014. Prepared for Bureau of Reclamation- Pacific Northwest Region Columbia Cascades Area Office and Washington State Department of Archaeology and Historic Preservation. Prepared by S.M. Stcherbinine, A.R. Taylor, P. Garrison, and S.M.H. Steinkraus. Ellensburg, WA: Central Washington University. |
| CEQ, 1997 | Council on Environmental Quality. 1997. *Environmental Justice, Guidance Under the National Environmental Policy Act*. December 10, 1997. Pages 25-27. https://www.epa.gov/sites/production/files/2015-02/documents/ej_guidance_nepa_ceq1297.pdf. . Accessed October 3, 2014. |
| Columbia River DART, 2017 | Columbia River DART. 2017. Columbia Basin Research, University of Washington. http://www.cbr.washington.edu. |

| In-text Citation | Full Reference Information |
|---|---|
| Conley et al., 2009 | Conley, A., J. Freudenthal,D. Lind, P. Mees., and R. Visser. 2009. *Yakima Steelhead Recovery Plan, Extracted from the 2005 Yakima Subbasin Salmon Recovery Plan with Updates.* August 2009. |
| Cooke and Azous, 1997 | Cooke, S. and A. Azous. 1997. "The hydrologic requirements of common Pacific Northwest wetland plant species." Pages 154-169 in Azous, A. L., and R.H. Horner, eds. *Wetlands and Urbanization, Implications for the Future.* Final Report of the Puget Sound Wetlands and Stormwater Management Research Program. Washington State Department of Ecology, King County Water and Land Resources Division, and University of Washington. |
| Copeland et al., 2010 | Copeland, J. P., K. S. Mckelvey, K. B. Aubry, A. Landa, J. Persson, R. M. Inman, J. Krebs, E. Lofroth, H. Golden, J. R. Squires, A. Magoun, M. K. Schwartz, J. Wilmot, C. L. Copeland, R. E. Yates, I. Kojola, and R. May. 2010. The bioclimatic envelope of the wolverine (Gulo gulo): do climatic constraints limit its geographic distribution? Canadian Journal of Zoology 88:233-246. |
| Corps and Ecology, 2014 | U.S. Army Corps of Engineers and Washington State Department of Ecology. 2014. Joint Public Notice: Application for a Department of the Army Permit Reference No. 2007-2080-DOT. http://www.ecy.wa.gov/programs/sea/fed-permit/pdf/200702080JPN2.pdf. |
| Cowardin et al., 1979 | Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States*. Washington, DC: U.S. Fish and Wildlife Service.<br>FWS/OBS-70/31. |
| Creech and Stuart, 2016 | Creech, J. and Stuart T. 2016. Upper Yakima Tributaries Temperature Total Maximum Daily Load. Water Quality Report and Implementation Plan. Ecology Publication Number 14-10-037. Olympia, WA. |
| Cuffney et al., 1997 | Cuffney, T.F., M.R. Meador, S.D. Porter, and M.E. Gurtz. 1997. *Distribution of Fish, Benthic Invertebrate, and Algal Communities in Relation to Physical and Chemical Conditions, Yakima River Basin, Washington, 1990.* Raleigh, North Carolina: U.S. Geological Survey, Water Resources Investigations Report 96-4280. |

| In-text Citation | Full Reference Information |
|---|---|
| Daniel et al., 1994 | Daniel, T.C., A.N. Sharpley, D.R. Edwards, R. Wedepohl, and J.L. Lemunyon. 1994. Minimizing surface water eutrophication from agriculture by phosphorus management. *Journal of Soil and Water Conservation*. 49(2):30-37 |
| Davidson, 1953 | Davidson, F. A. 1953. *Historical Notes on Development of Yakima River Basin.* Manuscript report. Portland, OR: National Marine Fisheries Service, Environmental and Technical Services Division. |
| Dean Potter and Associates, Inc., 2015 | Dean Potter and Associates, Inc. 2015. Real Property Value Impacts Study in Connection with Kachess Drought Relief Pumping Plant-PN (KDRPP). File No. 2256. December 2015. |
| Deichl et al., 2011 | Deichl, C., A. Hackett, D. Pierson, J. Sandberg, and J. Slavick. 2011. *Gold Creek: Development to Restoration.* June 2011. U.S. Forest Service, Okanogan/Wenatchee National Forest. |
| Dettmers et al., 2003 | Dettmers, J.M., M.J. Raffenberg, and A.K. Weis. 2003. “Exploring zooplankton changes in Southern Lake Michigan: Implications for yellow perch recruitment.” *Journal of Great Lakes Research* 29: 355–364. |
| DNR, 2014a | Washington Department of Natural Resources. 2014. Washington Natural Heritage Program Geographic Information System: WNHP Data Set. Shapefiles received February 2014. |
| DNR, 2014b | __________. 2014. *Washington Natural Heritage Program Field Guide to Selected Rare Plants.* https://www.dnr.wa.gov/NHPfieldguide . Accessed April 2014. |
| Department of the Interior, 1995 | U.S. Department of the Interior. 1995. *Departmental Manual Part 512*, Chapter 2. |
| Department of the Interior, 2000 | __________. 2000. *Departmental Manual Part 303*, Chapter 2.7 A. |
| Dirnberger and Weinberger, 2005 | Dimberger, J.M. and J. Weinberger. 2005. Influences of lake level changes on reservoir water clarity in Alltoona Lake, Georgia. *Lake and Reservoir Management* 21(1):24-29. |
| Downey and McCauley, 1992 | Downing, J.A. and E. McCauley. 1992. The nitrogen:phosphorus relationship in lakes. *Limnol. Oceanogr.* 37(5):936-945. |

| In-text Citation | Full Reference Information |
|---|---|
| Dubendorfer, 2002 | Dubendorfer, T. 2002. *Wetland Impact Analysis and Proposed Wetland Mitigation on the Keechelus Dam Project, Kittitas County, Washington.* April 8, 2002. Prepared for Bureau of Reclamation, Upper Columbia Area Office. |
| Dunham et al., 2001 | Dunham, J., B. Rieman, and K. Davis. 2001. "Sources and magnitude of sampling error in redd counts for bull trout." *North American Journal of Fisheries Management* 21: 343–352. |
| Easton School District, 2014 | Easton School District. 2014. *Bus Service*. http://www.easton.wednet.edu/busservice.html. Accessed on December 22, 2014. |
| Eaton and Scheller, 1996 | Eaton, J.G. and R.M. Scheller. 1996. "Effects of climate warming on fish thermal habitat in streams of the United States." *Limnol. Oceanogr.* 41: 1109–1115. |
| Ecology, 1995 | Washington State Department of Ecology. 1995. *1994 Statewide Water Quality Assessment Lakes Chapter*. https://fortress.wa.gov/ecy/publications/documents/95311.pdf . Accessed July 1, 2014. |
| Ecology, 1996 | __________. 1996. *Lake Water Quality Assessment Program*. Publication No. 96-304. Olympia, WA. |
| Ecology, 1998 | __________. 1998. *Lower Yakima River Suspended Sediment TMDL*. Publication No. 98-10-202. Prepared by the Washington Department of Ecology. August 1998. |
| Ecology, 2003 | __________. 2003. *Wenatchee National Forest Water Temperature Total Maximum Daily Load: Technical Report.* https://fortress.wa.gov/ecy/publications/publications/0310063.pdf. Accessed July 24, 2014. |
| Ecology, 2004 | __________. 2004. *Stormwater Management Manual for Eastern Washington.* Publication No. 04-10-076. Olympia, WA. |
| Ecology, 2007 | __________. 2007. *Chlorinated Pesticides, PCBs, and Dioxins in Yakima River Fish in 2006: Data Summary and Comparison to Human Health Critieria.* Publication No. 07-03-036. |
| Ecology, 2011 | __________. 2011. *Guidance for Ecology Including Greenhouse Gas Emissions in SEPA Reviews*. June 3, 2011. |
| Ecology, 2012a | __________. 2012. *Project Update for the Lower Yakima River Suspended Sediment TMDL.* Publication No. 12-10-034. |

| In-text Citation | Full Reference Information |
|---|---|
| Ecology, 2012b | __________. 2012. *Surface Water Quality Standards for the State of Washington. Chapter 173-201A WAC.* Publication No. 06-10-091. |
| Ecology, 2014a | __________. 2014. *Construction NPDES Stormwater Permit.* https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Stormwater-general-permits/Construction-stormwater-permit Accessed August 6, 2014. |
| Ecology, 2014b | __________. 2014. Environmental Information Management System: Groundwater Search. https://fortress.wa.gov/ecy/eimreporting/Groundwater/GWSearch.aspx?SearchType=Groundwater&State=newsearch&Section=all. Accessed October 15, 2014. |
| Ecology, 2014c | __________. 2014. *Determining if Areas within Washington meet National Air Quality Standards*. https://ecology.wa.gov/Regulations-Permits/Plans-policies/Areas-meeting-and-not-meeting-air-standards. Accessed January 27, 2014. |
| Ecology, 2014d | __________. 2014. *River and Stream Water Quality Monitoring – Station 39A090 (Yakima River).* https://fortress.wa.gov/ecy/eap/riverwq/station.asp?theyear=&tab=notes&scrolly=0&sta=39A090 . Accessed September 24, 2014. |
| Ecology, 2014e | __________. 2014. *EPA Approved Water Quality Assessment.* https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-improvement/Assessment-of-state-waters-303d/EPA-approved-assessment . Accessed August 6, 2014. |
| Ecology, 2014f | __________. 2014. *State Hazardous Materials Sites Map.* https://fortress.wa.gov/ecy/facilitysite/MapData/MapSearch.aspx?RecordSearchMode=New. Accessed September 16, 2014. |
| Ecology, 2014g | __________. 2014. *Upper Yakima River Tributaries Temperature Total Maximum Daily Load: Water Quality Improvement Report and Implementation Plan- DRAFT.* https://fortress.wa.gov/ecy/publications/publications/1410037.pdf. Accessed July 25, 2014. |
| Ecology, 2014h | __________. 2014. Washington State Well Log Viewer. https://fortress.wa.gov/ecy/waterresources/map/WCLSWebMap/default.aspx. Accessed October 15, 2014. |

| In-text Citation | Full Reference Information |
|---|---|
| Ecology, 2016a | __________. 2016. Ecology Ambient Water Quality Monitoring Station 39A090 Upper Yakima River near Cle Elum. Web site visited on August 24, 2016. Website: https://fortress.wa.gov/ecy/eap/riverwq/station.asp?theyear=&tab=wqi&scrolly=0&wria=39&sta=39A090 |
| Ecology, 2016b | __________. 2016. Ecology Water Quality Assessment and 303(d) List. Data search August 24, 2016. https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-improvement/Assessment-of-state-waters-303d |
| Ecology, 2016c | __________. 2016. *Upper Yakima River Tributaries Temperature Total Maximum Daily Load. Water Quality Improvement Report and Implementation Plan.* Publication No. 14-10-037 |
| Ecology, 2016d | __________. 2016. Kachess Reservoir Groundwater and Reservoir Level Monitoring Data, Preliminary Draft Technical Memo.<br>March 15, 2016. |
| Ecology, 2018 | __________. 2018. *Yakima River Basin Integrated Water Resource Management Plan Implementation Status Report*. Publication Number 18-12-005. May 2018. |
| Edwards et al., 1983 | Edwards, E.A., H. Li, and C.B. Schreck. 1983. *Habitat Suitability Index Models: Longnose Dace.* U.S. Fish and Wildlife Service. FWS/OBS-82/10.33. |
| Ellis et al., 2011 | Ellis, B.K., J.A. 2011. Stanford, D. Goodman, C.P. Stafford, D.L. Gustafson, D.A. Beauchamp, D.W. Chess, J.A. Craft, M.A. Deleray, and B.S. Hansen. 2011. "Long-term effects of a trophic cascade in a large lake ecosystem." *Proceedings of the National Academy of Sciences* 108:1070–1075. |
| EIA, 2016 | Energy Information Administration (EIA). 2016. *Voluntary Reporting of Greenhouse Gases Program*. From Appendix E of the instructions to Form EIA-1605. https://www.eia.gov/environment/pdfpages/0608s(2009)index.php. Accessed November 2016. |
| EPA, 2010 | U.S. Environmental Protection Agency. 2010. *Level III and IV Ecoregions of Washington.* ftp://ftp.epa.gov/wed/ecoregions/wa/wa_eco.pdf. |
| EPA, 2014a | __________. 2014. EPA STORET database search. https://www.epa.gov/waterdata/water-quality-data-wqx. Accessed August 21, 2014. |

| In-text Citation | Full Reference Information |
|---|---|
| EPA, 2014b | __________. 2014. *Superfund (CERCLA) in the Pacific Northwest and Alaska.* http://www.epa.gov/superfund/sites/npl/. Accessed September 16, 2014. |
| EPA, 2016 | __________. 2016. Storet Database Search. Search conducted by Anchor QEA on October 28, 2016. https://www.epa.gov/waterdata/water-quality-data-wqx |
| Fast et al., 1991 | Fast, D., J. Hubble, M. Kohn, and B. Watson. 1991. *Yakima River Spring Chinook Enhancement Study.* Final report submitted to Bonneville Power Administration, Portland, Oregon. DOE/BP-39461-9. |
| FHWA, 2006 | Federal Highway Administration. 2006. *Roadway Construction Noise Model User's Guide.* FHWA-HEP-05-054. January 2006. |
| Fisher and LaVoy, 1972 | Fisher, S.G. and A. Lavoy. 1972. "Differences in littoral fauna due to fluctuating water levels below a hydroelectric dam." *Journal of the Fisheries Research Board of Canada* 29:1472–1476. |
| Flotlin, 2011 | Flotlin, K. 2011. E-mail containing information on yellow-billed cuckoo surveys in the Columbia River. September 29, 2011. |
| Fraley and Shepard, 1989 | Fraley, J.J. and B.B. Shepard. 1989. "Life history, ecology, and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake river system, Montana." *Northwest Science* 63(4): 133-143. |
| Francis et al., 2009 | Francis, C.D., C.P. Ortega, and A. Cruz. 2009. "Noise pollution changes avian communities and species interactions." *Current Biology* 19:1415–1419. |
| Fraterrigo and Downing, 2008 | Fraterrigo, J.M. and J. M. Downing. 2008. The influence of land use on lake nutrients varies with watershed transport capacity. *J.A. Ecosystems*. 2008 (11):1021. https://doi.org/10.1007/s10021-008-9176-6 |
| Fulton, 1970 | Fulton, L.A. 1970. *Spawning Areas and Abundance of Steelhead Trout and Coho, Sockeye, and Chum Salmon in the Columbia River Basin—Past and Present*. U.S. Department of Commerce, NOAA, National Marine Fisheries Service. Special Scientific Report—Fisheries No. 618. |

| In-text Citation | Full Reference Information |
|---|---|
| Furey et al., 2004 | Furey, P.C., R.N. Nordin, and A. Mazumder. 2004. “Water level drawdown affects physical and biogeochemical properties of littoral sediments of a reservoir and a natural lake.” *Lake and Reservoir Management* 20:280–295. |
| Gabrielson and Jewett, 1970 | Gabrielson, I.N. and S.G. Jewett. 1970. *Birds of the Pacific Northwest, with Special Reference to Oregon.* New York: Dover Publications. |
| Gadomski et al., 2001 | Dena M. Gadomski, Craig A. Barfoot, Jennifer M. Bayer and Thomas P. Poe. 2001. Early Life History of the Northern Pikeminnow in the Lower Columbia River Basin, Transactions of the American Fisheries Society, 130:2, 250-262, DOI: 10.1577/1548-8659(2001)130<0250:ELHOTN>2.0.CO;2 |
| Garvey-Darda, 2014 | Garvey-Darda, P. 2014. Personal Communication. Wildlife Biologist. U.S. Forest Service. Cle Elum, Washington. |
| Goodwin and Westley, 1967 | Goodwin, C.L., and R. Westley. 1967. *Limnological Survey of Kachess, Keechelus, and Cle Elum Reservoirs, Summary Report.* State of Washington Department of Fisheries. |
| Google Maps, 2016 | Google Maps. 2016. *Yakima, Washington and Vicinity [search terms “lodging, hotels, campgrounds, RV parks”].* https://www.google.com/maps/place/. Accessed December 25, 2014. |
| Gregory and Levings, 1998 | Gregory, R.S., and C.D. Levings. 1998. “Turbidity reduces predation on migrating juvenile Pacific salmon.” *Transactions of the American Fisheries Society* 127:275–285. |
| Hallock and Mongillo, 1998 | Hallock, M. and P.E. Mongillo. 1998. *Washington State Status Report for the Pygmy Whitefish.* Washington Department of Fish and Wildlife. |
| Hansen, 2013 | Hansen, A.G., Beauchamp, D.A., Schoen, E.R. 2013. Visual Prey Detection Responses of Piscivorous Trout and Salmon: Effects of Light, Turbidity, and Prey Size. Transactions of the American Fisheries Society 142, 854–867. doi:10.1080/00028487.2013.785978 |
| Hansen et al., 2017 | Hansen, A.G., M. Polacek, K.A. Connelly, J.R. Gardner, and D.A. Beauchamp. 2017. Food web interactions in Kachess and Keechelus Reservoirs, Washington: implications for threatened adfluvial bull trout and management of water storage. Final Report prepared for Washington State Department of Ecology. |

| In-text Citation | Full Reference Information |
|---|---|
| Hanson and Hatch, 1998 | Hanson, T. R., and Hatch, L. U. 1998. *Impact of Reservoir Water Level Changes on Lakefront Property and Recreational Values*. Mississippi State University. |
| Hanson et al., 2002 | Hanson, T. R., Hatch, L. U., and Clonts, H. C. 2002. "Reservoir Water Level Impacts on Recreation, Property, and Nonuser Values." *Journal of the American Water Resources Association,* 38(4), 1007-1018. |
| Hanson et al., 2015 | Hanson, Adam, David A. Beauchamp, and Matt Polacek. 2015. Evaluation of factors affecting bull trout and kokanee production in Kachess and Keechelus Reservoirs, Yakima Basin, Washington. February 2015. Prepared for the Washington Department of Ecology. |
| Hanson et al., 2017 | Hanson, Adam, Matt Polacek, Kristin Connelly, Jennifer Gardner, and David Beauchamp. 2017. Food web interactionsin Kachess and Keechelus Reservoirs, Washington: Implications for threatened adfluvial bull trout and water storage management. January 2017. Prepared for the Washington Department of Ecology. |
| Haring, 2001 | Haring, D. 2001. *Salmonid Habitat Limiting Factors Analysis – Yakima River Watershed. Watershed Resource Inventory Areas 37-39.* Washington State Conservation Commission. |
| Hayward and Van Den Avyle, 1986 | Hayward, R.S. and M.J. Van Den Avyle. 1986. "The nature of 1986 zooplankton spatial heterogeneity in a nonriverine impoundment." *Hydrobiologia* 131:261-271. |
| Hawkins, 2015 | Hawkins, A.D. 2015. *Sound and vibration effects on migrating adult and juvenile salmon at hydropower projects, construction projects, and in the natural environment, draft literature synthesis*. Report to the U. S. Army Corps of Engineers, Walla Walla District on behalf of Anchor QEA, LLC. September 2015. |
| Hawkins and Johnstone, 1978 | Hawkins, A.D., and Johnstone, A.D.F. 1978. The hearing of the Atlantic Salmon, Salmo salar. Journal of Fish Biology 13:655-673. |
| Henley et al., 2000 | Henley, W.F., M.A. Patterson, R.J. Neves, and A.D. Lemly. 2000. "Effects of sedimentation and turbidity on lotic food webs: A concise review for natural resource managers." *Fisheries Science* 8: 125–139. Doi:10.1080/10641260091129198. |

| In-text Citation | Full Reference Information |
|---|---|
| Hickman and Raleigh, 1982 | Hickman, T. and R. F. Raleigh. 1982. *Habitat Suitability Index Models: Cutthroat Trout.* U.S Fish and Wildlife Service. FWS/OBS-82/10.5. |
| Hiebert, 1999 | Hiebert, S. 1999. *Draft Progress Report on Limnological Surveys of Five Reservoirs in the Upper Yakima River Basin Washington.* Bureau of Reclamation, Denver, Colorado. |
| Hockersmith et al., 1995 | Hockersmith, E., J.Vella, L. Stuehrenberg, R.N. Iwamoto, and G. Swan. 1995. *Yakima River Radio-telemetry Study: Steelhead, 1989-93*. Report to U.S. Department of Energy, Bonneville Power Administration, by Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington. Project No. 89-089, Contract No. DE-AI79-89BP00276. |
| Howard and Wells, 2009 | Howard, R.J., and C.J. Wells. 2009. “Plant community establishment following drawdown of a reservoir in southern Arkansas, USA.” *Wetlands Ecol Manage* (2009) 17:565–583. |
| Hruby, 2004 | Hruby, T. 2004. *Washington State Wetland Rating System for Western Washington – Revised.* Washington State Department of Ecology Publication No. 04-06-025. |
| Hubble, 2014a | Hubble, J. 2014. Fish Biologist, Bureau of Reclamation. Personal communication, September 2, 2014. |
| Hubble, 2014b | __________. 2014. Memo re: Expected Improvement in Fish Productivity in the Keechelus Reach with Implementation of the Proposed Keechelus-to-Kachess Conveyance (KKC). October 28, 2014. |
| Hupner and Lewandowski, 2008 | Hupfer, M. and J. Lewandowski. 2008. Review Paper: Oxygen controls phosphorus release from lake sediments – a long-lasting paradigm in Limnology. Internat. Rev. Hydrobiol. 93 (4-5):415-432. |
| Hurley, 2011. | Hurley, W. 2011. Case Study: Determination of Effects, Cle Elum Dam Fish Passage Facilities, Yakima Project, Washington. United States Bureau of Reclamation. Prepared by Warren F.X. Hurley. |
| Hyatt and Stockner, 1985 | Hyatt, K.D., and J.G. Stockner. 1985. “Responses of sockeye salmon (*Oncorhynchus nerka*) to fertilization of British Columbia coastal lakes.” *Can. J. Fish. Aquat. Sci.* 42: 320–331. doi:10.1139/f85-041. |

| In-text Citation | Full Reference Information |
|---|---|
| IMPLAN, 2014 | IMPLAN Group, LLC. 2014. IMPLAN System (data and software) 2014. 16740 Birkdale Commons Parkway, Suite 206, Huntersville, NC 28078 www.IMPLAN.com. |
| Institute of Transportation Engineers, 1989 | Institute of Transportation Engineers. 1989. *Traffic Access and Impact Studies for Site Development.* Washington, DC: Transportation Planners Council. September 1989. |
| ISO, 1996 | International Standards Organization Standard 9613-2 Acoustics – Attenuation of sound during propagation outdoors. 1996. https:www.iso.org/standard/20649.html. |
| James, 2002 | James, P.W. 2002. *Population Status and Life History Characteristics of Bull Trout in the Yakima River Basin, Final Report.* Bureau of Reclamation, Upper Columbia Area Office. |
| Jensen et al., 1982 | Jensen, A.L., S.A. Spigarelli, and M.M. Thommes. 1982. "Use of conventional fishery models to assess entrainment and impingement of three Lake Michigan fish species." *Transactions of the American Fisheries Society* 111:21–34. doi:10.1577/1548-8659(1982)111<21:UOCFMT>2.0.CO;2. |
| Jewett et al., 1953 | Jewett, S. G., W. P. Taylor, W. T. Shaw, and J. W. Aldrich. 1953. *Birds of Washington State.* Seattle: University of Washington Press. |
| Johnson, 1991 | Johnson, O. W., T. A. Flagg, D. J. Maynard, G. B. Milner, and F. W. Waknitz. 1991. *Status Review for Lower Columbia River Coho Salmon.* NMFS/NWFSC, Seattle. |
| Johnston, 2006 | Johnston, M. 2006. Fish Biologist, Yakama Nation. Personal communication. |
| Jude et al., 2013 | David J. Jude , Yu Wang , Stephen R. Hensler and John Janssen. 2013. Burbot Early Life History Strategies in the Great Lakes, Transactions of the American Fisheries Society, 142:6, 1733-1745, DOI: 10.1080/00028487.2013.795192 |
| Karl et al., 2009 | Karl, T.R., J.M. Melillo, T.C. Peterson, and S.J. Hassol, eds. 2009. *Global Climate Change Impacts in the United States.* Cambridge University Press. |
| Kayhanian et al, 2001 | Kayhanian, M., Murphy, K., Regenmorter, L., and Haller, R. 2001. Characteristics of storm-water runoff from highway construction sites in California. Transportation Research Record, 1743, 33-40. http://dx.doi.org/10.3141/1743-05. |

| In-text Citation | Full Reference Information |
|---|---|
| Kercher and Zedler, 2004 | Kercher and Zedler. 2004. "Flood tolerance in wetland angiosperms: a comparison of invasive and noninvasive species." *Aquatic Botany* 80: 89-102. |
| King, 2013 | King, T. F. 2013. *Cultural Resource Laws and Practice*. 4th ed. New York: AltaMira Press. |
| King County, 2007 | King County. 2007. *King County Biodiversity Report.* King County Water and Land Resources Division, Department of Natural Resources and Parks. https://www.kingcounty.gov/services/environment/animals-and-plants/biodiversity/king-county-biodiversity-report.aspx. Accessed September 2012. |
| Kinnison and Sceva, 1963 | Kinnison, H.B. and J.E. Sceva. 1963. *Effects of Hydraulic and Geologic Factors on Streamflow of the Yakima River Basin Washington.* Prepared for U.S. Geological Survey. Geological Survey Water-Supply Paper 1595. |
| Kittitas County, 1975 | Kittitas County. 1975. *Shoreline Master Program for Kittitas County, Washington*. March 5, 1975. |
| Kittitas County, 2008 | __________. 2008. *Kittitas County Long Range Transportation Plan*. Department of Public Works. June 3, 2008. |
| Kittitas County, 2010 | __________. 2010. *Final Draft Kittitas County 2010 Solid Waste and Moderate Risk Waste Management Plan Update Kittitas County Solid Waste Department.* https://www.co.kittitas.wa.us/solid-waste/default.aspx. Accessed September 23, 2014. |
| Kittitas County, 2012a | __________. 2012. *Kittitas County Critical Areas Ordinance - Wetlands Best Available Science Review and Considerations for Code Update.* May 2012.<br>https://www.co.kittitas.wa.us/uploads/documents/cds/cao/reports/May%2022_2012_Draft%20wetlands%20BAS%20paper%20w-Appx%20A-E.pdf |
| Kittitas County, 2012b | __________. 2012. *Kittitas County Hazard Mitigation Plan. Volume 2: Planning Partner Annexes.* Prepared by TetraTech. October 2012. |
| Kittitas County, 2013 | __________. 2013. *Kittitas County Regional Shoreline Master Program Update – Shoreline Inventory and Characterization Report: Kittitas County, City of Cle Elum, Town of South Cle Elum, and City of Ellensburg Shoreline Master Program Updates.* May 2013. |

| In-text Citation | Full Reference Information |
|---|---|
| Kittitas County, 2016a | __________. 2016. Kittitas County Comprehensive Plan. https://www.co.kittitas.wa.us/uploads/documents/cds/comp-plan/2016/2016%201206%20Comp%20Plan%20per%20Kittitas%20Co%20Ord%202016-023.pdf |
| Kittitas County, 2016b | __________. 2016. *Kittitas County Shoreline Master Program Ecology Approved*. March 2016. http://www.co.kittitas.wa.us/uploads/documents/cds/smp/20160307-Kittitas-County-Shoreline-Master-Program.pdf |
| Kittitas County Assessor, 2014 | Kittitas County Assessor. 2014. *Geographic Information Systems.* https://www.co.kittitas.wa.us/it/gis.aspx. Accessed December 25, 2014. |
| Lally, 2017 | Lally, Jessica. 2017. Lead Archaelogist, Yakama Nation. Personal communication. |
| Lansford and Jones, 1995 | Lansford Jr, N. H., and Jones, L. L. 1995. "Recreational and aesthetic value of water using hedonic price analysis." *Journal of Agricultural and Resource Economics*, 341-355. |
| Laprade, 2014 | Laprade, B. 2014. Geotechnical Engineer, Shannon & Wilson, Personal communication. December 17, 2014. |
| Lau, 2012 | Lau, H. 2012. *2012 USDA Forest Service Okanogan-Wenatchee National Forest Cle Elum Ranger District Study Requests for Botanical Resources.* May 8, 2012. |
| Lay, 2014 | Lay, C. 2014 Bureau of Reclamation. Personal communication. |
| Lin and Huyber, 2016 | Lin M and Huybers P (2016) Revisiting Whether Recent Surface Temperature Trends Agree with the CMIP5 Ensemble. Journal of Climate, 29, 8673–8687. |
| Lohr et al., 2000 | Lohr, S., T. Cummings, W. Fredenberg, and S. Duke. 2000. Listing and recovery planning for bull trout. Pages 80-87 in D. Schill, S. Moore, P. Byorth and B. Hamre, eds., *Wild Trout VII, Management in the New Millennium: Are We Ready?* Fort Collins, Colorado: Beyond Words. |
| Long et al., 2012 | Long, R.A., J.S. Begley, and P. MacKay. 2012. *Baseline Wildlife Monitoring at I-90 Snoqualmie Pass East, Prior to the Installation of Wildlife Crossing Structures.* Final report to the Washington State Department of Transportation, Yakima, Washington. Bozeman, Montana: Western Transportation Institute. |
| Lynch, 2014 | Lynch, C. 2014. Bureau of Reclamation. Personal communication. November 2014. |

| In-text Citation | Full Reference Information |
|---|---|
| Lynch, 2015 | __________. 2015. Bureau of Reclamation. Personal communication. October 2017. |
| Lynch, 2017 | __________. 2017. Bureau of Reclamation. Personal communication. October 2017. |
| Lytle and Poff, 2004 | Lytle, D.A.and Poff, N.L. 2004. "Adaptation to natural flow regimes." *Trends in Ecology & Evolution* 19: 94–100. Doi:10.1016/j.tree.2003.10.002 |
| MacDonald et al., 1996 | MacDonald, K., S. Noble, and J. Haskins. 1996. *An Assessment of the Status of Aquatic Resources within Subbasins on the Wenatchee National Forest.* U.S. Forest Service. |
| Mansfield et al., 1983 | Mansfield, P.J., Jude, D.J., Michaud, D.T., Brazo, D.C.and Gulvas, J. 1983. "Distribution and abundance of larval burbot and deepwater sculpin in Lake Michigan." *Transactions of the American Fisheries Society* 112, 162–172. Doi:10.1577/1548-8659(1983)112<162:DAAOLB>2.0.CO;2. |
| Mantua, et al., 2009 | __________. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. Chapter 6 in *The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate*. Seattle: Climate Impacts Group, University of Washington. June 2009. |
| Mantua, et al., 2010 | __________. 2010. "Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State." *Climate Change*. Doi:10.1007/s10584-010-9845-2. |
| Marshall, 1988 | Marshall, D.B. 1988. *Status of the Marbled Murrelet in North America: with Special Emphasis on Populations in California, Oregon, and Washington.* U.S. Fish and Wildlife Service Biol. Rep. 88. |
| Marshall, 1996 | __________. 1996. *Species at Risk: Sensitive, Threatened and Endangered Vertebrates of Oregon.* 2nd ed. Prepared for Wildlife Diversity Program, Oregon Department of Fish and Wildlife, Portland, OR. |
| Marshall, 2003 | __________. 2003. Yellow-billed cuckoo *Coccyzus americanus*. Pages 305-307 in D. B. Marshall, M. G. Hunter, and A. L. Contreras, eds., *Birds of Oregon: A General Reference.* Corvallis, OR: Oregon State University Press. |

| In-text Citation | Full Reference Information |
|---|---|
| Mastin, 2008 | Mastin, M.C. 2008. *Effects of Potential Future Warming on Runoff in the Yakima River Basin, Washington.* U.S. Department of the Interior, U.S. Geological Survey. |
| Maxell, 1999 | Maxell, B. A. 1999. "A power analysis on the monitoring of bull trout stocks using redd counts." *North American Journal of Fisheries Management* 19:860–866. |
| McGrath et al., 2006 | McGrath, K.E., E.M. Dawley, and D.R. Geist. 2006. *Total Dissolved Gas Effects on Fishes of the Lower Columbia River.* Prepared for U.S. Army Corps of Engineers, Portland District. |
| McIntosh et al., 1990 | McIntosh, B.A., S.E. Clark, and J.R. Sedell. 1990. *Summary Report for Bureau of Fisheries Stream Habitat Surveys: Yakima River Basin.* Prepared for US Department of Energy, Bonneville Power Administration, Portland, OR. No. 89-104. |
| McCullough, 1999 | McCullough, D.A. 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids, with special reference to Chinook salmon. U.S. Environmental Protection Agency EPA. |
| McQueen et al., 1986 | McQueen, D.J., R.J. Post, and E.L. Mills. 1986. "Trophic relationships in freshwater pelagic ecosystems." *Canadian Journal of Fisheries and Aquatic Science* 43:1571–1581. Doi:10.1139/f86-195. |
| Mech and Boitani, 2003 | Mech, L.D. and L. Boitani, eds. 2003. *Wolves: Behavior, Ecology, and Conservation*. Chicago, Illinois: University of Chicago Press. |
| Mech et al., 1988 | Mech, L.D., S.H. Fritts, G.L. Radde, and W.J. Paul. 1988. "Wolf distribution and road density of Minnesota." *Wildlife Soc. Bull.* 16:85-87. |
| Meyer, 2002 | Meyer, W. R. 2002. The Effects of Seasonal De-watering on Three Age Classes of Bull Trout, *Salvelinus confluentus*. M.S. Thesis. Central Washington University. Ellensburg, WA. |
| Miller, 2018 | Miller, C. 2018. *Traditional Cultural Property (TCP) Resource Study in the Upper Yakima River Basin* Proprietary to the Confederated Tribes of the Colville Reservation, History/Archaeology Program. Prepared for the State of Washington, Department of Ecology and Bureau of Reclamation |

| In-text Citation | Full Reference Information |
|---|---|
| Mitson and Knudsen, 2003 | Mitson, R.B., and H.P. Knudsen. 2003. "Causes and effects of underwater noise on fish abundance estimation." *Aquatic Living Resources* 16:255–263. Doi:10.1016/S0990-7440(03)00021-4. |
| Mongillo and Faulconer, 1982 | Mongillo, P. and Faulconer, L. 1982. *Yakima Fisheries Enhancement Study Phase II.* Washington Department of Game. Final report to U.S. Bur. Recl. Contr. 0-07-10-50218. |
| Murdoch, 2002 | Murdoch, A. 2002. Research Fish Biologist. Washington Department of Fish and Wildlife. Wenatchee, Washington. Personal communication. |
| Naiman et al., 2008 | Naiman, R.J., Latterell, J.J., Pettit, N.E. and Olden, J.D. 2008. "Flow variability and the biophysical vitality of river systems." *Comptes Rendus Geoscience* 340, 629–643. Doi:10.1016/j.crte.2008.01.002. |
| Nelson, 2004 | Nelson, S.M. 2004. *Aquatic invertebrates associated with unregulated tributaries and reservoir tailwaters in the Yakima area: a comparison with other Reclamation dams and examples of downstream recovery.* Technical Memorandum No. 8220-05-01. Bureau of Reclamation, Denver, Colorado. |
| Nelson and Bowen, 2003 | Nelson, S.M. and M. Bowen. 2003. "Naches River study." Unpublished. |
| Nelson et al., 1992 | Nelson, S.K., M.L.C. McAllister, M.A. Stern, D.H. Varoujean, and J.M. Scott. 1992. The marbled murrelet in Oregon, 1899-1987. Pp. 61-91 *in* Status and conservation of the marbled murrelet in North America (H.R. Cater and M.L. Morrison, eds.). Proc. West. Found. Vertebr. Zool. 5. |
| NIDCD, 2008 | National Institute on Deafness and other Communication Disorders. 2008. *Noise-induced Hearing Loss*. https://www.nidcd.nih.gov/health/noise-induced-hearing-loss . |
| Nilsson and Berggren, 2000 | Nilsson, C., and K. Berggren. 2000. "Alterations of Riparian Ecosystems Caused by River Regulation." *BioScience* 50:783–792. |
| NMFS, 2011 | National Marine Fisheries Service. 2011. Anadromous Salmonid Passage Facility Design. NMFS. Northwest Region, Portland, Oregon. July 2011. |

| In-text Citation | Full Reference Information |
|---|---|
| NPCC, 1986 | Northwest Power and Conservation Council. 1986. Council staff compilation of information on salmon and steelhead losses in the Columbia River Basin, Technical Appendix D of the 1987 Columbia River basin fish and wildlife program. Northwest Power Planning Council, Portland, OR. |
| NPCC, 2001 | __________. 2001. *Yakima Subbasin Summary*. Laura Berg, editor. Portland, OR. 376 pp. |
| Obertegger et al., 2007 | Obertegger, U., Flaim, G., Braioni, M.G., Sommaruga, R., Corradini, F.and Borsato, A. 2007. "Water residence time as a driving force of zooplankton structure and succession." *Aquat. Sci*. 69, 575–583. |
| Oidtmann et al., 2011 | Oidtmann, B.C., M.A. Thrush, K.L. Denham, and E.J. Peeler. 2011. "International and national biosecurity strategies in aquatic animal health." *Aquaculture* 320:22–33. Doi:10.1016/j.aquaculture.2011.07.032. |
| O'Reilly et al., 2005 | O'Reilly, C. M. et al. 2015. Rapid and highly variable warming of lake surface waters around the globe, *Geophys. Res. Lett*. 42, 10,773-10,781, doi:10.1002/20915GL066235. |
| Pearsons et al., 1996 | Pearsons, T.N., G.A. McMichael, S.W. Martin, E.L. Bartrand, J.A. Long, and S.A. Leider. 1996. *Yakima Species Interactions Studies Annual Report 1994*. U.S. Department of Energy. Bonneville Power Administration. Annual Report 1994. No. DOE/BP–99852-3. |
| Pearsons et al., 1998 | Pearsons, T.N., G.A. McMichael, K.D. Ham, E.L. Bartrand, A.I. Fritts, and C.W. Hopley. 1998. *Yakima River Species Interactions Studies. Progress Report 1995-1997*. |
| Peterschmidt, 2017 | Peterschmidt, M. 2017. K-Projects DEIS Water Quality Response. Personal communication to Teresa Merriman. <tmerriman@usbr.gov>. March 4, 2017. |
| Phelps, et al., 2000 | Phelps, S.R., B.M. Baker and C.A. Busack. 2000. Genetic relationships and stock structure of Yakima River basin and Klickitat River basin steelhead populations. Washington Department of Fish and Wildlife Genetics Unit unpublished report. Olympia, Washington. 56 pp. |
| Pickett, 2014 | Pickett, P. 2014. Washington Department of Ecology, Olympia, WA. Personal communication. December 9, 2014. |

| In-text Citation | Full Reference Information |
|---|---|
| Poff and Zimmerman, 2010 | Poff, N.L.and Zimmerman, J.K.H. 2010. "Ecological responses to altered flow regimes: a literature review to inform the science and management of environmental flows." *Freshwater Biology* 55, 194–205. Doi:10.1111/j.1365-2427.2009.02272.x |
| Polacek, 2016 | Polacek, Matt. 2016. "Food Web Structure of Kachess and Keechelus Reservoirs: Factors Limiting Bull Trout Production Final Data Collection Report." Washington Department of Fish and Wildlife (WDFW). December 2016 |
| Powell, 2005 | Powell, L. 2005. *Mass Wasting Assessment, Landslide Hazard Inventory Project, Kachess Watershed,Kittitas County, Washington*. Washington State Department of Natural Resources, Geology and Earth Resources, 15 p. |
| PSU, 2017a | PSU. 2017. Food Web Structure of Kachess and Keechelus Reservoir Factor Affecting Bull Trout Production. Prepared for Washington Department of Ecology. |
| PSU 2017b | __________. 2017. Memo. Results of Lake Kachess Pumping Alternatives. Dated December 2017. Prepared for Washington Department of Ecology. |
| Radomski, 2010 | Radomski, P., Bergquist, L.A., Duval, M. and Williquett, A. 2010. Potential Impacts of Docks on Littoral Habitats in Minnesota Lakes. Fisheries 35, 489–495. doi:10.1577/1548-8446-35.10.489 |
| Ralph, 1994 | Ralph, C.J. 1994. "Evidence of changes in populations of marbled murrelets in the Pacific Northwest." Pp. 286-292 in *A century of avifaunal change in western North America* (J.R. Jehl, Jr. and N.K. Johnson, eds.). Stud. Avian Biol. No. 15. |
| Ralph and Miller, 1995 | Ralph, C.J., and S.L. Miller. 1995. "Offshore population estimates of marbled murrelets in California." In: Ralph, C.J, G.L. Hunt, M.G. Raphael, and J.F. Piatt. Tech. Eds. *Ecology and conservation of the marbled murrelet.* Gen. Tech. Rep. PSW-GTR-152. Pacific Southwest Research Station, USDA Forest Service, Albany, California. |
| Reclamation, 1911a | Bureau of Reclamation. 1911. Detail Map and Records of Borings and Test Pits, Specifications No. 177, Accession No. 13085, Drawing No. 2 of 7, Kachess Dam, Yakima Project. U.S. Bureau of Reclamation, Yakima, Washington. |

| In-text Citation | Full Reference Information |
|---|---|
| Reclamation, 1911b | __________. 1911. General Plan and Profiles, Specifications No. 177, Accession No. 13085, Drawing No. 3 of 7, Kachess Dam, Yakima Project. U.S. Bureau of Reclamation, Yakima, Washington. |
| Reclamation, 1996 | __________. 1996. *Decision Memorandum No. KA-8312-3, Kachess Dam Outlet Works Modifications*, 4 p. |
| Reclamation, 1999 | __________. 1999. Draft progress report: *Limnolgical Surveys of five reservoirs in the Upper Yakima Basin, Washington*. Conducted August 3 – 7, 1998. |
| Reclamation, 2000 | __________. 2000. *Biological Assessment, Yakima Project Operations and Maintenance, Supplemental to the December 1999 Biological Assessment on the FCRPS. August 2000*. USBR Upper Columbia Area Office, Yakima WA. 236 pp. |
| Reclamation, 2001 | __________. 2001. *Geologic Design Data Report 2000 Field Investigation for Corrective Action Safety of Dams Program Keechelus Dam, Yakima Projec*t. Bureau of Reclamation, Boise, Idaho. |
| Reclamation, 2002 | __________. 2002. *Interim Comprehensive Basin Operating Plan, Yakima Project, Washington*. U.S. Department of the Interior, Bureau of Reclamation, Pacific Northwest Region, Upper Columbia Area Office, Yakima, Washington. |
| Reclamation, 2005a | __________. 2005. Anadromous Fish Reintroduction Plan, Storage Dam Fish Passage Study, Yakima Project, Washington, Technical Series No. PN-YDFP-003. Bureau of Reclamation, Boise, Idaho, February 2005. Boise, Idaho. |
| Reclamation, 2005b | __________. 2005. Phase I Assessment Report Storage Dam Fish Passage Study Yakima Project, Washington, Technical Series No. PN-YDFP-001. U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region, Boise, Idaho. |
| Reclamation, 2005c | __________. 2005. Steelhead movements in the Upper Yakima Basin, Winter 2003-2004. U.S. Department of the Interior, Bureau of Reclamation Technical Memorandum 8290-05-01. Prepared in Cooperation with the Yakama Nation and the University of Idaho. |

| In-text Citation | Full Reference Information |
|---|---|
| Reclamation, 2007 | __________. 2007. Physical, Chemical, and Biological Characteristics of Cle Elum and Bumping Lakes in the Upper Yakima River Basin. Storage Dam Fish Passage Study, Yakima Project. Technical Series No. PN-YDFP-005. U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region, Boise, Idaho. |
| Reclamation, 2008a | __________. 2008. *Aquatic Ecosystem Evaluation for the Yakima River Basin.* A Component of Yakima River Basin Water Storage Feasibility Study, Washington Technical Series No. TS–YSS–22. U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region Upper Columbia Area Office Yakima, Washington. |
| Reclamation, 2008b | __________. 2008. *Cle Elum and Bumping Lake Dams Fish Passage Facilities Planning Report.* Draft. Storage Dams Fish Passage Study, Yakima Project, Washington. September 2008. |
| Reclamation, 2008c | __________. 2008. *Yakima River Basin Water Storage Feasibility Study Final Planning Report/Environmental Impact Statement*. December 19, 2008. |
| Reclamation, 2008d | __________. 2008. *Yakima River Basin Reservoir and River Recreation Survey: Report of Findings.* January 2008. |
| Reclamation, 2009 | __________. 2009. *Steelhead movements in the Upper Yakima Basin, Winter 2002-2006.* U.S. Department of the Interior, Bureau of Reclamation Technical Memorandum 8290-05-01. Prepared in Cooperation with the Yakama Nation and the University of Idaho. |
| Reclamation, 2011 | __________. 2011. Reservoir Area Management Plan for the Secretary's Determination on Klamath River Dam Removal and Basin Restoration: Klamath River, Oregon and California Mid-Pacific Region. Technical Report No. SRH-2011-19. June 2011. |
| Reclamation, 2013 | __________. 2013. *Record of Decision for the Yakima River Basin Integrated Water Resource Management Plan Final Programmatic Environmental Impact Statement.* Yakima Project, Washington. July 9, 2013. |
| Reclamation, 2014a | __________. 2014. Kachess Dam. https://www.usbr.gov/projects/index.php?id=135 . Accessed August 7, 2014. |

| In-text Citation | Full Reference Information |
|---|---|
| Reclamation, 2014b | __________. 2014. Keechelus Dam. https://www.usbr.gov/projects/index.php?id=294 . Accessed August 7, 2014. |
| Reclamation, 2014c | __________. 2014. Reclamation Manual. http://www.usbr.gov/recman/. Accessed August 12, 2014. |
| Reclamation, 2014d | __________. 2014. Unpublished piezometer data from Keechelus Dam area, 2003 – 2014. June 2014. |
| Reclamation, 2014e | __________. 2014. *Reclamation Safety and Health Standards*. http://www.usbr.gov/ssle/safety/RSHS-all.pdf. July 2014. |
| Reclamation, 2015 | __________. 2015. Yakima Basin Water Supply – August Forecast. Available online at https://www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=49907. Accessed August 3, 2015. |
| Reclamation, 2016a | __________. 2016. Columbia River Basin Climate Impact Assessment. March 2016. |
| Reclamation, 2016b | __________. 2016. Unpublished Water Quality Data for Kachess and Keechelus Reservoirs. Data provided by Norbert Cannon on November 3, 2016. |
| Reclamation and Ecology, 2010 | Bureau of Reclamation and Washington State Department of Ecology. 2010. *Cle Elum Dam Fish Passage Facilities and Fish Reintroduction Project, Storage Dams Fish Passage Study, Yakima Project: Draft Environmental Impact Statement* (No. Ecology Publication 09-12-018). U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region Columbia-Cascades Area Office Yakima, Washington and State of Washington Department of Ecology Central Regional Office Yakima, Washington. |
| Reclamation and Ecology, 2011a | __________. 2011. *Addendum to the Yakima River Basin Study Volume 1 Proposed Integrated Water Resource Management Plan*. August 2011. U.S. Department of the Interior, Bureau of Reclamation and Washington State Department of Ecology. |

| In-text Citation | Full Reference Information |
| --- | --- |
| Reclamation and Ecology, 2011b | __________. 2011. *Cle Elum Dam Fish Passage Facilities and Fish Reintroduction Project, Storage Dams Fish Passage Study, Yakima Project: Environmental Impact Statement* (No. Ecology Publication No. 11-12-001). U.S. Department of the Interior Bureau of Reclamation Pacific Northwest Region Columbia-Cascades Area Office Yakima, Washington and State of Washington Department of Ecology Central Regional Office Yakima, Washington. |
| Reclamation and Ecology, 2011c | __________. 2011. *Yakima River Basin Study Instream Flow Needs Technical Memorandum*. April 2011 |
| Reclamation and Ecology, 2011d | __________. 2011. *Modeling of Reliability and Flows Technical Memorandum.* Prepared by HDR Engineering, Inc. and Anchor QEA. June 2011. U.S. Department of the Interior, Bureau of Reclamation and Washington State Department of Ecology. |
| Reclamation and Ecology, 2011e | __________. 2011. *Water Needs for Out-of-Stream Uses Technical Memorandum*. Prepared by HDR Engineering, Inc. and Anchor QEA. June 2011. U.S. Department of the Interior, Bureau of Reclamation and Washington State Department of Ecology. |
| Reclamation and Ecology, 2011f | __________. 2011. *Yakima River Basin Study, Volume 1 Proposed Integrated Water Resource Management Plan.* Contract No. 08CA10677A ID/IQ, Task 11. |
| Reclamation and Ecology, 2011g | __________. 2011. *Yakima River Basin Water Resources Technical Memorandum.* Prepared by Anchor QEA. March 2011. U.S. Department of the Interior, Bureau of Reclamation and Washington State Department of Ecology. |
| Reclamation and Ecology, 2012 | __________. 2012. *Yakima River Baisn Integrated Water Resource Management Plan Final Programmatic Environmental Impact Statement*. March 2012. |
| Reclamation and Ecology, 2013a | __________. 2013. *Lake Kachess Offshore Geophysical Reconnaissance, Yakima Basin Storage Alternatives – Early Actions – Phase 2*. Prepared by Golder Associates. |
| Reclamation and Ecology, 2013b | __________. 2013. *Technical Memorandum: Kachess Reservoir Inactive Storage Project Alternatives Comparison and Recommendation for Advancement*. Yakima River Basin Integrated Water Resource Management Plan. Prepared by HDR Engineering for Bureau of Reclamation, Yakima, WA. October 2013. |

| In-text Citation | Full Reference Information |
|---|---|
| Reclamation and Ecology, 2013c | __________. 2013. *Technical Memorandum: Screening of Alternatives for the Keechelus-to-Kachess Conveyance Project*. Yakima River Basin Integrated Water Resource Management Plan. Prepared by HDR Engineering and Anchor QEA. September 2013. |
| Reclamation and Ecology, 2014a | __________. 2014. *Cle Elum Pool Raise Project Draft Environmental Impact Statement, Kittitas County, Washington*. A Component of the Yakima River Basin Integrated Water Resource Management Plan. September 2014. |
| Reclamation and Ecology, 2014b | __________. 2014. *Draft Feasibility Study Technical Memorandum: Kachess Drought Relief Pumping Plant Construction Scheme and Schedule*. Yakima River Basin Integrated Water Resource Management Plan. September 25, 2014. |
| Reclamation and Ecology, 2014c | __________. 2014. *Keechelus-to-Kachess Conveyance Project Geotechnical Interpretation – Gravity Tunnel. Technical Memorandum.* Yakima River Basin Integrated Water Resource Management Plan. Prepared by HDR Engineering for Bureau of Reclamation, Yakima, WA. June 2014 |
| Reclamation and Ecology, 2014d | __________. 2014. *Scoping Summary Report – Keechelus-to-Kachess Conveyance and Kachess Drought Relief Pumping Plan Environmental Impact Statement*. A component of Yakima River Basin Integrated Water Resource Management Plan. Yakima Project, Washington. Pacific Northwest Region. March 2014. |
| Reclamation and Ecology, 2014e | __________. 2014. *Value Analysis Kachess Drought Relief Pumping Plant*. Prepared by U.S. Bureau of Reclamation. |
| Reclamation and Ecology, 2014f | __________. 2014. *Value Analysis Keechelus-to-Kachess Conveyance*. Prepared by U.S. Bureau of Reclamation. |
| Reclamation and Ecology, 2014g | __________. 2014. *Yakima River Basin Integrated Water Resource Management Plan Feasibility Study Technical Memorandum: Kachess Drought Relief Pumping Plant Geotechnical Analysis*. September 15, 2014. |
| Reclamation and Ecology, 2014h | __________. 2014. *Yakima River Basin Integrated Plan Feasibility Study Technical Memorandum: Kachess Drought Relief Pumping Plant Summary of Prior Geotechnical Data*. September 15, 2014. |

| In-text Citation | Full Reference Information |
|---|---|
| Reclamation and Ecology, 2014i | __________. 2014. *Yakima River Basin Integrated Water Resource Management Plan Feasibility Study Technical Memorandum: Kachess Drought Relief Pumping Plant Power Supply Analysis*. Prepared by HDR Engineering, Inc. 58 pages. |
| Reclamation and Ecology, 2015a | __________. 2015. *Cle Elum Pool Raise Project Final Environmental Impact Statement, Kittitas County, Washington*. A Component of the Yakima River Basin Integrated Water Resource Management Plan. May 2015. |
| Reclamation and Ecology, 2015b | __________. 2015. *Economic Analyses of the Proposed Kachess Drought Relief Pumping Plant* . Final Draft. Prepared by ECONorthwest. April 2015. |
| Reclamation and Ecology, 2015c | __________. 2015. *Economic Analyses of Proposed Keechelus Reservoir -to-Kachess Reservoir Conveyance*. Final Draft. Prepared by ECONorthwest. April 2015. |
| Reclamation and Ecology, 2015e | __________. 2015. *Feasibility-Level Design Report, Keechelus-to-Kachess Conveyance*. Prepared by HDR, Inc., Brierley Associates, Dr. Mole, Inc., and Engineering Solutions, LLC. March 2015. |
| Reclamation and Ecology, 2016a | __________. 2016. *Yakima River Basin Integrated Water Resource Management Plan: Kachess Reservoir Bull Trout Passage Appraisal Report*. May 2016. |
| Reclamation and Ecology, 2016b | __________. 2016. Feasibility Planning Report. Kachess Drought Relief Pumping Plant. Final Draft. February 2016. |
| Reclamation and Ecology, 2016c | __________. 2016. Feasibility Planning Report. Keechelus Reservoir-to-Kachess Reservoir Conveyance. Final Draft. February 2016. |
| Reclamation and Ecology, 2017a | __________. 2017. *Kachess Narrows Fish Passage Concept Development Technical Memorandum*. Unpublished Draft prepared by HDR Engineering. February 2017. |
| Reclamation and Ecology, 2017b | __________. 2017. *Appraisal Design Report, Drought Relief Pumping Plant, Floating Pumping Plant Alternative*. December 2017. |
| Reclamation and Ecology, 2017c | __________. 2017. *Yakima River Basin Integrated Water Resource Management Plan Technical Memorandum: Hydrologic Modeling of System Improvements Phase 3 Report.* Unpublished Draft prepared by HDR Engineering. January 2017. |

| In-text Citation | Full Reference Information |
|---|---|
| Reclamation and Ecology, 2017d | __________. 2017. *Feasibility-Level Design Report, Kachess Drought Relief Pumping Plant*. Prepared by HDR, Inc. December 2017. |
| Reclamation and Ecology, 2017e | __________. 2017. *Technical Memorandum, Reconciled Opinion of Probable Construction Cost, Kachess Drought Relief Pumping Plant – Floating Pumping Plant Alternative.* Prepared by HDR Engineering, Inc., Orion Marine Group, Glosten, and Shannon & Wilson. December 2017. |
| Reiss, et al., 2012 | Reiss, Y.K., J. Thomas, E. Anderson, and J. Cummins. 2012. *Final Yakima Bull Trout Action Plan*. September 2012. |
| Richardson, et al, 2016 | Richardson M, Cowtan K, Hawkins E, Stolpe MB (2016) Reconciled climate response estimates from climate models and the energy budget of Earth. Nature Climate Change, 6, 931–935. |
| Rieman et al., 2007 | Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C. Luce, and D. Myers. 2007. "Anticipated climate warming effects on bull trout habitats and populations across the interior Columbia River Basin." *Transactions of the American Fisheries Society* 136:1552–1565. Doi:10.1577/T07-028.1. |
| RMJOC, 2010 | River Management Joint Operating Committee. 2010. *Climate and Hydrology Datasets for Use in the RMJOC Agencies' Longer-Term Planning Studies: Parts I and II – Future Climate and Hydrology Datasets* (not published). U.S. Department of the Interior, Bureau of Reclamation, U.S. Army Corps of Engineers, and Bonneville Power Administration. |
| Roberson, 1980 | Roberson, D. 1980. *Rare Birds of the West Coast of North America*. Woodcock Publications, Pacific Grove, California. |
| Sallabanks et al. 2000 | Sallabanks, R., E. B. Arnett, and J. M. Marzluff. 2000. "An evaluation of research on the effects of timber harvest on bird populations." *Wildlife Society Bulletin* 28: 1144– 1155. |
| Salzer, 2010 | Salzer, L.J. 2010. In litt. E-mail from L.J. Salzer of Washington Department of Wildlife to K. Leyse of the Service regarding yellow-billed cuckoo status in Washington state. February 25, 2010. |
| Santer, et al, 2016 | Santer, B.D., Solomon, S., Pallotta, G., Mears, C., Po-Chedley, S., Fu, Q., Wentz, F., Zou, C.Z., Painter, J., Cvijanovic, I. and Bonfils, C., 2017. Comparing tropospheric warming in climate models and satellite data. Journal of Climate, 30(1), pp.373-392. |

| In-text Citation | Full Reference Information |
|---|---|
| Santer, et al, 2017 | Santer, B.D., Fyfe, J.C., Pallotta, G., Flato, G.M., Meehl, G.A., England, M.H., Hawkins, E., Mann, M.E., Painter, J.F., Bonfils, C., Evijanovic, I., Mears, C., Wentz, F.J., Po-Chedley, S., Fu, Q., Zou, C.: Causes of differences in model and satellite tropospheric warming rates, Nature Geosciences, June 2017, DOI: 10.1038/NGEO2973. |
| Sass et al., 2006 | Sass, G.G. J.F. Kitchell, S.R. Carpenter, T.R. Hrabik, A.E. Marburg, and M.G. Turner. 2006. "Fish community and food web responses to a whole-lake removal of coarse woody habitat." *Fisheries* 31:321–330. Doi:10.1577/1548-8446(2006)31[321:FCAFWR]2.0.CO;2. |
| Schindler, 1977 | Schindler, D.W. 1977. Evolution of phosphorus limitation in lakes. Science, 195, 260–262. |
| Schindler, 2001 | __________. 2001. "The cumulative effects of climate warming and other human stresses on Canadian freshwaters in the new millennium." *Canadian Journal of Fisheries and Aquatic Sciences* 58:18–29. Doi:10.1139/f00-179 |
| Sealy and Carter, 1984 | Sealy, S.G., and H.R. Carter. 1984. "At-sea distribution and nesting habitat of the marbled murrelet in British Columbia: Problems in the conservation of a solitary nesting seabird." Pp. 737-781 in *Status and conservation of the world's seabirds* (J.P. Croxall, P.G.H. Evans, and R.W. Schreiber, eds.). ICBP Tech. Publ. no.2. |
| Service, 1998 | U.S. Fish and Wildlife Service. 1998. *Bull trout status summary and supporting documents lists: Klamath River and Columbia River Distinct Population Segments*. |
| Service, 2001 | __________. 2001. *Hydrologic and Water Temperature Investigations of Tributaries to Keechelus Reservoir*. http://www.ybfwrb.org/Assets/Documents/References/Thomas_2001b.pdf. Accessed: November 3, 2014. |
| Service, 2002 | __________. 2002. Chapter 21, Middle Columbia Recovery Unit, Washington. 86p. In: U.S. Fish and Wildlife Service. Bull Trout (Salvelinus confluentus) Draft Recovery Plan. Portland, Oregon. |

| In-text Citation | Full Reference Information |
|---|---|
| Service, 2003 | __________. 2003 revised September 2004. *Biological Opinion and Letter of Concurrence for Effects to Bald eagles, Marbled Murrelets, Northern Spotted Owls, Bull Trout, and Designated Critical Habitat for Marbled Murrelets and Northern Spotted Owls from Olympic National Forest Program of Activities for August 5, 2003, to December 31, 2008*. United State Department of the Interior, Fish and Wildlife Service, Lacey, Washington. |
| Service, 2005a | __________. 2005. *Bull trout core area templates – complete core area by core area analysis*. W. Fredenberg and J. Chan, editors. U. S. Fish and Wildlife Service. Portland, Oregon. 660 pp. |
| Service, 2005b | __________. 2005. *Bull Trout (Salvelinus confluentus) 5-year review: summary and evaluation*. U.S. Fish and Wildlife Service. Portland, OR. 53 pp. |
| Service, 2008 | __________. 2008. Judy Delavergne, USFWS, unpublished Recovery Team Bull Trout Core Area Status Assessment Template. |
| Service, 2011 | __________. 2011. *Revised Recovery Plan for the Northern Spotted Owl* (Strix occidentalis caurina). U.S. Fish and Wildlife Service, Portland, Oregon. Xvi + 258 pp. |
| Service, 2012 | __________. 2012. *Endangered and Threatened Wildlife and Plants; Designation of Revised Critical Habitat for the Northern Spotted Owl; Final Rule*. Federal Register (73FR47326) Vol. 77 No. 233. December 4, 2012. |
| Service, 2013 | __________. 2013. National Wetlands Inventory spatial view GIS data layer. Last updated March 5, 2013. |
| Service, 2014 | __________. 2014. USFWS Critical Habitat Mapper and metadata. https://ecos.fws.gov/ecp/report/table/critical-habitat.html. |
| SFMTA, 2008 | San Francisco Municipal Transportation Authority. 2008. *Central Subway Project Final SEIS/SEIR – Volume 1, Chapter 6*. https://www.sfmta.com/reports/central-subway-final-seisseir |
| Shannon and Wilson, 2014a | Shannon & Wilson, Inc. 2014. *Geology Report, Kachess Drought Relief Pumping Plant (KDRPP), Kittitas County, Washington*. |

| In-text Citation | Full Reference Information |
|---|---|
| Shannon and Wilson, 2014b | __________. 2014. *Geology Report, Keechelus to Kachess Conveyance (KKC) Report, Kittitas County, Washington*. Unpublished draft. |
| Singleton and Lehmkuhl, 2000 | Singleton, P.H., and J.F. Lehmkuhl. 2000. *I-90 Snoqualmie Pass Wildlife Habitat Linkage Assessment. Final Report to the Washington State Department of Transportation GCA1177*. USDA Forest Service Pacific Northwest Research Station. PNW-98-0513-CC. |
| Sigler et al., 1984 | Sigler, J.W., Bjornn, T.C., Everest, F.H. 1984. Effects of chronic turbidity on density and growth of steelheads and coho salmon. Transactions of the American Fisheries Society 113, 142–150. |
| Smith et al., 1997 | Smith M.R., W. Mattocks, Jr., and K.M. Cassidy. 1997. *Breeding birds of Washington State. Volume 4 in: Washington State gap analysis – Final report*. K.M. Cassidy, C.E. Grue, M.R. Smith, and K.M. Dvornich (eds.). Seattle Audubon Society Publications in Zoology No. 1, Seattle, Washington. 538 pp. |
| Stanford et al., 2002 | Stanford, J.A., E.B. Snyder, M.N. Lorang, D.C. Whited, P.L. Matson, and J.L. Chaffin. 2002. *The reaches project: ecological and geomorphic studies supporting normative flows in the Yakima River basin, Washington. Final Report*. Bureau of Reclamation, Yakima Office, Washington. USA. Yakama Nation, Toppenish, Washington. |
| Tabor and Wurtsbaugh, 1991 | Tabor, R.A., and W.A. Wurtsbaugh. 1991. “Predation risk and the importance of cover for juvenile rainbow trout in lentic systems.” *Transactions of the American Fisheries Society* 120:728–738. Doi:10.1577/1548-8659(1991)120<0728:PRATIO>2.3.CO;2 |
| Tabor et al., 2000 | Tabor, R.W., V.A. Frizzell, Jr., D.B. Booth, and R.B. Waitt. 2000. Geologic Map of the Snoqualmie Pass 30 x 60 Minute Quadrangle, Washington. U.S. Geological Survey, Tacoma, Washington. |
| Tabor et al., 2011 | Tabor, R.A., Fresh, K.L., Piaskowski, R.M., Gearns, H.A. and Hayes, D.B. 2011. Habitat use by juvenile Chinook salmon in the nearshore areas of Lake Washington: Effects of depth, lakeshore development, substrate, and vegetation. North American Journal of Fisheries Management, 31(4), pp.700-713. |

| In-text Citation | Full Reference Information |
|---|---|
| Tarleton State University, 2014 | Tarleton State University. 2014. Range Sites. http://www.tarleton.edu/departments/range/Home/home.htm. Accessed September 2014. |
| Thomas, 2009 | Thomas, J. 2009. U.S. Fish and Wildlife Service. Personal communication. |
| Thomas, 2014 | Thomas, A. 2014. Bureau of Reclamation. Personal Communication. |
| Thomas et al., 1990 | Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, and J. Verner. 1990. *A conservation strategy for the northern spotted owl*. Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl. USDA Forest Service, USDI Bureau of Land Management, USDI Fish and Wildlife Service, and USDI National Park Service. Portland, Oregon. 458 pp. |
| Thurow, 1987 | Thurow, R. 1987. *Completion Report, Evaluation of the South Fork Salmon River Steelhead Trout Fishery Restoration Program*. U.S. Fish and Wildlife Service Lower Snake River Fish and Wildlife Compensation Plan. Contract No. 14-16-0001-86505. Boise, Idaho. |
| Tiner, 1997 | Tiner, R.W. 1997. NWI Maps: What they tell us. National Wetlands Newsletter, Vol. 19, No.2. March-April 1997. |
| URS, 2012 | URS Corporation. 2012. *Probabilistic Seismic Hazard Analyses Project for the Mid-Columbia Dams*. February 2012. |
| USDA, 1995 | U.S. Department of Agriculture [USDA], Forest Service. 1995. *Landscape aesthetics: a handbook for scenery management* Agricultural Handbook Number 701. Washington DC. |
| USDA NRCS, 2014 | U.S. Department of Agriculture Natural Resources Conservation Service. 2014. Web Soil Survey. http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm. Accessed April 2014 |
| USDA and USFS, 1995. | U.S. Department of Agriculture and U.S. Forest Service. 1995. Landscape Aesthetics, A Handbook for Scenery Management. Agricultural Handbook Number 701. |
| U.S. Department of Commerce, 2015 | U.S. Department of Commerce. 2015. Census Bureau, American Community Survey Office. |
| USFS, 1974 | U.S. Forest Service. 1974. *National Forest Landscape Management, Volume 2, Chapter 1 – The Visual Management System*. Agricultural Handbook # 462. Washington D.C. |

| In-text Citation | Full Reference Information |
|---|---|
| USFS, 1990 | __________. 1990. *Wenatchee National Forest Land and Resource Management Plan.* Wenatchee National Forest. Wenatchee, WA. |
| USFS, 1995 | __________. 1995. *Mainstem Box Canyon Creek Survey Report*. Wenatchee National Forest, Cle Elum Ranger District. Unpublished report. |
| USFS, 1997 | __________. 1997. *Yakima Watershed Analysis*. Conducted by Cle Elum Ranger District, Wenatchee National Forest. |
| USFS, 2001 | __________. 2001. *Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines*. *In* Forest Service and Bureau of Land Management, Planning Documents within the Range of the Northern Spotted Owl. January 2001. |
| USFS, 2002 | __________. 2002. *Common Plants of the Okanogan and Wenatchee National Forests*. Draft of June 2002. |
| USFS, 2004 | __________. 2004. *Information for recovery plan for Yakima bull trout genetics*. Yuki Reiss, Fish Biologist, USFS, Naches Ranger District, Naches, WA. 9 p. |
| USFS, 2007 | __________. 2007. *White Pass Master Development Plan Proposal Final Environmental Impact Statement*. Okanogan and Wenatchee National Forests and Gifford Pinchot National Forest. |
| USFS, 2011 | __________. 2011. *Proposed Action for Forest Plan Revision Okanogan-Wenatchee National Forest*. June 2011. |
| USFS, 2014 | __________. 2014. Northern spotted owl known sites in Cle Elum Ranger District. Map provided by USFS. |
| USFS and BLM, 1994a | U.S. Forest Service and Bureau of Land Management. 1994. *Record of Decision for Amendments ot Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl*. April 13, 1994. |
| USFS and BLM, 1994b | __________. 1994. *Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl*. Attachment A to the Record of Decision for Amendments ot Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl. |

| In-text Citation | Full Reference Information |
|---|---|
| USGS, 2014 | U.S. Geological Survey. 2014. National Hydrography Geodatabase for Washington State. ftp://nhdftp.usgs.gov/DataSets/Staged/States/FileGDB/HighResolution/NHDH_WA_931v210.zip. Accessed September 2014. |
| Vano et al., 2010 | Vano, J.A., M. Scott, N. Voisin, C. Stöckle, A.F. Hamlet, K.E.B. Mickelson, M.M. Elsner, and D.P. Lettenmaier. 2010. “Climate Change Impacts on Water Management and Irrigated Agriculture in the Yakima River Basin, Washington, USA.” *Climatic Change* 102:287–317. |
| Vartapetian and Jackson, 1996 | Vartapetian, B.B. and M.B. Jackson. 1996. “Plant Adaptations to Anaerobic Stress.” *Annals of Botany* 79 (Supplement A): 3-20, 1997. |
| Wahl et al., 2005 | Wahl, T.R., B. Twiet, and S.G. Miodinow. 2005. *Birds of Washington*. Oregon State University Press. Corvallis, OR. 436 pp. |
| Walters et al., 1980 | Walters, M., R. Teskey, and T. Hinckley. 1980. *Impact of water level changes on woody riparian and wetland communities. Volume III: Pacific northwest and Rocky Mountain regions*. Fish and Wildlife Service, U.S. Dept. of the Interior FWS/OBS – 78/94. Washington, D.C. |
| Washington Department of Agriculture, 2015 | Washington Department of Agriculture. 2015. Interim Report: 2015 Drought and Agriculture. A Study by the Washington State Department of Agriculture. Publication No. [AGR PUB 104-495]. December 2015. |
| WDFW, 1998 | Washington Department of Fish and Wildlife. 1998. *Washington Salmonid Stock Inventory: Bull Trout and Dolly Varden.* Olympia, Washington. |
| WDFW, 2011a | __________. 2011. *Fourth State Wolf Pack Confirmed*. Washington State Department of Fish and Wildlife Press Release of July 5, 2011. http://wdfw.wa.gov/news/release.php?id=jul0511a. Olympia. Washington. |
| WDFW, 2011b | __________. 2011. *Wolf conservation and management plan for Washington*. Washington Department of Fish and Wildlife, Olympia, Washington. 297 pp. |
| WDFW, 2013 | __________. 2013. *Threatened and Endangered Wildlife in Washington: 2012 Annual Report*. Listing and Recovery Section, Wildlife Program, Washington Department of Fish and Wildlife, Olympia. 251 pp. |

| In-text Citation | Full Reference Information |
|---|---|
| WDFW, 2014a | __________. 2014. Habitats and Species Database. Olympia, Washington. |
| WDFW, 2014b | __________. 2014. Fish Washington: Kachess Lake. http://wdfw.wa.gov/fishing/washington/262/. Accessed on August 12, 2014. |
| WDFW, 2014c | __________. 2014. Fish Washington: Keechelus Lake. http://wdfw.wa.gov/fishing/washington/263/. Accessed on October 3, 2014. |
| WDFW, 2015 | __________. 2015. Environmental Impact Statement (EIS) Development for the Keechelus to Kachess Conveyance and Kachess Drought Relief Pumping Plant. Region 3, Yakima, Washington. |
| WDFW, 2016 | __________. 2016. Deliverable 2G: Northern Spotted Owl Surveys Report for Capital Water Storage Infrastructure Project Support. Contract Deliverable for Contract IAA C1600076: Yakima Basin Integrated Plan. 18pp. |
| WDFW, 2017 | __________. 2017. Yakima Basin Bull Trout. |
| Washington Historical Quarterly, 1920 | Washington Historical Quarterly. 1920. Origin of Washington Geographic Names. Vol. 11, No. 1. University of Washington. |
| Washington State Parks, 2014 | Washington State Parks. 2014. *Blewett/I-90 Snowmobile Sno-Parks: Crystal Springs*. https://parks.state.wa.us/459/Blewett-I-90 . Accessed on December 22, 2014. |
| Weathers et al., 2001 | Weathers, W.W., P.J. Hodum, and J.A. Blakesley. 2001. "Thermal ecology and ecological energetics of the California spotted owl." *Condor* 103:678–690. |
| Weisberg et al., 1987 | Weisberg, S.B., Burton, W.H., Jacobs, F.and Ross, E.A. 1987. "Reductions in Ichthyoplankton Entrainment with Fine-Mesh, Wedge-Wire Screens." *North American Journal of Fisheries Management* 7, 386–393. doi:10.1577/1548-8659(1987)7<386:RIIEWF>2.0.CO;2 |
| Welker et al., 1994 | Welker, M.T., C.L. Pierce, and D.H. Wahl. 1994. "Growth and survival of larval fishes: roles of competition and zooplankton abundance." *Transactions of the American Fisheries Society* 123:703–717. doi:10.1577/1548-8659(1994)123<0703:GASOLF>2.3.CO;2 |

| In-text Citation | Full Reference Information |
|---|---|
| Wetzel, 1983 | Wetzel, R.G. 1983. *Limnology*. (3rd ed.) Saunders College Publishing. Philadelphia, Pennsylvania. |
| Wiley and Sons, Inc., 1997 | J. Wiley & Sons. 1997. Encyclopedia of Accousitcs. Malcom Crocker, ed. |
| Wissmar and Craig, 1997 | Wissmar, R.C.and Craig, S. 1997. *Bull Trout Spawning Activity, Gold Creek, Washington*. Fisheries Research Institute, School of Fisheries University of Washington. |
| Wolf, 2014 | Wolf, D. 2014. Personal communication. February 21, 2014. |
| WSDF, 1967 | Washington State Department of Fisheries. 1967. *Limnological Survey of Kachess, Keechelus, and Cle Elum Reservoirs: Summary Report.* |
| WSDOH, 2014 | Washington State Department of Health. 2014. Washington State Water System Data. http://www.doh.wa.gov/DataandStatisticalReports/EnvironmentalHealth/DrinkingWaterSystemData/SentryInternet. Accessed October 2014. |
| WSDOT, 2008 | Washington State Department of Transportation. 2008. I-*90 Snoqualmie Pass East Final Environmental Impact Statement and Section 4(f) Evaluation*. Prepared by the US Department of Transportation Federal Highway Administration and Washington State Department of Transportation and US Bureau of Reclamation. FHWA-WA-ESI-05—1-F. |
| WSDOT, 2011 | __________. 2011. *Peak Hour Report*. January 1 through December 31, 2011. http://www.wsdot.wa.gov/mapsdata/travel/peakhourreport.htm. Accessed December 12, 2014. |
| WSDOT, 2012 | __________. 2012. *Avalanche Structure Draft Supplemental Environmental Impact Statement, October 2012*. http://www.wsdot.wa.gov/projects/i90/snoqualmiepasseast/I90FinalSEISandROD.htm |
| WSDOT, 2013 | __________. 2013. *2013 Annual Traffic Report.* http://www.wsdot.wa.gov/mapsdata/travel/annualtrafficreport.htm. Accessed August 8, 2014. |
| WSDOT, 2014a | __________. 2014. *Biological Assessment Preparation Advanced Training Manual, Version 02-2014.* Olympia, Washington. |

| In-text Citation | Full Reference Information |
|---|---|
| WSDOT, 2014b | __________. 2014. *Joint Aquatic Resource Permit Application (JARPA) for I-90 Phase 2A Snoqualmie Pass East, Keechelus Lake Dam to Stampede Pass Project*. February 14, 2014. |
| WSDOT and FHWA, 2005 | Washington State Department of Transportation and Federal Highway Administration (WSDOT and FHWA). 2005. *I-90 Snoqualmie Pass East Draft Environmental Impact Statement and Section 4(f) Evaluation*. June 2005. |
| WSPRC, 2000 | Washington State Parks and Recreation Commission. 2000. Iron Horse State Park and the John Wayne Pioneer Trail Management Plan. https://parks.state.wa.us/DocumentCenter/View/1282/Iron-Horse-State-Park---John-Wayne-Pioneer-Trail-Management-Plan. Approved June 29, 2000. |
| WSPRC, 2014 | __________. 2014. Iron Horse Master Plan Addendum. http://parks.state.wa.us/DocumentCenter/Home/View/5491. Approved March 27, 2014. |
| Wydoski and Whitney, 2003 | Wydoski, R.S. and Whitney, R.R. 2003. *Inland Fishes of Washington: Second Edition, Revised and Expanded, 2 Rev Expedition*. ed. University of Washington Press, Bethesda, MD. |
| Yakama Nation Fisheries, 2014a | Yakama Nation Fisheries. 2014. *Yakima Basin Sockeye Reintroduction.* http://yakamafish-nsn.gov/restore/projects/sockeye. Accessed on January 16, 2014. |
| Yakama Nation Fisheries, 2014b | __________. 2014. *Pacific Lamprey Project*. http://yakamafish-nsn.gov/restore/projects/pacific-lamprey-project#. Accessed on January 16, 2014. |
| Yakima River Basin Conservation Advisory Group, 1998 | Yakima River Basin Conservation Advisory Group. 1998. *Basin Conservation Plan for the Yakima River Basin Water Conservation Program.* |
| Yellowpages.com, 2016 | The Real Yellow Pages. 2016. [Search functions for businesses in Cle Elum, Ellensburg, and Yakima]. https://www.yellowpages.com. Accessed November 2016. |
| Young et., 1996 | Young W.J, F.M. Marston and J.R. Davis. 1996. Nutrient Exports and Land Use in Australian Catchments. Journal of Env. Management. (1996) 47, 165-183. |

| In-text Citation | Full Reference Information |
|---|---|
| YCRP, 2014 | Yakama Nation Cultural Resources Program (YCRP). 2014. *Cultural Resources Investigation of the Yakima Basin Integrated Plan: Keechelus Lake, Kachess Lake, Cle Elum Lake*. Prepared for the Bureau of Reclamation. |
| YCRP, 2015 | __________. 2015. *Yakama Nation Cultural Resources Program. Cultural Resources Investigation of the Lake Kachess, Geotechnical Bore Hole Testing, Kittitas County, WA*. Prepared for the Bureau of Reclamation. |
| YCRP, 2017 | __________. 2017. *Cultural Resources Investigation of the Kachess Drought Relief Pumping Plant and Lake Keechelus to Lake Kachess Conveyance Project for the Yakima Basin Integrated Plan, Kittitas County, Washington.* Prepared for the Bureau of Reclamation. |
| YCRP, 2018 | __________. 2018. *Cultural Resources Investigation of the Kachess Narrows; Kachess Reservoir Volitional Bull Trout Passage Improvement Yakima Basin Integrated Plan, Kittitas County, Washington.* Prepared for the Bureau of Reclamation. |
| YKFP, 2011 | Yakima/Klickitat Fisheries Project. 2011. Fish Count Web site. http://ykfp.org/docsindex.htm. Accessed November 1, 2011. |
| Ziller, 1992 | Ziller, J.S. 1992. “Distribution and relative abundance of bull trout in the Sprague River subbasin, Oregon.” Pages 18-29 in: P.J. Howell and D.V. Buchanan, editors. *Proceedings of the Gearhart Mountain Bull Trout Workshop*. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon. |

*(This page intentionally left blank)*

# LIST OF PREPARERS

*(This page intentionally left blank)*

# List of Preparers

| NAME | BACKGROUND | RESPONSIBILITY |
|---|---|---|
| Reclamation | | |
| Corey Carmack | Tribal Liaison | Indian Trust Assets and Indian Sacred Sites |
| Wendy Christensen | Civil Engineering | Program Manager, Document Review |
| Nancy Coulam | Environmental Compliance | Document Review |
| Teresa Hauser | Hydraulic Engineering | Document Development and Review |
| Joel Hubble | Fishery Science | Fish, Threatened and Endangered Species, Wildlife, Vegetation review<br>Coordination and Document Review |
| Warren Hurley | Anthropology, Archeology, Cultural Resources Management | Cultural Resources |
| Julia Long | Environmental Compliance | Assistant Program Manager, FEIS Development and Review |
| Chris Lynch | Engineering, Water Management, and Water Resource Planning | Surface Water Resources, Climate Change Review<br>Document Review |
| Candace McKinley | Environmental Compliance | NEPA Manager, Document Review |
| Juddson Sechrist | Environmental Compliance | NEPA Policy Review and Guidance |
| Rick Rieber | Fish Biology | Document Review |
| Washington State Department of Ecology | | |
| Danielle Squeochs | Environmental Engineering and Geology | Input, Oversight, Document Review |
| Tom Tebb | Geology | SEPA Responsible Official, Study Oversight, Document Review |
| HDR, Inc. | | |
| Malia Bassett | Environmental Planning | NEPA and SEPA Document Preparation |
| Sandy Cody | Environmental Science/Planning | Document Management and Editing |
| Lisa Danielski | Biology/Wetlands Science | Vegetation and Wetlands |
| Andrew Graham | Environmental Management and Water Resource Planning | Project Manager for Contractor Team |
| James Gregory | NEPA Compliance and Documentation | EIS Task Lead |
| Bob King | Engineering | Alternatives Engineering |
| Adam Kessler | Geology | Earth, Groundwater |
| Rona Spellecacy | NEPA/SEPA Documentation, Water Resources Planning | NEPA and SEPA Document QC |
| Adam Teepe | NEPA Compliance and Documentation | Transportation, NEPA and SEPA Document Production |
| Steve Thurin | Water Resource Planning and Engineering | Climate Change |

| NAME | BACKGROUND | RESPONSIBILITY |
|---|---|---|
| Michelle Victor | Geographic Information Systems (GIS) Analysis | GIS Analysis |
| Ian Welch | Wildlife Biology | Wildlife, T&E Species |
| Anchor QEA | | |
| Adam Hill | Water Resources Planning and Engineering | Surface Water |
| Larissa Rohrbach | Biology | Fisheries |
| Bob Montgomery | Water Resources Planning and Engineering | Water Resources |
| ECONorthwest | | |
| Mark Buckley | Economics | Socioeconomics |
| Sarah Reich | Economics | Socioeconomics |

## DISTRIBUTION LIST

*(This page intentionally left blank)*

# Distribution List

This FEIS is available for information and review on Reclamation's Pacific Northwest Region Web site at www.usbr.gov and at 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. In addition, copies were sent to those who provided comments during the scoping period and to those who requested a copy. All locations are in the State of Washington, unless otherwise noted.

## U.S. Congressional Delegation

### *United States Senate*

Honorable Maria Cantwell, Richland, Seattle, Spokane; Washington DC

Honorable Patty Murray, Seattle, Tacoma, Yakima; Washington DC

### *House of Representatives*

Honorable Dan Newhouse, Richland, Yakima; Washington, DC Honorable

Kim Schrier, Wenatchee, Issaquah; Washington DC

## Governor of Washington

Honorable Jay Inslee, Olympia

## Indian Tribes

Confederated Tribes and Bands of the Yakama Nation, Toppenish, Yakima

Confederated Tribes of the Umatilla Indian Reservation, Pendleton, Oregon

Confederated Tribes of the Colville Reservation, Nespelem

Columbia River Intertribal Fish Commission, Portland, Oregon

## Washington State Legislature

### *13th Legislative District*

Senator Judy Warnick, Olympia

Representative Matt Manweller, Olympia

Representative Tom Dent, Olympia

### *14th Legislative District*

Senator Curtis King, Olympia

Representative Norm Johnson, Olympia

Representative Gina Mosbrucker, Olympia

*15th Legislative District*

Senator Jim Honeyford, Olympia

Representative Bruce Chandler, Olympia

Representative David Taylor, Olympia

*8th Legislative District*

Senator Sharon Brown, Olympia

Representative Brad Klippert, Olympia

Representative Larry Haler, Olympia

*4th Legislative District*

Senator Mike Padden, Olympia

Representative Bob McCaslin, Olympia

Representative Matt Shea, Olympia

## Federal Agencies

Advisory Council on Historic Preservation, Washington, DC

Department of Agriculture

U.S. Forest Service, Cle Elum, Naches, Wenatchee; Portland, OR; Washington, DC Natural Resources Conservation Service, Spokane

Department of Defense

Department of the Army

U.S. Army Corps of Engineers, Seattle

Yakima Training Center, Yakima

Department of Energy

Bonneville Power Administration, Richland; Portland, Oregon

Department of Commerce

National Oceanic and Atmospheric Administration

National Marine Fisheries Service, Ellensburg, Seattle; Portland, Oregon

Department of the Interior

Bureau of Indian Affairs, Toppenish; Portland, Oregon

Bureau of Land Management, Spokane Valley; Portland, Oregon

Bureau of Reclamation, Yakima; Boise, ID; Denver, CO

Office of the Solicitor, Pacific Northwest Region, Boise, ID

U.S. Fish and Wildlife Service, Lacey, Wenatchee, Yakima; Portland, Oregon

U.S. Geological Survey, Tacoma

Department of Transportation

Federal Highway Administration, Olympia

U.S. Environmental Protection Agency, Region 10

Seattle; Washington, DC

## State and Local Government Agencies

### *State of Washington*

Department of Agriculture, Olympia

Department of Archaeology and Historic Preservation, Olympia

Department of Ecology, Yakima

Department of Ecology SEPA Unit, Lacey

Department of Ecology, Surface Water Unit, Yakima

Department of Ecology, Water Resources, Union Gap

Department of Commerce, Olympia

Department of Fish and Wildlife, Yakima, Wenatchee, Olympia

Department of Natural Resources, Olympia

Department of Recreation and Conservation Office, Olympia

Department of Transportation, Union Gap, Olympia

Department of Transportation, Real Estate Services, Olympia

State Parks and Recreation Commission, Olympia

### *Local Agencies*

Benton County

Board of County Commissioners, Prosser

Parks and Economic Development

City of Cle Elum

City of Ellensburg

City of Kennewick

City of Pasco

City of Richland

City of Roslyn

City of Selah

City of Sunnyside

City of West Richland

City of Yakima

Easton Water District

Ellensburg Water Company

Town of Naches

Kittitas County

- Board of Commissioners, Ellensburg
- Department of Public Works, Ellensburg
- Conservation District, Ellensburg
- Fire & Rescue District No. 8, Easton

Port of Benton

- Commissioners, Prosser, Richland

Port of Sunnyside, Sunnyside

Snoqualmie Pass Fire and Rescue, Snoqualmie

Yakima County

- Board of Commissioners, Yakima
- Planning Department, Yakima
- Public Services, Yakima
- Yakima Regional Clean Air Agency, Yakima
- Yakima Valley Conference of Governments, Yakima

## Irrigation Districts

Ahtanum Irrigation District

Benton Irrigation District, Benton City

Cascade Irrigation District, Ellensburg

Columbia Irrigation District, Kennewick

Kennewick Irrigation District, Kennewick

Kittitas Reclamation District, Ellensburg

Naches-Selah Irrigation District, Selah

Roza Irrigation District, Sunnyside, Wapato

Selah-Moxee Irrigation District, Moxee

Sunnyside Valley Irrigation District, Sunnyside

Union Gap Irrigation District, Wapato

Wapato Irrigation Project, Wapato

Westside Irrigation Company PUC, Ellensburg

Yakima-Tieton Irrigation District, Yakima

## Libraries

Benton City Library, Benton City

Carpenter Memorial Library, Cle Elum

Ellensburg Public Library, Ellensburg

Kennewick Library, Kennewick

Kittitas Public Library, Kittitas

Mid-Columbia Library, Kennewick

Pasco Library, Pasco

Prosser Library, Prosser

Richland Public Library, Richland

Roslyn Public Library, Roslyn

Selah Public Library

Sunnyside Public Library, Sunnyside

Toppenish Library, Toppenish

Wapato Library, Wapato

Washington State Library, Olympia

West Richland Library, Richland

West Valley Public Library, Yakima

Yakama Nation Library, Toppenish

Yakima Valley Regional Library, Yakima

## Organizations

Alpine Lakes Protection Society

American Rivers, Bellingham

American Whitewater, Seattle

Aqua Permanente, Ellensburg, Cle Elum

Atlantic States Legal Foundation, Inc., Syracuse, New York

Backcountry Horsemen of Washington, Benton City, Thorp, Yakima

Badgley Ranches, Wapato

Center for Environmental Law and Policy, Seattle

Center for Biological Diversity, Washington DC

Central Washington Homebuilders Association, Ellensburg, Cle Elum

Central Washington Resource Energy Collaborative, Ellensburg

Columbia River Intertribal Fish Commission, Portland, Oregon

Conservation Northwest, Seattle

East Kachess Homeowners Association, Issaquah

ECONorthwest, Eugene, Oregon

Endangered Species Coalition, Washington D.C.

FFF Steelhead Committee (email)

Federation of Western Outdoor Clubs, Molalla, Oregon

Forterra, Seattle

Friends of Bumping Lake, Seattle

Friends of the Earth, Washington D.C.

Friends of the Teanaway, Cle Elum

Friends of Wild Sky, Duvall

Heart of America Northwest, Seattle

Hyak Property Owners Association, Snoqualmie

Kachess Community Association, Easton, Seattle

Kachess Lake Homeowners Association, Bellevue

Kachess Ridge Maintenance Association, Easton

Kittitas Audubon Society, Ellensburg

Kittitas Conservation Trust, Roslyn

Kittitas County Chamber of Commerce, Ellensburg

Kittitas County Conservation Coalition, Easton

Kittitas County Conservation Trust, Roslyn

Lake Easton State Park, Easton

Lake Kachess Homeowners Association, Easton

League of Women Voters, Yakima

Mid-Columbia Fisheries Enhancement Group, Ellensburg

Middlefork Outdoor Recreation Coalition, Ellensburg

North Cascades Conservation Council, Seattle

Olympic Forest Coalition, Quilcene

Pacific Northwest Waterways Association, Portland, Oregon

Pacific Northwest Four-Wheel Drive Association, Auburn

Pilchuck Audubon Society, Marysville

Plum Creek Timber Company, Columbia Fall, Montana

Seattle Audubon Society, Seattle

Sierra Club, Seattle

Tapash Sustainable Forest Collaborative, Yakima

The Wilderness Society, Seattle

Trout Unlimited, Wenatchee

Trust for Public Land, Seattle

Washington Cattlemen's Association, Harrah

Washington State Insurance Pool, Ellensburg

Washington State University, Pullman

Washington Water Trust, Ellensburg

Western Watersheds Project, Boise, Idaho

Wise Use Movement, Seattle

Xerces Society for Invertebrate Conservation

Yakima Basin Fish and Wildlife Recovery Board, Yakima

Yakima Basin Joint Board, Sunnyside

Yakima Basin Storage Alliance, Yakima, Zillah

Yakima County Cattlemen's Association, Yakima

Yakima County Democrats, Yakima

Yakama Nation Fisheries, Toppenish

Yakima County Clean Air Agency, Yakima

Yakima County Farm Bureau, Grandview, Moxee

Yakima Valley Audubon Society, Yakima

## Business Entities

Bear Creek LLC

Encompass Engineering and Survey, Cle Elum

Entrust North LLC, Chelan

Halverson Northwest Law Group, Yakima, Sunnyside

Jacobs Engineering, Ellensburg

J&D's Hydraulic and Repair, Auburn

Lake Kachess Mountain Retreat, Renton

Lake Kachess Resort, North Bend

Lodge Creek Land Company LLC - Tacoma

MCH2 LLC, Kent

Mount Baldy Ranch LLP, Seattle

Mountain High Hamburger

Mountain Property LLC, Easton

Murphy at Lake Kachess LLP

Normandeau Associates, Seattle

North Anabilis LLC, Seattle

Plum Creek Timber Company, Columbia Falls, MT

Riverglen Properties, Bellevue

Shimmick Construction Southwest, Irvine, CA

Ski Tur Valley Maintenance, Snoqualmie Pass

Tanscape Ventures LLC – Bonney Lake

Tatoosh Law and Policy Group, Seattle

The Boeing Company, Seattle

VanNess Feldman, LLP, Seattle

Wells Fargo Bank Trustees, Merrill Lynch – Maimisburg OH

Western Water Futures LLC, Seattle

Yakima Auto Dealers, Yakima

## Media

Ellensburg Daily Record, Ellensburg

North Kittitas County Tribune, Cle Elum

Tri-City Herald, Tri-Cities

Yakima Herald Republic, Yakima

North Kittitas County Tribune, Cle Elum

## Individuals

Abercrombie, Janet

Adair, Steve – Poulsbo

Adams, Alexis

Adams, Leah

Adams-Kessinger, Cody

Agnew, Theresa

Aguilar, Mr. & Mrs. – Hawthorne CA

Aguilar, Bonnie

Ahlers, Carl

Ahlers, John

Ahlers, Julie

Ahlers, Lynn – Cle Elum

Aigner, Kimberly

Aigner, Rob – Easton

Aiken, Shannon – Snoqualmie

Aiken, Michael – Lake Kachess

Aiken, Michael & Madeline – North Bend

Aikens, Kimberly

Aikens, Megan

Aikens, Michelle

AlAzzam, Ahmad

Albulet, Mr. & Mrs – Redmond

Albulet, Lucretia – Redmond

Albulet, Michelle – Seattle

Alexander, Michael

Aliment, Mr. & Mrs. Randy J. – Renton

Allan, Tynan

Allen, David L. & Katya M. – Bellevue

Allen, Don – Renton

Allen, Erick

Allen, Justin

Allen, Michael

Allen, Yvonne

Alley, Janet

Allgaier, Robert

Allott, Sessi

Allyn, Sharon

Alma, Mr. & Mrs. John – Easton

Ament, Janet – Redmond

Anderson, Anna – Edmonds

Anderson, Arnols – Seattle

Anderson, Mr. & Mrs. William E. – Spanawy

Anderson, Terry E. – Snohomish

Anderson, Brigit

Anderson, Kasper

Anderson, Mary

Anderson, Meghan – Ellensburg

Anderson, Phillip

Andrews, Gayle & Steven – Silvana

Andrews, David – Easton

Cranton, Timothy – Easton

Annis, Mr. & Mrs. Michael A. – Snoqualmie

Applin, Raini

Archey, Chris

Archey, Jacquelyn

Ardea, Brigitte

Aresu, Avery
Aresu, Diana E – Lake Tapps
Aresu, Tony – Lake Tapps
Armstrong, Angie
Arndt, Mr. & Mrs. Kraig – Pacific
Arnold, Hannah
Arsenhault, Mr. & Mrs. Bret P. – Bellevue
Aspinall, Emma
Atkins, Muhammad
Auckland, Caraline
Avdeyev, Inessa
Avey, Tricia
Ayres, Thomas G. – North Bend
Babitsky, Pam
Babunovic, Emile
Bacon, Britta
Badda, Cecelia A. – Cle Elum
Bahhage, Monir
Bailey, Mr. & Mrs. Gregory F. – Olympia
Bailey, Hailly
Bailey, Jennifer
Bailie, Bob – Issaquah
Baily, Alanda
Baily-Sun, Erin
Baker, Brandi
Baker, Chris
Baker, Sam
Baldi, Gloria nd Jeb – Ellensburg
Baldwin, Angel
Baldwin, Keith and Margaret – Woodinville
Ball, James – Redmond
Ballard, Kay

Banks, Morgan

Barmuta, Stacy

Barnbaum, Bruce – Granite Falls

Barnes, Christine

Barney, Joshua

Baron, Trace

Barrett, Scott

Barry, Peter

Barzen, Erin and Ncy – Seattle

Bastedo, Amber

Baston, Maggie

Batteiger, Debbie – Issaquah

Batty, DeAnn

Bautista, Juan

Beach, Jason

Beaman, Mr. & Mrs. Brian – Carnation

Beard, Kurt & Carol Anne Rozelle – Bothell

Beardsley, John

Beaty, Rebecca

Beaudoin, Paul

Beauvais, Susan

Beck, Michelle

Becker, Jim and Nancy

Becker, Jennifer

Beckman, Jesse R. – Renton

Beekley, Gina

Beers, Sarah

Beilke, Janelle

Benediktsson, Gerald G, Newman, and Lynn – Ellensburg

Benediktssonm, Mike

Benediktsson, Tom and Lynn – Glen Ridge NJ

Benediktsson, Mike Owen

Benitz, Max – Prosser

Bensen, Steven

Benward, Amber

Berg, Berg – Seattle

Berg, Alexa

Berger, Richard

Bergford, Scott & Patricia – Olympia

Bergsma, Jeffrey B. – Maple Valley

Bergstrom, Mary – Cle Elum

Berline, Michael

Berndt, Gary – Ellensburg

Bernhardt, Kathryn

Berry, Anna Lauren

Berry, Jennifer

Berthon, Ralph – Yakima

Bettcher, Cerara

Betz, Nicole

Bianchi, Tom – Prosser

Bickford, Alice

Bierek, D.M. – Cle Elum

Billings, Darren

Binder, Kurt

Birds, Steve

Birdsall, Sandy

Bishop, Martha

Black, Julius W. – Kennewick

Black, Christopher W. – Seattle

Blair, Blair – Camano Island

Blair, Wayne C. – Renton

Blair, Letizia

Blanco, Kassy

Bluestein, Benjamin

Bobovski, Mr. & Mrs. William P. – Ellensburg

Bobovski, Carol

Bocchetti, Aaron

Bocek, Thomas M. And Eileen C. – Burien

Bocek, Jospeh

Bocek, S.

Bocek, Thomas – Easton

Boeing Company, The – Seattle

Bogart, Brandy

Bold, Shawna

Bondarenko, Raya

Bonney, Caitlin

Boock, Max

Bookter, Teresa

Bosnick, Donald L. & Karen K. – Gig Harbor

Bosord, Hank – Zillah

Botkin, Linnet – Ellensburg

Boudreau, Lucinda

Boug, Chelsea

Bourassa, Raymond – Mesquite NV

Bowen, Kevin

Boyle, James – Ronald

Boyle, Lisa

Braaten, Aaron

Bradbury, Ben

Bradner, Mr. & Mrs. Mark – Lake Tapps

Bradshaw, Bart & Michele – Ellensburg

Braile-Huss, Laura

Brasser, Justin

Brault, Paul

Brauworth, Jason

Breckel-Lindelof, Haley

Breitbach, Melanie J. – Fall City

Brennan, Taylor

Brettmann, Kenneth F. – Coupeville

Brewer, Lynn and Douglas – Easton

Brill, Gary – Seattle

Broehl, Mitchell

Bronson, Andria

Brookens, Doug & Darcy – Issaquah

Brooks, Jamesy

Broughton, Eldon – Moses Lake

Broussard, Paula

Brown, Kaylene E. – Auburn

Brown, Kim

Brown, Travis

Brummond, Carol

Brunson, Barry – Cle Elum

Bryson, Michael

Bui, Johnny

Buitron, Charles – Seattle

Bultman, Mr. & Mrs. Thomas – Bothell

Bunn, Shelby

Burbidge, James

Burbidge, Jeanne

Burbidge, Scott

Burgher, Nate

Buri, Sarah

Burk, Bill – Bend OR

Burke, Mary – Fox OR

Burke, Andrew – Sammamish

Burke, Austin – Brighton MA

Burke, Mark & Maria – Sammamish

Burnham, Jay & Nancy – Auburn

Burns, Mr. & Mrs. Michael – Issaquah

Burns, Sean

Burton, Mr. & Mr. Kenneth – North Bend

Busby, Marci Dawn Whitham – North Bend

Bussman, Mr. & Mrs. Joseph – Bothell

Butchart, Janet

Butler, David

Byrd, Rebecca

Cadwalader, Wende

Cain, Kyler

Callis, Abigail

Callis, Elizabeth

Caminos, Nathaniel – Seattle

Campbell, Cathy – Burien

Campbell, Karen & Bill – Easton

Campbell, Mr. & Mrs. Richard L. – Bellingham

Campbell, Canny

Campbell, Craig

Campbell, Lyssa

Campbell, Nick

Canan, Mary Hansen – Seahurst

Canan, Mike

Canas, Shawna

Capell, Fred & Sue – Newberg OR

Cardone, Nancy

Carins, Ian

Carl, Jeffrey

Carl, Sarah

Carlin, Howard D. – Roslyn

Carlson, John – Snoqualmie Pass

Carlson, John M. And Sharon – Easton

Carlson, Courtney

Carmichael, Deborah

Carmody, Lori – Issaquah

Carmody, Thomas

Carnahan, Donaldson & Sharon, and Mr. & Mrs. David W. – Renton

Carns, Mr. & Mrs. David W. – Fall City

Carolan, Quinn

Carpenter, Laura

Carter, Adam

Carter, Donna

Carter, Micah

Castaneda, Kalani

Castillo, Yoseline

Casto, Amy

Cavanagh, Liam – Sammamish

Cavanaugh, Jessica

Cavelia, Jan

Cavenaugh, Jeanne

Centioli, Mr. & Mrs. Sam, & Michael Messina – Seattle

Cernick, Robert – Cle Elum

Cernick, Debbie

Chabal, Sharon – Bellevue

Chamberlain, Zack

Chambers, Matt – Cle Elum

Chan, William

Chapman, Mr. & Mrs. Murray L. – Carnation

Charles, Clifford

Charles, Karther

Charlton, Mark

Chellew, Nikki

Kapaska, Michelle, and Marvin – Easton

Childs, Krista

Christensen, Mr. & Mrs. Tage – Tacoma

Christensen, Robert Class – Olympia

Christiansen, Erik

Christie, Betsy

Christie, Kerri

Christinat, Jennifer

Christman, Tiffany

Chu, Amy

Clark, Christi

Clark, Dennis – Anacortes

Clark, Jonathan

Clark, Katy

Clark, Theresa

Clark, Tom

Clarke, Ronald

Clay, Lacey

Clements, Lori

Clements, Scott

Clerf, Roger N. – Cle Elum

Clinger, Summer

Coan, Michael – Seattle

Coan, Riley

Cobb, Heather

Codd, Stuart

Coddington, Brittany

Coder, Chad

Cody, Regina – Seattle

Cohen, Fritzi

Cohen, Ronald L. – Mercer Island

Cole, Brian & Margaret – Yakima

Cole, Elena

Cole, Max

Coleman, Mr. & Mrs. Brian C. – Yakima

Coleman, Mr.& Mr. Roger E. – Sumner

Coleman, Phoebe

Collamore, Christina M. & David – Enumclaw

Collazo, Jonah

Coluccio, Mr. & Mrs. Nicola – Seattle

Comstock, Robin Stringer & Todd – Poulsbo

Congswell, Dana and Andrea Radosevich – Seattle

Connell, Tiffini

Conner, Glen – Bellevue

Conner, Eric

Conner, Sarah

Contreras, Nick – Lake Stevens

Cook, Carroll – Shoreline

Cook, Paul & Koleen – Bellevue

Cook, Daniel

Cooke, Helen

Cooley, Hannah

Cooper, Jonathan

Correa, Darci

Cotton, Michelle

Coughtry, Chairein

Courage, Sean

Court, Danelle

Cowan, David – Grandview

Cox, Emily

Coy, Alexander

Crampton, Andrew

Crandall, Clifford E. – Auburn

Crews, Kevin

Crilly, Jennifer

Crim, John

Crisostomeo – Auburn

Crooks, Brian
Crume, Nicole
Cruth, Ryan – Lynnwood
Cuddie, Gavin
Cumiford, Jerry – Eagle Point OR
Cunningham, Cassandra
Curd, Kevin
Cure, Lillie
Curtis, Mr. & Mr. Robert – Newcastle
Cushman, Kelly
Cutler, Courtney
Cyzner, Eric
da Silva, Kelli
da Silva, Ryan
Dahlquist, Mr. & Mrs. – Sumner
Daley, Michael – Redmond OR
Dallman, Amanda
Dalrymple, Breanna
Dalrymple, Brent
Dalrymple, Erika
Dalrymple, Paula
Daly, Andi
Daly, Greg – Seattle
Damm, Joylynn
Dang, Johnny
Daniels, Michael W. – Woodinville
Danielson, Mr. & Mrs. Alvin G. – Redmond
Darland, Mr. & Mrs. Michael – Bellevue
Dash, Trevor – Bellevue
Daugherty, John & Nancy – Seattle
Davenport, Jim – Buena
Davenport, Mr. & Mrs. Jeff – Easton

Davidson, Mr. & Mrs. Doug, and Joseph – Bellevue

Davidson, Steven E. – Shoreline

Davidson, Doug – Bellevue

Davis, Claudia – Seattle

Davis, Delmar – Seattle

Davis, Mr. & Mrs. Robert – Bothell

Davis, Mr. & Mrs. Theodore – Seattle

Davis, Blake

Davis, Holly

Davis, Mr. & Mrs Bob R. & Mr. & Mrs. Comer, & Mrs. J. Jarvis – East Wenatchee

Davis, Sherry

Davis, Teresa

Davydenko, Valerity

Dawes, Alyssa

Dawson, Kirk & Susun Shyne – Mercer Island

Day, Phil – Easton

de La Chapelle, Charlie

De Leon, Bethany

De Sgrosellier, Katherine M. – Seattle

Dean, Arnie & Delores – Cle Elum

Dean, Heather

Deaton, Thomas

Deaver, Chuck

Decker, Jessica

DeFoe, Josetta – Kennewick

Defoe, Mr. & Mrs. Steven – Kennewick

Delachica, Amy

DeLaHousaye, Paula

Delarosa, Nicole

Delegans, George and Alexandra H. – Sammamish

Dempster, Jacque

Denhoed, John – Grandview

Denney, Gavin

Denton, Marc – Portland OR

Deriso, Dawn and John Gowan

DeRuyter, Jake – Outlook

Deschenes, Chauncey – Tacoma

Detmer, Susan

DeVore, Michael

DeWitt, Emily

DeWolf, Marie

Deyette, Kevin

DeYoung, Mr. and Mrs. Daniel O. – Preston

Diamond, K.S. – Redmond

Diaz de Leon, Michelle

Diaz, Doris

Dickman, Mary

Diekman, Jane E. and Lori Hanson – Mercer Island

Diener – Bellingham

Diener, Mr. and Mrs. Doug, & Janet Ribby – Bend OR

Diether-Martin, Liz – Seattle

Dill, Joe – Seattle

Dinusson, Ruth

DiPangrazio, Anthony J. – Port Angeles

Dire, Heather

Dolan, Robert

Doland, Tara

Doles, Diane

Donaldson, Johnny

Donavan, Mr. and Mrs. John P. – Easton

Doran, Sherrill – Bellevue

Dore, George D. III and Cecelia A. – Kent

Dore, Rian

Dornan, Kaitlin – Baton Rouge LA

Dornan, Kathleen – Seattle

Dornan, Kelly – Omaha NE

Dornan, Stuart – Omaha NE

Dornan, Madelyn

Dounis, Anthony

Dove, David

Dowell, Megan

Downs, Mr. and Mrs. Oren – Olympia

Draaisma, Maja

Drake, Marcia

Drenbert, Robert

Dressler, Aaron

Driskell, David and Stephanie – Snoqualmiee Pass

Duclos, Timothy

Dulin, Andy and Linda – Edmonds

Duncan, Susan

Duncanson, Harold – Seattle

Duncanson, Henry

Duncanson, Kay

Duncanson, Maxine

Dunkel, Sarah

Dunn, LaShanda

Durkan, Martin J. – Maple Valley

Dwyer, Patrick F. and Jennifer – Kenmore

Eckert, Josephine – Washington DC

Eckert, Henry

Edde, Marilyn A. – Bellevue

Edde, Mike – Bellevue

Eddy, Mr. and Mrs. Alan – Kent

Edelbrock, Michael and Lois – Snohomish

Edwards, Jack and Pat – Lake Stevens

Edwards, Aaron

Effer, Keith

Egger, Ashley

Egger, Chad

Eggers, Malisa

Eggleston, David

Elder, Greg

Elder, James – Puyallup

Eliot, Scott

Elkins, Colette

Ellioitt, Sean

Ellison, Cody

Elmer, Gary – Quilcene

Elsing, Chris

Emmons, Mary and Dennis – Ellensburg

Engberg, Gregory – Renton

Engberg, Mr. and Mrs. Douglass – Bellevue

Engberg, Brah – Bellevue

England, Jan – Renton

England, Alex

Entrust North LLC – Chelan

Erickson, Mr. and Mrs. – Arlington

Erickson, Brandon – Seattle

Erickson, Cheri

Erickson, Kama

Eslinger, Kevin

Evanger, Brayden

Evans, Brock – Washington DC

Evans, Richard – Richland

Evans, Mr. and Mrs. James – Vashon

Evers, Kristen

Fahey, Nicholas

Farquar, Leisa

Fehrenbach, Veronica

Felix, Brianna Busby – North Bend

Fellman, Scott – Frisco TX

Fendell, Larry – Zillah

Fergsuson, Dan and Carol – Woodinville

Ferguson, Dan – Easton

Fevergeon, Matt

Fife, Mr. and Mrs. Brian – Renton

Finke, Dr. Janet

Finley, Sharra – Yakima

Meyer, Michael. – Denver CO

Fischer Craig A. and Heidi Anne Kelley – Issaquah

Fischer, Curtis

Fitch, Mr. and Mrs. Mike – Easton

Fitzpatrick, Camille, – Mukilteo

Flaccus, Karl and Chris Balk – Seattle

Flamiatos, Lucinda

Flaten, Allison

Fleck, Sawyer

Fleischer, Alex

Fleury, William L. – Seattle

Florian, Michael

Ford, Michelle

Foster, Avery – Woodinville

Foster, Roger A. and Kelsey – Woodinville

Fountain, A. P.

Fountain, Jean

Fountain, Jean and Tim

Fountain, Jeffrey

Fountain, Makyla

Fountain, Mrs. J.M.

Fountain, Nikki

Fountain, Tim

Fox, Courtney

Fox, Lucia

Frank, Erik and Janelle – Monore

Franklin, Troy and Jana – Marysville

Franklin, Beverly – Easton

Franks, Larry E. and Mary L. – Kent

Franks, Tammy

Fraxier, Mr. and Mrs. Lee – Easton

Frazier, Bob and Barbara

Freeberg, Jennifer

Freeborn, Phelps – Yakima

Freeman, Cassi

Friedman, Tanya

Friedrick

Frost, Eythan

Frye, Carll – Easton

Frye, Doug

Fudge, Mr. and Mrs. Michael W. – Easton

Fuller, Joseph H. – Seattle

Fulton, Bruce

Fury, Denis – North Bend

Fury, Gail – North Bend

Fury, C. Steven and Nancy Lawton – Seattle

Gaiudrone, Edward A.

Gallagher, Jennifer

Galom, Jennifer

Garber, Tomarra

Gardner, Jackie – Lake Forest Park

Gardner, Kay

Garrison, Tom – Outlook

Garrison, Neil

Gehrmann, Braden

Geiger, Mr. & Mrs. Todd – Auburn

Geiger, Laurie

Geiger, Todd

Geiger, Vanessa

Geinger

Gentry, Rex and Mary – Seattle

Gentry, Sharon

George, Chris – Kirkland

Gerard, Chris, and Laurie Tatalick – Redmond

Gest, Neil c. – Sammamish

Gest, Erick

Gest, Neil

Giaudrone, Edward

Giaudrone, James

Giaudrone, Suzanne

Giboney, Greg

Gienger, Chelann

Gienger, Kylon & Teliah – Easton

Gienger, Lonnie – Easton

Gienger, Michelle

Giese, Petrina

Gilbert, Nona – Fall City

Gilbert, Trevor

Gile, Melissa

Giovenale, Susan

Gipson, Jerry M. – Easton

Gloyd, Caren

Goeke, Steve, and Jennifer Kohout – Easton

Goemger, Lonnie – Easton

Goiney, Matt

Gold, Raelene – Lake Forest Park

Golden, Jim

Golding, Mr. and Mrs. Gerald – Bellevue

Golliver, Mr. and Mrs. Robert R. – Oro Valley AZ

Golliver, Greg

Gonzales, Josette

Goode, Robert – Snoqualmie Pass

Gorchels, Christopher and Kay – Richland

Gorchels, Mark

Gorder, Jonathan

Gordon, Barbra

Gordon, Madeline

Gordon, Maurice

Gorski, Adam and Tiffany – North Bend

Gorski, Adam

Gorski, Tiffany

Gracey, Jeremy – Honolulu HI

Gracic, Jack

Graham, Barbara C. – Easton

Graham, Emily

Grande, Wendy – Kirkland

Grande, Elizabeth

Grank, Erik and Janell – Monroe

Grantham, Jesse

Gratama, Candace and Pete – Kirkland

Gratias, Cindee

Gray, Gary and Jennifer

Gray, Gordon – Seattle

Grays, Monica

Greben, Oleg

Greben, Paul & Galina – Bothell

Greben, Yelena

Greear, Deanna

Greear, Joel

Green, Lisa

Green, Sarah

Griffin, Danese

Griffith, Kristin A. – Issaquah

Griffith, Mr. and Mrs. Mitchell – Easton

Grimes, Darren

Grimes-Richfield, Tabatha

Grinius-Hill, Sue

Grinstead, Mr. and Mr. Mark A. – Medina

Griswol – Cle Elum

Groeneweg, Bob – Outlook

Groeneweg, Paul – Outlook

Grouws, Ryan A. and Steve – Bellevue

Grubb, Donald – Bellevue

Gruber, William

Gruits, Laura

Guerra, Lino – Sunnyside

Guhlke, Marlena – Spokane

Guilfoyle, Carol

Guilfoyle, Josh

Gunnarsson, Gunvore – Renton

Guzman, Terry

Hablutzel, Mike

Hagan, Frank

Hajduk, Jonathan

Hall, David and Lee Randall – Ellensburg

Hall, Bonnie

Hall, Teresa

Hallisey – Cle Elum

Hallisey, Brad M. and Tiffany J. – Redmond

Halpin, Maggie

Halstead, Clyde L. – Seattle

Halvorson, Henry

Halvorson, Melissa

Halvorson, Paul

Halwachs, Carrera – Renton

Hamberlin, Mr. and Mrs. – Ronald

Hambert, Stevie

Hamilton, Alistair – Sammamish

Hamilton, Grace

Hamilton, Jory

Hamilton, Laura Lottman

Hamilton, Sara

Hamm, Sarah

Hammond, Mr. and Mrs. Wayne S. – Renton

Hammond, Bryant

Hammond, Melissa

Hammond, Nancy

Hanan, Morris – Issaquah

Hanan, Thomas

Hance, Mr. and Mrs.Barry – Woodinville

Hanches, Constantine – Portland OR

Hand, Patrick – Ellensburg

Hangartner, Mikaela

Hansberry, Tina

Hansen, Jody – Ellensburg

Hanvold, Chris – Redmond

Harder, Scott

Harja, David

Harlow, Devin

Harris, Mr. and Mrs. Tony – Mabton

Harris, Kirk – Fall City

Harris, Sophie

Harrison, Trevor

Hart, Olivia

Hartman, Jana

Hartpence, Andy

Hartpence, Jennifer – Seattle

Harvey, David – Bellevue

Harvey, Kristen

Harwood, Arlyn – Mercer Island

Haslund, Leif

Hastings, Rae Ann

Haugen, Geraldine

Hayes, Donald L. and Shirley M-Hayes Decendents Trust – Issaquah

Hayes, Shan

Hayne, Shelby

Haysom, Jeremy

Hazard, Albert

Hazard, Taylor – Edmonds

Hazard, Emily

Hazard, Morgan

Hazard, Alyxandra

Hazard, Dr. Keifer

Hazard, Nicholas

Heaverlo, Jess – Yakima

Hegge, Stephen B. – Everett

Heil, Jeralyn

Heintz, Mr. and Mrs. Mark A. – Federal Way

Helgeson, Chris

Hellene, Sadera

Heller, Gills

Heller, Nicole

Helmerson, Vicki

Henderson Jr., Edward M. – Seattle

Henderson, Laura

Henderson, Rachel

Hendren, Alec

Hendricks, Brooke – Seattle

Hendricks, Lorelle Edmonson – Sammanish

Hendry, Courtney

Heneghan, Shannon

Henkle, Charlotte

Henne, Erik

Henninger, Steven

Henrichsen, Tessa

Henry, Hannah

Hentges, Katie

Heoper, Mr. and Mrs. James, and Mr. and Mrs. Troy Jackdon – Rona ld

Heric, David and Cindy – Edmonds

Hermanson, Diane – Spokane

Hernandez, Karla

Herndon, Rick – Sunnyside

Herron, Karla P. – Easton

Herron, Kyle

Hickman, Nicole

Hilfer, Stephanie

Hill, Renee

Hill, Francis

Hinton, Leonard

Hix, Mr. and Mrs.Steven – Camas

Hoban, Mike – Cle Elum

Hochstein, Rachel

Hodorowski, Brenda

Hoey, Patricia & Peter Deboldt – Seattle

Hofferber, Jacob

Hoffine, Pearl G. – Easton

Holland, Susan

Holmes, Edward

Home, Nancy

Homes, Carolyn

Honeyford, Jim – Sunnyside

Hood, Megan

Hoots, David

Hoover, Mark

Hopkins, Keith – Kent

Hopkins, Adrian

Horner, Janelle

Howard, Dan – Monroe

Howbert, Sarah

Howell, Abbey

Howland, Jon – Seattle

Hubble

Huber, Stephanie

Hubert, Marilyn – Auburn

Huggett, Judy

Huggett, Kevin – Snoqualmie Pass

Hughart, Jenny

Hughes, Ashley – Easton

Hummel, Mr. and Mrs. Stanley – Federal Way

Hummel, Kathleen

Hundley, Rick

Hunsaker, Mr. and Mrs. Timothy – Auburn

Hunt, Evelyn – Mattawa

Hunter, Mary Ellen

Hurley

Hurley, Sonja

Hurst, Eric

Hutson, Jeannine

Huynh, Michelle

Hynes, Gregory – Easton

Ilgenfritz, Robert

Ilisan, Mr. and Mrs. Ioan T. – Issaquah

Illstrup, Sharon

Inlow, Alana

Ipsen, Ashley

Ireton, Lori

Irinel, Susan – Redmond

Iverson, Richard J. – Vancouver

Iverson, Virgil R., and Debra Belcourt – Kent

Iverson, Kevin

Jackson, Bradford G. and Jill A. – Mercer Island

Jackson, Rachael

Jacobson, Lavelle

Jahn, Brandy – Sammamish

Jancola, Kelsey

Janecke, Shannyn

Jarvis, James

Jarvis, Kelsey

Jarvis, Lindsey

Jefferson, Ethel

Jelovich, Joslynn

Jelovich, Micah

Jelovich-Jonas, Jodi

Jensen, John – Easton

Jensen, Mr.and Mrs. Steve – Puyallup

Jensen, Erick

Jensen, Gail

Jensen, Kevin

Jensen, Kristin

Jensen, Linda

Johnson, Brian T. – Bellevue

Johnson, Don and Delores – Easton

Johnson, Doug – Roslyn

Johnson, Mr. and Mrs. Joel M. – Auburn

Johnson, Pamela – Fall City

Johnson, Christine – Maple Valley

Johnson, Jolie

Johnson, Dulce

Johnson, Dustin

Johnson, Garrett

Johnson, Kathy M.

Johnson, Martha

Johnson, Nancy & Joel

Johnson, Parker

Johnston, Milt – Ellensburg

Johnston, Richard A. – Fircrest

Jonas, Jayme – Sammamish

Jonas, Mr. and Mrs. Brad S. – Sammamish

Jonas, Brad – Sammamish

Jones, Michael – Lake Stevens

Jones, Traci – Easton

Jones, Jackie

Jongeward, Emilee

Jordan, Patty

Jorgensen, Ursula

Judge, Tom

Junchmes, Molly

Jung, Mr. and Mrs. Charles – Mercer Island

Jung, Christopher

Kaemingk, Danae

Kahn, David

Kahn, Peter

Karaus, Matt

Karn, Todd

Kast, Jessica

Kaufer, Jeff

Kauffman, Matthew

Kaumheimer, Dave – Selah

Kearney, Katherine and Ryan

Kearny, Katherine L. – Kenmore

Keilholz, Natalie

Keithahn, Durea

Kelleher, Pat – Ellensburg

Keller, Taryn

Kelley, Tina

Kelley

Kent, Mr. and Mrs. Geerald G. – Mercer Island

Kerslake, David

Kersten, Emily

Kerstetter, Christina

Kerzner, Olia – Seattle

Keser, Jason

Keylard, Mr. and Mrs. Franz – Kent

Kiefer, Margaret

Kilian, Carl – Sunnyside

Kilian, Paul – Prosser

Kilroy, Sandy and Thomas – Seattle

Kim, Paul

King, Mary P. and Thomas – Arlington

King, Don

King, Lindsey

Kinkle, Suzanne

Kirkham, Randy

Kirkman, Janis

Kirkpatrick, Marc – Cle Elum

Kirkpatrick, Danny, and Timothy Herdt – Mount Vernon

Kirlin Family Trust – Seattle

Kirlin, Alan – Seattle

Kismarton, Susan

Kissinger, Mr. and Mrs. James and Richard Seibert – Woodinville

Kitchel, Sarah

Kitchell, Andrew, Marianne, and Erin – Seattle

Kitchell, Eleanor – Helena MT

Kitchell, Fraser – Pittsburgh PA

Kitchell, Mr. and Mrs. Robert W. – Seattle

Kitchell, Mur and Leo – Seattle

Kitchell, William – Denver CO

Kitchell, Angus

Kitchell, Drs. Robert & Carolyn – Seattle

Kitchell, Ellie

Kitchell, Murphy

Klarich, Charles

Klebanoff, Mr. and Mrs. Mark – Seattle

Klebanoff, Carolyn

Klebanoff, Mark

Klein, Chad

Klein, Cinnamon

Klick, Leslie – Wenatchee

Kloes, Leila – Snohomish

Kloss, Richard – Cle Elum

Knauft – North Bend

Knbalcom, Kent

Knowles – Seattle

Knox – Snoqualmie Pass

Koch, Mellvin – Seattle

Koehn, Trevor

Kolbrick, David

Kolbrick, Paige

Kolbrick, Ryan

Kolde, Judith – Pullman

Komarnitsky, Michael

Kooppy, Jessica

Korol, Christa, and Gregory J. Lauckhart – Seattle

Krahenbuhl, Sam A. – Cle Elum

Krantz, Dennis – Lake Tapps

Kraus, Chrissy

Krause, Julianne

Kretschman, Rita

Krnjic, Edis

Kruy, Mr. and Mrs. Steven – Carnation

Krzyci, Mr. and Mrs. James – Renton

Kuhn, Mr. and Mrs. Terrace – Lincoln NE

Kujath, Karen

Kumagai, Fumie

Kutschia, Klaus

Lafferty, Mr. and Mrs. Jeffrey D. – Maple Valley

Lafferty, Jeff

Laird, Matt

Lake Kachess Mountain Retreat – Renton

Lake Kachess Resort – North Bend

Lake, Drew

Lambregts, Anthony and Maria – Belleview

Lampshire, Kevin

Lancaster, Michael

Landen, Richard H. and Bonnie – Kent

Landen, Dick

Lane, Michael – Renton

Lange, Stehpen and Marla – Bellevue

Langworthy, Barbara – San Jose CA

Lanz, Traci

LaRoque, Jamie

Larsen, Bob and Valarie – Pacific

Larson, Bill – Issaquah

Larson, Chris

Larson, Emily

Larson, Jessica

Larson, Todd

LaVasser, JoAnn – Seattle

Lavrentyev , Kristina

Lavrentyev, Larisa

Lavrentyev, Max

Lavrentyev, Sergey

L+979:1006awler, Stephen and Ann – Kirkland

Lawrence, Guy

Lawson, Billie Z. – Snoqualmie Pass

Lawton, Nancy – Easton

Le, Mrs. Tien

Leach, Camille

Leahy, Brian

Learned – Seattle

Learned Sr., Grant – Easton

Leavitt, Loralee – Kirkland

Lederman, Rachael

Lee, Vicki – El Sobrante CA

Lee, DeAnna

Lee, Katie

Lee, Thomas

Leeder, Farrington

Lees, Greg

Leese, Marty – Everett

Legg, Linda – Snoqualmie Pass

Lehner, Tim

Lehrman, Kayla

Lehrman, Nancie

Leiper, Joan Kaltz, and Mr. & Mrs. Andrew J. – Snoqualmie Pass

LeMay, Holly

Lemoine, Shaun

Leptich, Lisa, M.

Lese, Natalya

Lestelle, Cory

Lester, Karin

Lewis, Katie

Lewis, Kristi

Lewis, Leanne

Lewis, Ruby

Lewis, Tanner

Libby, Stephanie

Lieberman, Suzanne

Limmer, Jocelyn

Lind, Ronald – Carbonado

Link, Laura – Snoqualmie

Link, Katie

Lisowski, Ed – Yakima

Littlefield, Katie

Lodge Creek Land Company LLC – Easton

Loftus, Jeff & Stacie – Maple Valley

Loftus, Stacie

Lombardi, Mr. and Mrs. Vince – Green Valley AZ

Lonchari, Erin

Long, Ronald

Lonnquist, Hayley

Lopez, Leonard

Lopez, Oscar T. and Maricarman, M. – Edmonds

Lorenz, Michael and Katherine – Issaquah

Lougheed, Mr. and Mrs. Brad – Poulsbo

Love, Lisa

Lovre, Christopher

Lovre, Elaine

Lovre, Jeff

Lowe, Heidi

Lowrey, Mr. & Mrs. Jeffrey D. – Easton

Lowrey, Robert

Lurie, Gale D.

Lusier, Sarah

Lux, Edward and Lisa – Issaquah

Lynch, Fred – Benton City

MacDonald, Stephanie

MacFetridge, Dan – Seattle

Machholz, Jeanette

Mackey, Willaim

MacLeod, Malcolm

Madedo, Albert Barrera

Magenheim, Gordon and Brigitte – The Woodlands TX

Maggs, Vance

Magnuson, Andrew – Seattle

Magnuson, Andrew Craig – Forks

Makela, Bryce

Mallard, Scott

Mallon, Jim and Judith – Sammamish

Mallon, James

Mallory, Joseph – Easton

Mandelkorn, Laura

Mankus, Ashley

Mankus, Joanne

Manolache, Bogdan

Marchand, Ann – Seattle

Marconi, Jason

Marie-Vannatta, Sherann

Marks, Keri

Marlatt, Joan Dee – Covington

Marmorstein, Barry L. – Corwnpoint NM

Marquiss, William R. and Billie – Ellensburg

Martin, Arnold – Sunnyside

Martin, Joel – Bellingham

Martin, Keith – Seattle

Martin, Mr. and Mrs. Steven – Clinton

Martin, Troy – Outlook

Martin, Justin

Martinez, Daniel – Moxee

Marusa, Mr. and Mrs. Robert – South Cle Elum

Maryanski, John – Auburn

Matheson, Lyle

Mathews, Rebecca

Matich, Mr. and Mrs. Roy – Seattle

Matsuda, Rachel

Matthews, Mark

Maykut, Naydene – Seattle

Mayo, Therese

McCallum, Valerie

McConnell, Dr. Iain

McCoy, Mr. and Mrs. Lawrence – Seattle

McCrindle, Mr. and Mrs. Camerson – Bothell

McDaniel, Michele

McDermott, Mr. and Mrs. John E. – Bellevue

McDermott, Anna

McDonald, Craig

McDonald, Karidwyn

McDonough, Mr.and Mrs. Cory – Ravensdale

McDougall, Elizabeth L. – Seattle

McDougall-Treacy, Dan

McElroy, Dona

McGee, John W. – Des Moines

McGinnis, Katelyn

McGowan, Mr. and Mrs. John D. – Kirkland

McGuffin, Michael and Melony – Mercer Island

McGugin, Donald N. – Ronald

McIntyre, Danielle

McKenna, Mr. and Mrs. John W. Jr. – Auburn

McKenzie, David W. – Carnation

McKinley, Mary Jane – Seattle

McLaughlin, Mr. and Mrs. Mark P. – Sammamish

McNallan, Joseph

McNally, Shelby

McNulty, Rachel

McPhee, Miles – Naches

McPherson, Mary

McQuiston, Shawn – Maple Valley

McShane, Cathie – Ellensburg

Mead, Leonard and Darlene – Orting

Mead, Robert – Mesa AZ

Meadows, Chelsea

Meas, Alexander

Meck, Dale – Yakima

Mecklenburg, Robert and Susan – Seattle

Medrano, Mary Beth – Selah

Meisels, Lillian

Mele, Alexandra

Mellon, Laura L.

Mendez, Gordy

Mendoza, Grace

Mendoza, Jessica

Menser, Dan – Issaquah

Mercado, Jason

Mesick, Colby

Metz, C.

Meyer, Ed

Meyers-Rall, Danielle

Miller, Doug – Goldendale

Miller, Clinton

Miller, Ryan

Miller, Tom

Millz, Kris

Misocky. Jill – Easton

Misocky, William – Easton

Mitchell, Alyssa

Mitchell, Erin

Mitchell, Shanalee

Modery, Elizabeth

Moldoveanu, Anca – Bothell

Monroe, Mr. and Mrs. Daniel H. – Issaquah

Monroe, Jake

Montoys, Terry W. and Lisa A. – Lake Tapps

Moon, Katy

Moore, David – North Bend

Moore, Ella R. – Issaquah

Moore, Monty D. and Phyllis M. – Snohomish

Moore, Andrew

Moore, Brendan

Moore, Jennifer Sloop

Moore, Misty

Moore, Vicki

Morgan, Bill

Morgan, Sue

Morehouse, Rob – Easton

Morissey, Jessa

Morris, Aloma and Jenny – Easton

Morris, Mr. and Mrs. Jerry G. – Bellevue

Morris, Don

Morris, Loree

Morris, Sheila

Morrison, Dr. Lisa – Vancouver

Morzol, Mr. & Mrs. Alfred – Seattle

Moslo, Rebecca

Motofi, Aaron

Moulton, Jadon

Mudwilder, Linda

Mueller, Eric – Seattle

Muir, Robert

Muller, Katharina – Woodinville

Mulqueeney, Kiana

Mulqueeney, Shawn and Kara – Easton

Mundy, Mr. and Mrs. Richard R. – Ellensburg

Mundy, Lee

Murphree, Lowel, and Michele Cawley – Ellensburg

Murphy, Brian – Seattle

Murphy, John

Murphy, Kerry

Mustelin, Mr. and Mr. Tomas – Potomac MD

Myers, Dr. Lafe

Myers, Ryan

Myre, Bryan – Yakima

Najar, Mr. and Mrs. Larry M. – Cle Elum

Naranjo, Pablo

Nash, Michelle

Nelson, Nelson – Mill Creek

Nelson, Jay B. and Heather – Mill Creek

Nelson, Alyse

Nemeck, Benjamin and Molly Jo – Orting

Ness, Amy

Ness, Steven

Netzky, Arianna

Neuswanger ,Dr. Jason

Newhouse, Steve – Outlook

Newman, Lance – Maple Valley

Newman, Gerald G. – Ellensburg

Newman, Katie

Newman, Pete

Newton, Whitney

Nguyen, Paige

Nielsen, Rose

Nieman, Danielle

Nishikawa, Carol

Nishimura, Timothy

Nolan, Patrick

North, Rick – Easton

Northrup, Sara

Norvell, Michelle

Nussbaum, Rene

Nye, Wesley and Debbie – Easton

O'Banion, Judy R. – Easton

O'Brien, Timothy – Tukwila

Ochs, Gordon J., and Tina Mankowski – Easton

O'Connell, Auren – Easton

O'Connell, Lachelle

O'Connell, Cathleen

Odman, Faith

Oh, Drs. Shenton and Gigli – Seattle

Ohlson, Mr. and Mrs. Kenneth R. – Puyallup

Ohlson, Mr. and Mrs. Edward A. – Puyallup

Ohm, Maria T., and James Knipp – Seattle

O'Keefe, Leonard

Olmon, Jennifer

Olmos, Aaron

Olsen, Martin – Prosser

Olson, Kense

Olson, Zachary

Olsson, Kjell T., and Richard Anderson – Redmond

Olsson, Sylvia – Lake Forest Park

Oneal, Aaron

Opel, Kurt – Easton

Orcutt, Christina

Orevella, Mr. and Mrs. Robert J. – Kent

Oslund, Mr. and Mrs. Steve – Duvall

Ostrem, Dan – Kirkland

Oswald, Emma

Otley, Travis – Grandview

Otto, Karen

Owens, J.P.

Owens, CC

Owens, Charles

Owens, Cliff

Owens, Jaxon

Owens, Joann

Owens, J.R.

Owens, Rachael

Owens, Stephanie

Owens-Fountain, Ms. J.J.
Padget, Joseph
Pagel, Maximilian
Pageler, John C. – Seattle
Palmer, Christine
Palmer, Douglas
Palmer, Lewis
Pappas, Tina
Pappas, Jim – Ellensburg
Pappas, James
Papritz, Tanner
Paredes, Jessic
Parker, Elizabeth
Parker, Jennifer
Parker, Kevin
Parkhurst, David
Parkhurst, Donna
Parr, Susan
Parrett, Mark
Parry, Jeff and Tammy – Seattle
Parry, Jeff
Parsons, Mr. and Mrs. Stuart – Redmond
Parsons, Marvin J. and Elizabeth Sheldon – Woodinville
Pasin, Jim
Pass, Cynthia
Patnode, Drew
Pawluskiew, Mr. and Mrs. Zionne K. and Icz & Jerzy Gordo – Bellevue
Payne, Renee
Peach, Cindy – Ronald
Peckman, Mr. and Mrs. Michael D. – Federal Way
Pedersen, Mr. and Mrs. Alan – Seattle
Pen, Mindy

Penner, Jonathan
Perala – Apache Junction AZ
Percy, Megan
Perez, Francisco and Amy – Seattle
Perez, Amber
Perkins, Mr. and Mrs. Robert – Ellensburg
Perrone, Nathaniel
Perry, Mikaela
Person, Melinda
Persson, Mr. and Mrs. Anne – Kenmore
Pessolano, Craig
Peters, Sarah – Easton
Peterson, Mr. and Mrs. Roger – Seattle
Peterson, Mr. and Mrs. Erik – Bothell
Perterson, Tim – Monroe
Peterson, Jennifer
Peterson, Shirley
Pettet, J. Scott and Anne L. – Renton
Pettet, Lola – Renton
Pettit, Gerald
Petzoldt, Cameron
Pfeiffer, Scott
Phifer, Kierra – Tacoma
Phillips, John
Phillips, Patricia
Pieser, Derek
Pistorese, Brent P.
Pistorese, Linda
Pizzo, Michael – Bellevue
Pizzo, Kathryn
Plesha, John F. – Ronald
Ploegman, Lonnie

Plouse, Dan – Easton

Plouse, Gwilymn – Easton

Plouse, Kevin – Easton

Plouse, Dan

Podar, Alexandra

Poe, Cherri

Possani, Laila – Easton

Potter, Lauren

Poulin, Mr. and Mrs. Bruce A. – Sammamish

Poulin, Baraka

Poulin, Bruce

Powell, Mr. and Mrs. Michael A. – Tukwila

Powell, Brad

Powers, Sandy

Prest, Gretchen and Scott Nicholson – Easton

Price, Mr. and Mrs. Willard E. – Easton

Pruett, Brett

Pruitt, Joe

Public, Jean

Puetz, Amanda

Purcell, Samantha

Puryear, Alicia Marie

Quinn, Stuart and Sarah Kitchell

Gunderson, R. Frank and S. – Bellevue

Rabideau, Chase

Raether, Christian

Rains, Brigitt

Ralston, David and Antonio C Biag – Bellevue

Rancourt, Edward

Randolf, Daniel

Rankin, Mr. and Mrs. Jeffrey L. and Mr. and Mrs. Steven Rankin – Gig Harbor

Ransavage, Adam

Rao, Amy

Rat, Sorina

Rathe, Janet – Pouslbo

Rautenberg, Carl – Shoreline

Ray, Robert

Rayfield, Mr. and Mrs. Thomas – Sammamish

Rayfield, Patti

Rayfield, Tom

Raymond, Mr. and Mrs. David A. – Mercer Island

Rebman, Matthew

Record, Ben

Reddick, Miranda

Reece, Conner

Reece, Ronald

Reed, Colwell & Robin

Reed, Paul

Reeves, Harold and Lynora E. – Newcastle

Reeves, Christian

Reeves, Christine

Reeves, Emily

Reeves, Harold et al.

Reeves, Heidi

Reeves, Jeremy

Reeves, John

Reeves, Travis

Reil, Dawn

Reinertsen, Conner

Remick, Cindy

Remick, Larry

Repp-Faith

Restad, Chris – Easton

Reuther, Geoffrey

Reyes, Alvin A. and Lisa – Renton

Reymundo, Martin

Reynold, Kim

Reynolds, DeAnna

Riach, Jodi – Easton

Riach, Karter

Rice, Mr. and Mrs. Beveraly Ann – Edmonds

Rice, Nancy

Richards, Derek

Richards, James Scott

Richardson, Kayla

Richter, Jenna

Rinckenberger, Scott

Ringoen, Mr. and Mrs. Howard G. – Redmond

Ripley, Brittanie

Rippe, Eric

Rippy Janet, and Doug Diener – Bend OR

Risher, Ronda

Rivas, Phillip

Rivera, Michelle

Rixon, Shelley

Roberts, Jeff

Robertson, Jeff – Seattle

Robinson, Craig – Seattle

Robinson, Laura

Rocca, William – Mercer Island

Rochester, William – Ronald

Roddewig, Craig

Rodriguez, Kaitlyn

Rodriguez, Phillip

Rodstrom, Angelina – Fall City

Rogers, Treda

Rohan, Mike
Rohrbach, John – Sammamish
Rolfe, Nick
Romano, Starla
Roos, Amanda
Rosen, Ross – Seattle
Rosen, Geoff
Roshchuk, Inna
Rostron, Kaylin, Weisman Design Group
Rothkugel, Michael L. and Jay Nelson – Bothell
Rothschiller, Randall L. and Tamara R. – Kent
Roundhill, John and Arlene – Lacey
Rowe, Jim and Janet – Kent
Rowe, Steve and Sarah – Bellevue
Rowe, James E. – Kent
Ruppert, Ken – Sunnyside
Rushton, JoAnn
Russell, Ashley
Ruttan, Tori
Ryan, Paige & Scott – Sammamish
Ryan, Buddy
Ryan, Delaney
Ryan, Scott
Ryen, Lillian
Ryno, Dan
Ryynanen, Daniel and Cynthia – Hobart
Sabo, Derek
Sabo, Kristi
Saday, Jihan
Salyer, Dana
Salyer, Rachell
Sampalis, Nicholas

Sampson, Isabella

Sandberg, Bryanna

Sanford, Kristain

Sapios, Kathleen

Sather, Tom

Saunders, Brenda

Saunders, Stephanie

Scappini, Jay

Schaefbauer, Sammi

Schauss, David

Schindler, Ashley

Schlentz, Holly

Schmedeke, Alesha

Schmidt, Alicia R. – Seattle

Schoeggl, Mr. and Mrs. James E. – Bellevue

Schoener, Linda C. – Edmonds

Scholl, Larry

Schorn, Payton

Schorn, Timothy

Schumacher, Benajmin D. and Amy – Seattle

Schuyleman, Christi

Schwab, Dennis – Cle Elum

Schwandt, Dale

Schwartz – Seattle

Schwartz, Michael

Scoccolo, Mr. and Mrs. Anthony – Bonney Lake

Scott, Robert C. – Seattle

Scott, Livia

Scott, Marcia

Sebuchi, Sarah

Seefried, Nicole

Seguin, Kerry and Paige – Woodinville

Seguin, John

Seiler, Milton – Venice FL

Sen, Ruth

Sequin, Kaitlyn

Serapin – Newcastle

Seymour, Jane-Ellen

Seymour, Scott

Shaffer – Issaquah

Shain, James W. and Pamela – Cle Elum

Shaw, Alison

Sheehan, Jason – Sunnyside

Sheldon, Jeanne – Woodinville

Sheldon, Peter – Easton

Sheldon, Sue – Sheldon

Shelton, Linda

Shepherd, Preston L. – Selah

Shimeall, Nancy

Shipley, Gwenda

Shirley, Amy

Shuart, Ian

Shumaker, Laury

Shyriaiev, Kirill

Siddoway, Mr. and Mrs. Robert B. – Gilbert AZ

Siegel, Jessica

Silver, Dan – Olympia

Silver, Kevin – San Jose CA

Simenstad, Diane

Simmons, Katherine

Simmons, Stephen

Singer, Opal

Skiba, Alise

Skiba, Jan

Skold, Jill – Snohomish

Skone, Mr. and Mrs. Donald – Selah

Skone, Suzanne – Mercer Island

Smith, Angela

Smith, Corry

Smith, Dane

Smith, Delaney

Smith, Doug

Smith, Douglas

Smith, Jen

Smith, Jeremy

Smith, Kayla

Smith, Melissa

Smith, Paris

Smith, Rachel

Smith, Shawna

Smith, Walter

Snow, Gayland and Shery – Coulee Dam

Snow, Mr. and Mrs. Kelly L. – Belleview

Snow, Kelly

Snow, Kolea

Snyder, Candi

Snyder, Maggie

Solomon, Shannon

Sosnowski, Corinne

Soule, Michael and Holly – Seattle

Sparks, Mr. and Mrs. Roy E. – Seattle

Spurrier, Crystal

Staberow, Katherine

Stafford, Allen – Milton

Staley, Sheri – Shelton

Stalter, Carolyn

Stamschror, Andy – Sunnyside

Standley, James

Starcevich, Mr. and Mrs. Joseph – Monroe

Starevich PE GE, John P.

Stark, Jaylene

Stearns, Dan

Steele, Larry and Stasia – Kirkland

Steffen, Sarah

Steil, Kevin

Stemley, Mr. and Mrs. Craig – Redmond

Stephens, Duncan

Sternard, Sally, and Ann Mehl – Auburn

Sternen, Darci

Stevenson, Melyssa

Stewart, Mr. and Mrs. Ron – University Way

Stewart, Mr. and Mrs. Douglas, F. – Mercer Island

Stice, Jr., Mr. and Mrs. James L. – Tacoma

Stickley, David and Rhonda – Snoqualmie Pass

Stillings, Melanie

Stoita, Vasile and Rodica – Easton

Storch, John

Storey, Mitchel D. – Seattle

Story, Alexander

Stout, Andi

Straight, Jennifer

Strait, Richard

Stratton, Vern and Kathie – Easton

Strieb, Dayna

Stroup, Ashley

Stubbs, Colleen

Stuit, Mr. and Mrs. David – Snoqualmie

Stumf, Adrian

Suckow, Jessica-Ray

Sukert, Brianna

Sullivan, David M. – Seattle

Sumi, Irene

Sumi, Mason

Sumi, Matthew

Summers, Colin

Sumner, Scott and Diane – Snoqualmie Pass

Sutherland, Jennifer

Swearingen, Garret

Sylvester, Weston

Symonds, Lisa

Sytsma, Don – Newcastle

Szalay, Mr. and Mrs. Andrew – Seattle

Szlendak, Agata

Taber, Bruce – Marysville

Talbott, Mrs. Rudi

Talerico, John – Puyallup

Tangen, Shyann

Tanzillo, Kristin

Tarasevich, Janice

Tarzaban, Cameron

Tavenner, Starr

Tayer, Jeff

Taylor, Mr. and Mrs. Wade – Poulsbo

Taylor, Trent D. and Vickie – Lake Tapps

Taylor, Adam

Taylor, Jamie

Tecca, Crystal

Temple, Michael

Templin, Matt

Terry, Kathyryn

Teske, Helen

Teuber, Nicole

Thaxton, Stephen

Thayer, Cara – Ellensburg

Thayer, Todd M., Kyle, and Ray – Ellensburg

Thoday, David V., Stacy Johnson and Lauri Valaski – Milton

Thomas, Benjamin – Battleground

Thomas, Brandi

Thomas, Joel

Thomas, Lynne

Thompson, Ann and Jeffery – Auburn

Thompson, Sigmund – East Wenatchee

Thompson, David J. – Tukwila

Thompson, Mr. and Mrs. Ray D. – Cle Elum

Thompson, Raylan

Thon, Mr. and Mrs Gary – Marion MT

Thorman, Lisa

Thorman, Trisha

Thornton, Rebecca – Yakima

Thornton, Tami

Thues, Mr. and Mrs. Steven – Sammamish

Tidball, Emily

Tignor, Michelle

Tillett, Amanda

Tison, Julian R. – Easton

Tobin, Mike – Yakima

Todd, Maisie

Tofthagen, Mr. and Mr. Brad – Renton

Togerson – Everett

Togher, Pat – Seattle

Tolentino, Christopher

Tomanosaw LLC – Kirkland

Tomchick-Carlson, Danna Lee

Toothman, Adam

Torres, Lindsey

Toussaint – Black Diamond

Towers – Seattle

Tracy, Sarah

Trantina, Steve

Trujillo, Leticia

Tsagalakis, Pat – Seattle

Tsao, Aileen

Tsuneoka, Junichi – Seattle

Tuck, Bob – Selah

Turnbull, Trevor – Olalla

Turner, Henry

Turner, Marilyn

Tutino, Alexandria

Tweter, David

Ubil, Ashley

Ultican, Timothy E. – Kirkland

Underwood, Stephanie

Unland, Duane

Unruh, Dr. Janie

Upton Melissa

Uretz, Mike – Issaquah

Vaccaro, Regina

Vallee, Nicole

Van Belle, Chris – Sunnyside

Van Buskirk, Pamela

van der Hoeven, Karla

Van Swearingen, Garret

Van Valkenbert, Nick

Van Winkle, Cody

Vanbeek, Jeremy – Kirkland

VanBeek, Kathleen

Vancour, Mr. and Mrs. Brad – Woodinville

Vang, Mr. and Mrs. Isiah – Seattle

VanGaver, Natalie

Vanmeter, Zack

Vaughn, Bill – Auburn

Vaughn, Jeffrey

Vaughn, Michael

Vaughn, Nancy

Vaughn, William

Veiga, Anothony – Sunnyside

Veremchuck, Lidiya

Vermeersch, Elizabeth

Vermillion, Katherine, and Lawrence Brown – Fall City

Vernon, Allison

Vice, Ali

Vij, Vidur

Villa, Steve

Vincent, Margaret A. – Ellensburg

Vincent, Mr. and Mrs. Scott J. – Easton

Vinsonhaler, Larry – Boise ID

von Flotow, Walter

Von Wald, Kim

Vroman, Kristi

Waas, Erich

Wakefield, Steve and Margo – Woodinville

Walcott, Christopher C. – Bellevue

Walker, Scott A. and Lynae – Gig Harbor

Walker, Aaron

Walker, Nick

Walker, Scott

Wallace, Patricia – Kent

Wallace, Elliott

Wallace, Josh

Wallace, Megan

Waller, Heather

Wamsley, Stacie Joe – Seattle

Wanechek, Connie – Cle Elum

Wantanabe, Shannon

Ward, Mr. and Mrs. Wes – Auburn

Ward, B

Wass, Kim

Wassmann, Maurice and Shari B. – Tacoma

Watanabe, Anne – Roslyn

Waterman, Sandra, and Garald McDonald – Entiat

Waters, Brandon

Waters, Timothy, Jr.

Wattenbarger, Kevin

Watts, Mr. and Mrs. Jerry – Easton

Watts, Claire

Watts, Jerry

Waymire, Elizabeth

Waymire, Kathryn

Webb, Mr. and Mrs. Larry a. – Black Diamond

Weber, Mr. and Mrs. Bradley M. – Puyallup

Weber, Michael

Weber, Nora

Weber, Victoria

Wedenoja, Gwen

Wegner, Genny

Wehowski, Anna

Weiher, Randy – Kent

Weirauch, Jason

Weishaar, Cheyenne
Weiss, Lisa M. – Ronald
Wenstrup, John – Carnation
Wenstrup, Alexis
Wenstrup, Paula
Wentz, Steve
Werner, Wendy
West, Mr. and Mrs. Gary – Black Diamond
West, Holly
Westendorf, Ryan Dawson – Enumclaw
Wharton, Grace
Wheeler, Darrell – Sunnyside
Wheeler, Christopher
Wheeler, Viktoria
Whelpley, Cathy
Whisler, Penny and Doug – Seattle
White, Mr. and Mrs. Tracey – Graham
Whitemarch, Cheryl, and Barbara Steele – Pasco
Whitfield, Eileen
Whitham, Mr. and Mrs. Arthur – Newcastle
Whitney, Dan
Whittaker, Megan
Wicks, Jared
Wiediger, David
Wildinson, Parker
Wilhite, Mr. and Mrs. Mark – Burein
Wilkerson, David
Wilkinson, David A. – Issaquah
Wilkinson, Mr. and Mrs. Wilbur – Renton
Wilkinson, Amanda
Wilkinson, Kennedy
Wilkinson, Landon

Wilkinson, Richelle

Willett, Brian

William, Justin

Williams, Mr. and Mrs. John A. – Redmond

Williams, Jerald – Maple Valley

Williams, Rochelle

Williams, Tarek

Williams, Tina

Williamson, Lawrence and Donna – Federal Way

Willits, Aron

Wilson, Mr. and Mrs. Larry E. – Kirkland

Wilson, Aidan

Wilson, Elizabeth

Wilson, Larry – Kirkland

Wilson, Sidney

Windsor-Newman, Judith – Maple Valley

Winkel Family Trust – Bellevue

Winslow, Mr. and Mrs. Steven – Sammamish

Winston, Anastasia

Wise, Wise – Bonney Lake

Wiseman, Jeremy – Snoqualmie Pass

Woerner, Dr. Jeffry

Wolcott, Kevin

Wollam, Christopher D.

Wolter, Thomas

Wood, Kimberly and Thomas – Issaquah

Woodcock, Amanda

Woods, Kathleen – S. Cle Elum

Woods, Vickie

Woodward, Frances

Woodwell, Maura

Worcester, Karen

Worley, Nolan

Wray, Nancy – North Bend

Wright, Mr. and Mrs. Douglas D. – Sammamish

Wright, Kendall

Wyman, Larry and Jean – Easton

Yates, Larry – Easton

Yotz, Brian

Yotz, Charlene

Young, Tom – Issaquah

Young, Chloe

Young, Heather

Zacharias, Matthew

Zak, Justin

Zaremba, Ron and Beverly – Goldendale

Zink, Paul

Zolper, Alec

Zora, Jon

Zuber, Joan – Mollalla OR

Zunker, Mr. and Mrs. Hans – Woodinville

Zwiefelhofer, Lyn R. – Enumclaw

Zyskowski, Kathryn

*(This page intentionally left blank)*

# GLOSSARY

*(This page intentionally left blank)*

# Glossary

| Term | Definition |
|---|---|
| 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. |

| Term | Definition |
|---|---|
| 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). |

| Term | Definition |
| --- | --- |
| 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, place, landscape, or object (that has archeological or cultural significance) included in, or eligible for inclusion in, the National Register. |
| hydraulic conductivity | The ratio of the velocity to the potential gradient. It is a resistance term, it is not a rate. |
| 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 (as distinguished from “proratable water rights”, see below). |

| Term | Definition |
|---|---|
| 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. |
| Participating Entities | Roza Irrigation District and potentially other proratable users entitled to water from the Yakima Project, who agree to participate in funding, constructing, operating and maintaining KDRPP |

| Term | Definition |
|---|---|
| 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 entities | Kittitas Reclamation District, Wapato Irrigation Project, and Kennewick Irrigation District, that may also participate in the Kachess Drought Relief Pumping Plant project. |
| 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). |

| Term | Definition |
|---|---|
| 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

# BULL TROUT ENHANCEMENT MEMORANDUM OF UNDERSTANDING

*(This page intentionally left blank)*

**MEMORANDUM OF UNDERSTANDING**
**between**
**Yakama Nation**
**and**
**State of Washington Department of Ecology**
**and**
**State of Washington Department of Fish and Wildlife**
**And**
**United States Department of Agriculture**
**Forest Service**
**Okanogan-Wenatchee National Forest**
**and**
**United States Department of Interior**
**Fish and Wildlife Service**
**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 the Bureau of Reclamation, Pacific Northwest Region, Columbia-Cascades Area Office, (Reclamation), Washington State Department of Fish and Wildlife (WDFW), Washington State Department of Ecology (Ecology), United States Fish and Wildlife Service (USFWS), United States Forest Service Okanogan-Wenatchee National Forest (USFS-OWNF) and the Yakama Nation (YN), (collectively, "the parties") to define their respective roles in the development and the implementation of bull trout restoration and enhancement actions as part of the Yakima River Basin Integrated Water Resource Management Plan (Integrated Plan). The goal of these bull trout restoration and enhancement actions is to achieve self-sustainable, healthy, harvestable populations of native bull trout (*Salvelinus confluentus*) in the Yakima River Basin. Bull trout are currently listed 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 have 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

[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

approach to water resources and ecosystem restoration improvements in the Yakima River Basin. 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. 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 stream and fisheries protection and restoration demands. In addition – climate change.

The Integrated Plan Workgroup is primarily made up of representatives of statutorily created organizations. The Workgroup includes State and Federal agencies, the Yakama Nation, local governments, irrigation districts, and environmental groups. The Integrated Plan does not supersede or impair any organizations' responsibilities, contracts, rights or authorities.

The USFWS listed bull trout as a threatened species in 1998. The historic abundance and distribution of bull trout in the basin was greater and broader than currently exists with many distinct and interconnected populations. In 2010, much of the basin was designated as critical bull trout habitat, and there is a need to restore connectivity of bull trout habitat between lakes, their tributaries, and downstream mainstem rivers, including the Yakima and Naches Rivers.

As a stated long-term goal within the *Integrated Water Resource Management Plan Final Programmatic Environmental Impact Statement* (PEIS) (March 2012), the parties acknowledge that bull trout restoration and enhancement efforts should be developed and implemented to achieve self-sustainable, healthy, harvestable populations of bull trout within the Yakima 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 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 support (through planning, funding, etc.), develop, and implement bull trout restoration and enhancement actions within the Yakima River Basin. Bull trout restoration and enhancement actions are intended to support fish passage, habitat restoration, and habitat/watershed protection elements within the 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 restoration actions are effective at achieving bull trout restoration and enhancement in the Yakima Basin. The USFWS Bull Trout Recovery Plan, Yakima Basin Bull Trout Action Plan (BTAP), and the knowledge and experience of local biologists will be used to guide the process.

Pursuant to this MOU, the parties agree that:

[3] Draft Bull Trout Recovery Plan, USFWS (2014).

a. Development and implementation of Integrated Plan actions will continue to move forward through a collaborative process, in conjunction with ongoing bull trout recovery planning and implementation within the Yakima River Basin;

b. This MOU will 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)[4] and other future actions with similar goals;

c. WDFW, USFWS, and Yakama Nation each have legal authority and responsibility for protection and restoration of the fish and aquatic habitat resources of the Yakima basin;

d. Ecology has legal authority for water rights management in the Yakima Basin except for the Yakama Reservation where there Yakama Nation maintains regulatory authority for a variety of instream and out-of-stream uses including fisheries protection, restoration, and recovery;

e. Reclamation has authority to construct, operate, and maintain facilities in the Yakima Project for multiple purposes, including fish, wildlife, and recreation;

f. USFS-OWNF manages land, including aquatic habitats important in supporting bull trout spawning, rearing, and other aspects of resident and migratory life history traits;

g. Working together will ensure bull trout protection and recovery efforts are accomplished concurrently with out-of-stream needs within the Yakima Basin;

h. Restoration and enhancement, for the purposes of this MOU and the Integrated Plan, is achieved when self-sustainable, healthy, harvestable populations of salmonids, including bull trout, occur throughout their natural range in the Yakima Basin;

i. Bull trout populations are critically depressed or functionally extirpated in parts of the basin and are susceptible to direct and indirect impacts from new water supply projects, reservoir operations and maintenance activities including drawdown timing, short-term and long-term habitat response, predator-prey interactions, passage barriers ,changes in flow regimes, recreation activities, and exacerbating effects of climate change; and

j. Implementation of Integrated Plan projects should result in a net gain to bull trout and other native fish populations and their habitats.

## 3. Implementing Actions

The parties will work cooperatively through the Integrated Plan Workgroup and its subcommittees to provide oversight and direction for bull trout restoration and enhancement actions related to the Integrated Plan and will coordinate with ongoing bull trout recovery efforts. The parties, working through the Integrated Plan processes and committees, will continue to develop bull trout restoration and enhancement actions concurrent with development, construction, and operation of the Cle Elum

[4] Appendix C - Bull Trout Enhancement in *Kachess Drought Relief Pumping Plant and Keechelus Reservoir-to-Kachess Reservoir Conveyance Draft EIS*, Reclamation and Ecology (2015)

Dam Fish Passage Facilities, Cle Elum Pool Raise, the Kachess Drought Relief Pumping Plant, the Keechelus-to-Kachess Pipeline, and other future projects.

The 2013 MOU between the Department of the Interior (DOI), Bureau of Reclamation, and Department of Agriculture (USDA), USFS, recognized the USFS's role in providing healthy watersheds that produce clean drinking water and managing the land to improve natural resources, including contributing to recovery of federally threatened and endangered fish, wildlife and rare plant species. Pursuant to the 2013 DOI-USDA MOU, development of any specific bull trout enhancement plans of action resulting from the parties implementing this MOU will be coordinated with the USFS-OWNF. All resulting plans of action will be consistent with the National Forest Management Act, and in compliance with the National Environmental Policy Act, Endangered Species Act, Clean Water Act, and other pertinent laws applicable to managing National Forest System lands.

The parties agree to work together, contingent on available funding, both in the Integrated Plan process and other related bull trout recovery planning and project action efforts 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 will be accomplished concurrently with the construction of Kachess Drought Relief Pumping Plan/Keechelus-to-Kachess Conveyance; implement additional bull trout restoration and enhancement actions as Integrated Plan water enhancement projects are developed and implemented contingent on funding;

b. Evaluate/conduct: a) bull trout population assessments; b) habitat assessments and/or limiting factor analyses, c) fish passage for juvenile and adult fishes; d) interaction with nonnative species; e) primary and secondary productivity assessment(s) (prey base and limiting factors); f) climate change resiliency planning; and g) monitoring, evaluation, and adaptive management as projects are implemented;

c. Support Reclamation and Ecology through subsequent project-level environmental compliance development, permitting processes, and project-level scientific and technical review and assistance (e.g. finding solutions to address negative impacts to bull trout populations and habitat caused by Integrated Plan projects);

d. 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;

e. Select bull trout recovery and enhancement actions and/or projects recommended through the Integrated Plan that support Reclamation and Ecology's Integrated Plan obligations;

f. Ensure water supply projects are accompanied with a set of fish/habitat enhancement projects that improve conditions for bull trout or other native fish species of the Yakima Basin, specifically, projects that measurably benefit bull trout and bull trout critical habitat; and

g. 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, USFS, USFWS, and the Yakama Nation:

a. BTE projects shall be incorporated in all relevant State and Federal permits;

b. Assist with securing short-term and long-term funding from local, State, and Federal entities to execute bull trout restoration and enhancement actions and/or projects and activities necessary to accomplish the purposes of this MOU;

c. Actively participate in the Integrated Plan habitat subcommittee to support bull trout recovery actions and/or projects within the Yakima River basin;

d. Utilize previous and ongoing bull trout planning and enhancement work including the USFWS Bull Trout Recovery Plan and the BTAP;

e. Enlist local fishery experts to assist in Integrated Plan fish restoration and enhancement project planning, development, implementation, and monitoring to ensure effective and cost efficient actions; and

f. Continue to explore opportunities to implement priority bull trout restoration and enhancement 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 and enhancement goals and objectives.

**4. Period of Performance**

This MOU shall become effective on the date of the 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. Phase 1 and 2 of the BTE can occur before or during the development and the construction of the Kachess Drought Relief Pumping Plant Project, and the Keechelus-to-Kachess Conveyance Project. 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 in writing to all parties. 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<br>1917 Marsh Road<br>Yakima WA 98902 | G. Thomas Tebb<br>1250 West Alder St<br>Union Gap WA 98903 | Mike Livingston<br>1701 S. 24th Ave<br>Yakima WA 98902 |
| **USFWS** | **Yakama Nation** | **USFS** |
| Jeff Thomas<br>U.S. Fish & Wildlife Service<br>1917 Marsh Road<br>Yakima WA 98902 | Phil Rigdon<br>PO Box 151<br>Toppenish WA 98948 | Jason Kuiken<br>215 Melody Lane<br>Wenatchee, WA 98801 |

## 7. General Provisions

a. **<u>This MOU is neither a fiscal nor a funds obligating document.</u>** 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. **<u>No Binding Rights or Obligations.</u>** Nothing in this MOU is intended to create any right or benefit, substantive or procedural, enforceable at law by a party against the United States, its agencies its officers, or any other person. Nothing in this MOU shall be deemed to increase the liability of the United States beyond that currently provided in the Federal Tort Claims Act (28 U.S.C. 2671 et seq.).

c. **<u>No Sharing of Benefits.</u>** 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.

d. **<u>Freedom of Information Act.</u>** Any information furnished to Reclamation, under this MOU, is subject to the Freedom of Information Act (5 U.S.C. 552).

e. **<u>Compliance with Federal Laws.</u>** 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.

f. **<u>Text Messaging While Driving.</u>** In accordance with Executive Order (EO) 13513, "Federal Leadership on Reducing Text Messaging While Driving," any and all text messaging by

Federal employees is banned: a) while driving a Government owned vehicle (GOV) or driving a privately owned vehicle (POV) while on official Government business; or b) using any electronic equipment supplied by the Government when driving any vehicle at any time. All Cooperatives, their Employees, Volunteers, and Contractors are encouraged to adopt and enforce policies that ban text messaging when driving company owned, leased or rented vehicles, POVs or GOVs when driving while on official Government business or when performing any work for or on behalf of the Government.

g. **Notices**. Any communications affecting the operations covered by this agreement given by the Forest Service or the Cooperator is sufficient only if in writing and delivered in person, mailed, or transmitted electronically by e-mail or fax, as follows:

To all Parties, at each Parties' address shown in the MOU or such other address designated within the MOU.

Notices are effective when delivered in accordance with this provision, or on the effective date of the notice, whichever is later.

h. **Participation In Similar Activities**. This MOU in no way restricts any of the Parties from participating in similar activities with other public or private agencies, organizations, and individuals.

i. **Termination**. Any of the parties, in writing, may terminate this MOU in whole, or in part, at any time before the date of expiration.

**8. Signatures**

**This MOU** is executed by authorized representatives of the respective parties in multiple original, with one original executed copy for each of the parties. The parties hereto have executed this MOU as of the last date written below and agree actions related to this MOU shall result in a net gain for bull trout, and 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.

9-9-15

Phil Rigdon, Director of Natural Resources — Date
Confederated Tribes and Bands of the Yakama Nation

9-9-15

G. Thomas Tebb, Director, Office of Columbia River — Date
State of Washington Department of Ecology

Mike Livingston, Director, Region 3
State of Washington Department of Fish and Wildlife

9-9-15
Date

Michael R. Williams, Forest Supervisor
Okanogan-Wenatchee National Forest

9/23/2015
Date

Roy Elicker, Assistant Regional Director, Fishery Resources
United States Fish and Wildlife Service

10/23/15
Date

Dawn Wiedmeier, Area Manager
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office

9/9/15
Date

**~~ End of Document ~~**

Appendix B

## NOTICE OF ADOPTION

*(This page intentionally left blank)*

# 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

*(This page intentionally left blank)*

# Bull Trout Enhancement

## 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**



**October 2017**

# 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

| | |
|---|---|
| BTE | Bull Trout Enhancement |
| BTTF | Bull Trout Task Force |
| Ecology | Washington State Department of Ecology |
| ESA | Endangered Species Act |
| EIS | Environmental Impact Report |
| FS | Forest Service |
| I-90 | Interstate Highway 90 |
| KCT | Kittitas Conservation Trust |
| LWM | Large Woody Material |
| MOU | Memorandum of Understanding |
| NEPA | National Environmental Policy |
| NMFS | National Marin Fisheries Service |
| Reclamation | Bureau of Reclamation |
| USFWS | U.S. Fish and Wildlife Service |
| USDA | U.S. Department of Agriculture |
| USFS | U.S. Forest Service |
| WDFW | Washington State Department of Fish and Wildlife |
| YBTAP | Yakima Bull Trout Action Plan |

This page intentionally blank

# Contents

Page

CHAPTER 1. INTRODUCTION ........................................................................1

CHAPTER 2. POPULATIONS .......................................................................2

2.1 Threats ........................................................................................3

2.1.1 Summary of Baseline Threats ....................................................6

CHAPTER 3. BTE PHASE 1 PROJECTS, ASSESSMENT AND DESIGN ACTIONS........7

3.1 Gold Creek Passage and Habitat Improvements ...................................8

3.1.1 Gold Creek Instream Restoration ................................................8

3.1.2 Gold Creek Pond Reconfiguration ...............................................9

3.1.3 Gold Creek Drain Decommissioning..........................................12

3.1.4 Heli's Pond Reconfiguration .....................................................13

3.2 Gold Creek USFS Bridge Replacement Assessment and Design...................13

3.3 Cold Creek Habitat Assessment.........................................................21

3.4 Bull Trout Task Force .....................................................................22

3.5 Box Canyon Creek Passage ...............................................................22

3.6 Kachess River Assessment and Design.................................................24

3.7 Box Canyon Passage Assessment – Peek-a-Boo Falls..................................27

3.8 USFS Kachess Watershed Health ........................................................28

3.8.1 Box Canyon and Gale Creeks Restoration ....................................28

3.8.2 Upper Kachess River Project –Trailhead Restoration ..........................31

3.9 South Fork Tieton River Passage Assessment, Design, and Construction ....34

3.10 Clear Creek Dam Passage Assessment and Design ...............................35

3.11 Bull Trout Salvage and Population Enhancement Assessment ......................38

3.12 Nutrient Enhancement to Increase Ecological Productivity........................39

CHAPTER 4. BENEFITS AND THREATS ADDRESSED.............................................41

CHAPTER 5. PHASE I ESTIMATED COSTS ...................................................44

CHAPTER 6. BULL TROUT ENHANCEMENT PHASE 2...........................................45

CHAPER 7. MEMORANDUM OF UNDERSTANDING ...........................................45

CHAPTER 8. MAPS.................................................................................47

REFERENCES.........................................................................................59

**Tables**

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). ........ 3
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). ........ 4
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). ........ 4
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). ........ 5
Table 5. North 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). ........ 6
Table 6. Descriptions of the 13 riparian restoration and 12 road projects Figure 3-16 that would reduce fine-sediment delivery and restore riparian vegetation to Box Canyon and Gale creeks. ........ 30
Table 7. Summary of enhancement projects and assessments and the primary threats addressed for Bull Trout populations. ........ 42
Table 8. Summary of estimated project costs for BTE Phase 1 ........ 44

## Figures

Figure 3-1. Representative habitat in lower Gold Creek. Narrowing the creek channel would improve habitat function (Photo by William Meyer, WDFW). ........ 10
Figure 3-2. Properly functioning consolidated, narrow channel in upper Gold Creek (Photo by William Meyer, WDFW). ........ 11
Figure 3-3. Gold Creek Pond (Photo by William Meyer, WDFW). ........ 11
Figure 3-4. Concept design for the Gold Creek Drain Decommissioning project. ..... 12
Figure 3-5. Concept design for the Keechelus Reservoir and Lower Gold Creek Access Management project. Two gates (yellow) and approximately 1,900 feet of guardrail (red) would be installed to control reservoir access during low pool conditions. ........ 15
Figure 3-6. Location of existing Forest Service Road 4832 bridge relative to I-90 and Keechelus Reservoir. ........ 15

Figure 3-7. 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. All I-90 fill has been removed (Source: William Meyer, WDFW). .......... 16
Figure 3-8. Recommended Gold Creek USFS Bridge Replacement Design Sheet 15 (drawing obtained from Sargent, 2011). .......... 19
Figure 3-9. Recommended Gold Creek USFS Bridge Replacement Design Sheet 16 (drawing obtained from Sargent, 2011). .......... 20
Figure 3-10. Existing passage barrier at Cold Creek culvert. .......... 21
Figure 3-11. Existing Cold Creek channel condition downstream from the culvert.. 21
Figure 3-12. Fish cannot pass through Box Canyon Creek sections. .......... 24
Figure 3-13. There are two Kachess River reaches that experience dewatering. .......... 25
Figure 3-15. Dewatered section of Kachess River upstream from Kachess Reservoir (Photos by William Meyer, WDFW) .......... 26
Figure 3-14. Dewatered reach of lower Kachess River within the reservoir bed. .......... 26
Figure 3-16. Twelve locations of restoration work along Box Canyon Road. Roadwork areas are highlighted in red, and proposed revegetation sites are highlighted in yellow. .......... 29
Figure 3-17. Erosion along lower section of Forest Service Road 4600. .......... 32
Figure 3-18. Imagery showing current trailhead, current trailhead roadway (red), helicopter landing areas, and potential roads to landing areas (purple, green). .......... 33
Figure 3-19. Rimrock Reservoir drawdown resulting in a passage barrier at the South Fork Tieton River below Forest Service Road 1200 (Photo by William Meyer, WDFW). .......... 35
Figure 3-20. Map of Clear Lake showing the location of the Clear Lake Spillway and Dam. .......... 36
Figure 3-21. Clear Creek Dam on the downstream side of the dam. .......... 37
Figure 3-22. Clear Creek spillway on the downstream side of the spillway. .......... 37
Figure 9-1. Gold Creek project area depicting Gold Creek, Keechelus Reservoir, and adjacent land ownership. .......... 49
Figure 9-2. Cold Creek project area depicting Cold Creek, Keechelus Reservoir, and adjacent land ownership .......... 51
Figure 9-3. Kachess River project area depicting Kachess River, Mineral Creek, Kachess Reservoir, and adjacent land ownership. .......... 53
Figure 9-4. Box Canyon Creek project area depicting Box Canyon Creek, Kachess Reservoir, and adjacent land ownership. .......... 55
Figure 9-5. South Fork Tieton River project area depicting South Fork Tieton River, Rimrock Reservoir, and adjacent land ownership. .......... 57

This page intentionally blank

# Chapter 1. Introduction

As part of the Yakima River Basin Water Resource Management Plan (Integrated Plan), the Bureau of Reclamation and Washington State Department of Ecology (Ecology) identified several Bull Trout Enhancement (BTE) projects to address the need to improve the resiliency of Bull Trout populations in the Yakima River basin (Reclamation and Ecology 2011). This BTE framework report identifies BTE projects and the rational used to prioritize, develop, and implement them.

Reclamation and Ecology recommended further refinements and identified a number of passage and habitat restoration projects to benefit Bull Trout in the 2012 *Yakima River Basin Integrated Water Resource Management Plan Final Programmatic Environmental Impact Statement* (Integrated Plan FPEIS (Reclamation and Ecology 2012). The Integrated Plan has seven elements: Reservoir Fish Passage, Structural and Operational Changes, Surface Water Storage, Groundwater Storage Element, Habitat/Watershed Protection and Enhancement, Enhanced Water Conservation, and Market Reallocation Element, each were analyzed in the FPEIS. The BTE framework is a product of both Reservoir Fish Passage and Habitat/Watershed Protection and Enhancement-Mainstem Floodplain and Tributary Fish Habitat Enhancement Program.

As a product of the Integrated Plan FPEIS, the intent of the BTE framework is to support, develop, and implement Bull Trout restoration and enhancement actions with particular focus on improving the abundance and resiliency of Bull Trout populations.[1] The BTE framework was developed collaboratively by the Yakama Nation and State and Federal agencies in an effort to identify on-the-ground projects to benefit Bull Trout and their habitat within the Yakima River basin. Reclamation and Ecology worked with the other signatories (USFS, USFWS, Yakama Nation, and WDFW) from the Bull Trout MOU (Appendix C) to identify actions which focused on projects that will benefit upper Yakima River Bull Trout populations, but they also include projects implemented on the North and South Forks of the Tieton River. Actions include both construction projects and assessments. The assessments will develop future restoration and enhancement projects and population management actions that would continue recovery efforts.

In June 1998, the USFWS listed the Columbia River Basin “distinct population segment” of Bull Trout as threatened under the Endangered Species Act (ESA). The USFWS subsequently identified 15 local populations of Bull Trout in the Yakima River basin (USFWS 2014) and designated critical habitat in many reaches of the Yakima River and its tributaries.

The Bull Trout enhancements described in this report include two types of actions: (1) on-the-ground projects that improve Bull Trout habitat and (2) assessments and designs action that define future efforts to increase Bull Trout populations.

The actions described consider and evaluate both habitat enhancements and population enhancements. Habitat enhancements improve the function and productivity of reservoirs and tributaries; population enhancements use salvage, translocation and supplementation to increase populations. These

[1] The Bull Trout projects were discussed in the 2012 Integrated Plan FPEIS. The associated Fish and Wildlife Coordination Act (FWCA) Report requested Reclamation to implement conservation measures associated with the Habitat/Watershed Protection and Enhancement Element specific to Bull Trout, which formed the foundation for the BTE framework.

enhancement actions do not intend to represent the full scope of potential restoration and enhancement activities within the upper Yakima River basin.

The BTE actions will be implemented in two phases. BTE Phase 1 includes implementation of the following: Gold Creek Instream Restoration, Gold Creek Drain Decommissioning, Gold Creek U.S. Forest Service (USFS) Bridge Replacement Final Design and Geomorphic Assessment, Cold Creek Passage Habitat Assessment Bull Trout Task Force, Box Canyon Creek Passage, USFS Kachess Watershed Health, and Increased Ecological Productivity. Project assessments and design actions are also included in BTE Phase 1. BTE Phase 2 (Chapter 6) includes project implementation based on the results of the assessments and designs prepared in Phase 1.

# Chapter 2. Populations

A key to Bull Trout characterization is life history strategies. In the Yakima River basin, these life history strategies include fluvial (river and stream), 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, fluvial Bull Trout migrate downstream to large rivers, and adfluvial Bull Trout migrate to lakes to rear. These migratory fish live for several years in large rivers or lakes, where they grow larger than resident forms, before returning to the 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; 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; 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 their persistence (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. Bull Trout migrants may also reestablish local populations extirpated by catastrophic events.

In the Yakima River basin, nine adfluvial, four fluvial, and two resident Bull Trout populations have been identified (Reiss et al. 2012). The nine adfluvial populations were located upstream of storage reservoirs. A fluvial population has been assigned to the upper Yakima River, but there is no evidence that the few spawning fish observed in this area constitute a distinct and self-supporting population. Two adfluvial populations in the Cle Elum drainage have the potential for extirpation (Reiss et al. 2012) and the Teanaway population is considered functionally extirpated (Thomas 2017); therefore, there may be only three local populations remaining in the upper Yakima River watershed. They are located in the Kachess (Box Canyon Creek and Kachess River) and Keechelus (Gold Creek) drainages. Each of these populations has critically low abundances with 10-year geometric means of 8, 11, and 13 redds, respectively (Anderson 2014).

Non-natural barriers to passage have reduced or eliminated population movement and the potential for genetic exchange. These barriers have also reduced habitat quality and quantity in migratory corridors (Reiss et al. 2012). According to a comprehensive genetic analysis, Bull Trout in the Yakima River basin appear to be losing genetic diversity in comparison to Bull Trout throughout its 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, the risk of inbreeding increases, and resilience in the face of catastrophic events declines. While there is evidence that small populations of Bull Trout have persisted at low numbers for many generations (Whitesel et al. 2004), reduced genetic diversity combined with current habitat threats may threaten the long-term viability of Bull Trout in the Yakima River basin.

## 2.1 Threats

Bull Trout populations in Keechelus and Kachess watersheds have chronically low abundance, reduced genetic diversity, and they are isolated from other populations. Reservoir dams have effectively eliminated connectivity for adfluvial Bull Trout populations to access their habitat, both upstream and downstream from the dams, and opportunity to comingle with other Bull Trout populations. These migration barriers have reduced or in many cases eliminated population and genetic interactions within the Yakima River basin. In recognition of this threat, Reclamation and Ecology have identified reservoir fish passage as one of the seven elements of the Integrated Plan (Reclamation and Ecology, 2011).

In addition, each Bull Trout population has specific threats that are unique to the geographic spawning and rearing habitats within the reservoirs shown in the following tables: Gold Creek (Table 1); Box Canyon Creek (Table 2); Kachess River (Table 3); South Fork Tieton River (Table 4); and North Fork Tieton River (Table 5). Climate change (Mastin 2008) adds another layer of risk. The *Yakima Bull Trout Action Plan* (YBTAP) provides a comprehensive analysis of threats throughout the Yakima River watershed (Reiss et al. 2012).

**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[2] | 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 |
| Development | NOT PRESENT | | NA |
| Grazing | NOT PRESENT | | NA |
| Transportation | NOT PRESENT | | NA |
| Mining | NOT PRESENT | | NA |

[2] This cell was updated to “Significant” (E. Anderson, Personal Communication, August 22, 2014)

**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 |

**Table 5. North 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 Clear Creek and Tieton dams | HIGH |
| Angling | UNKNOWN SIGNIFICANT | Outreach | MEDIUM |
| Entrainment | UNKNOWN SIGNIFICANT | Passage at Clear Creek and Tieton dams | MEDIUM |
| Introduced species | UNKNOWN SIGNIFICANT | Monitor brook trout introgression | MEDIUM |
| Prey base | UNKNOWN SIGNIFICANT | Carcass analogs | MEDIUM |
| Low abundance | UNKNOWN | Monitor; improve passage at Clear Creek Dam | MEDIUM |
| Forest management | LOW | — | LOW |
| Recreation | LOW | — | LOW |
| Agriculture | NOT PRESENT | — | NA |
| Altered flows | NOT PRESENT | — | NA |
| Development | NOT PRESENT | — | NA |
| Dewatering | NOT PRESENT | — | NA |
| Grazing | 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 significant threats to the three remaining populations in Keechelus and Kachess watersheds are low abundance and passage barriers created by storage dams, reservoir drawdown, and dewatering events that occur in tributaries where Bull Tour spawn and rear (Table 1, Table 2, Table 3). The YBTAP considered these threats as a high priority for Gold Creek and Kachess River populations, and considered low abundance and passage barriers as the high priority for the Box Canyon Creek population. The following were indicated at unknown or significant threats: angling, entrainment, prey base, introduced-species, limited habitat, forest practices, and recreation.

Table 4 and Table 5 show that the most significant threats to the South and North Fork Tieton River populations is the presence of the Tieton and Clear Creek dams, which create passage barriers, entrain Bull Trout, and contribute to a reduced prey base (Reiss et al., 2012). These dams preclude anadromous fish passage and eliminate upstream genetic exchange with the Naches River fluvial Bull Trout populations.

# Chapter 3. BTE Phase 1 Projects, Assessment and Design Actions

BTE Phase I projects along with the assessment and design actions described in this document address, specifically, low abundance, passage barriers above the reservoirs, degraded habitat, dewatering, and prey-base threats for Keechelus and Kachess reservoirs. BTE Phase I also addresses two passage barrier threats for the South and North Fork Tieton river populations.

The proposed projects and actions are consistent with recommendations in the YBTAP (Tables 1 through 5) and reflect input from regional biologists from WDFW, the USFWS, Yakama Nation, and Reclamation. Recognizing that low abundance and poorly functioning habitat are among the threats driving Bull Trout decline, these enhancement measures include projects to improve habitat function and directly increase Bull Trout abundance in the watersheds.

BTE Phase 1 includes implementation of the following projects:

- Gold Creek Passage and Habitat Improvements
    - Gold Creek Instream Restoration
    - Gold Creek Drain Decommissioning
- Bull Trout Task Force
- Box Canyon Creek and Reservoir Passage
- USFS Kachess Watershed Health
    - Box Canyon and Gale Creek Restoration
    - Upper Kachess River Project –Trailhead Restoration
- South Fork Tieton River Passage Restoration
- Nutrient Enhancement
- Bull Trout Salvage (Gold Creek, Kachess River and other tributaries if needed)

BTE Phase I also includes assessments and design work for the following:

- Gold Creek Passage and Habitat Improvements
    - Gold Creek Pond Reconstruction
    - Heli's Pond Assessment and Design
- Gold Creek USFS Bridge Replacement Assessment and Final Design
- Cold Creek Habitat Assessment
- Kachess River Assessment and Design
- Box Canyon Passage Assessment and Design
- North Fork Tieton River Passage Assessment and Design
- Nutrient Enhancement Study
- Bull Trout Population Enhancement Assessment

Reclamation, Ecology, and other participating entities will advance the assessment and design efforts through implementation of BTE Phase 2. Phase 2 actions will be subject to further environmental review and permitting, and their estimated costs would require funding approval.

## 3.1 **Gold Creek Passage and Habitat Improvements**

This project includes four actions that would improve habitat connectivity within Gold Creek by addressing dewatering and passage barrier issues (Figure 8-1). Gold Creek is the sole documented spawning tributary for the Keechelus Reservoir's Bull Trout population (Reiss et al. 2012). During mid-July to late September, channel dewatering occurs in the lower 3.1 miles of this tributary and impedes adult Bull Trout from moving upstream to spawn. Bull Trout mortality has occurred as they become stranded in the dewatered reach. Stream dewatering also affects juvenile 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). Historically, this tributary likely experienced dewatering during drought conditions. Current assessment indicates that land management practices, including previous timber harvests 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 passage to spawning grounds, improve rearing habitat, and reduce the number of stranded fish. Kittitas Conservation Trust (KCT) and their contractor have completed project assessment and conceptual designs.

Preliminary assessment findings have identified two key mechanisms causing dewatering in this reach. 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 (Heli's Pond). Restoration actions identified to address dewatering are Gold Creek instream restoration, Gold Creek pond reconfiguration, drain decommissioning, and Heli's Pond reconfiguration described below.

### 3.1.1 **Gold Creek Instream Restoration**

The objective of the Gold Creek Instream Restoration project is to restore historical channel form, function, and stability. This will be accomplished by reconstructing the channel and floodplain, connecting disconnected side channels, and placing channel and floodplain roughness in strategic locations. Tasks include the following actions:

- Mobilize, transport, and establish a staging site for construction materials (e.g., rock, large woody material (LWM) and equipment, which includes excavators, dozer, and helicopter based equipment.
- Implement erosion and sediment control plans to reduce the risk of upland sediments entering the creek.
- Construct temporary access roads to the construction site; clear and grub vegetation where necessary.
- Conduct fish salvage operations prior to construction.
- Narrow channel width along 1.0 to 2.3 miles of Gold Creek (Figure 3-1 and Figure 3-2); lower range focus on dewatered reach, upper range includes entire over-widened reach).
- Narrow channel down 100 to 200 feet, to a 50- to 125-foot-wide channel (based on 1944 aerial photo); this may change based on hydraulics and flooding issues.
- Construct a stable low-flow channel using wood and rock to aid in perennial flow, and add habitat along 1.0 to 2.3 miles of Gold Creek. Place large woody material (LWM) and logjams (with and without rock collars) in the creek using land and helicopter-based equipment. Install piles (piling-

sized trees) to anchor control structures and habitat features; this will require an impact hammer or driller.

- Shape gravel bars to fit channel needs using dozer or excavators.
- Enhance existing floodplain side channels and wetlands by reestablishing floodplain connections, which will require strategic excavation at channel and floodplain inlets.
- Plant native vegetation in disturbed upland sites and on streambanks identified in the project plans.
- Some work will occur on private land; real property or easement acquisitions may be necessary.

Expected cost is approximately $250,000 for final design work and approximately $4 million for project implementation.

### 3.1.2 Gold Creek Pond Reconfiguration

The goal of the Gold Creek Pond Reconfiguration is to restore historical groundwater flow into Gold Creek. The pond currently draws groundwater away from the creek. Filling and sealing the pond in strategic locations will reduce groundwater draw away from the creek and improve instream flows. Project tasks may include the following:

- Reconfigure pond size and shape, and reconfigure pond outlet to reduce surface and groundwater draw from Gold Creek into the pond, e.g., partial filling of the pond or raising the pond surface elevation (Figure 3-3).
- Regrade the berms surrounding pond (13 to 16 acres); this could be considered under complete or partial filling of pond.
- Reconfigure existing trails, picnic areas, parking areas, and other infrastructure, to match pond reconfiguration.
- Plant native vegetation including wetland, riparian, and upland species.
- Close the Gold Creek Pond Trail system during project construction.

This action requires extensive public outreach and input followed by project design before it is implemented. Outreach and design work is expected to cost approximately $300,000, and project implementation costs will be determined after the design work is completed. Implementing this project is part of BTE Phase 2. The public outreach and design work will provide information needed to adhere to local, State and Federal regulatory requirements.

**Figure 3-1. Representative habitat in lower Gold Creek. Narrowing the creek channel would improve habitat function (Photo by William Meyer, WDFW).**

**Figure 3-2. Properly functioning consolidated, narrow channel in upper Gold Creek (Photo by William Meyer, WDFW).**

**Figure 3-3. Gold Creek Pond (Photo by William Meyer, WDFW).**

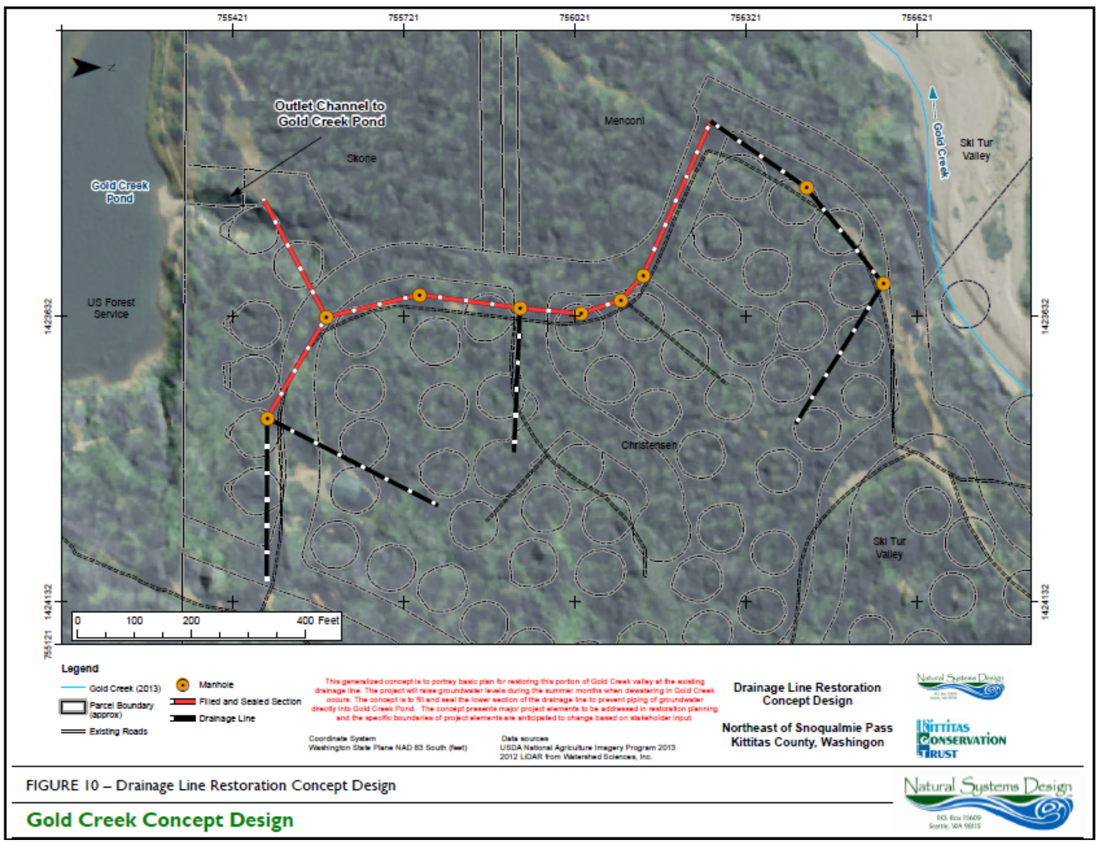
# 3.1.3 **Gold Creek Drain Decommissioning**

The objective of the Gold Creek Drain Decommissioning project is to restore historical groundwater flow into Gold Creek. Decommissioning the drain will reduce groundwater draw away from the creek (Figure 3-4). Project tasks would include the following:

- Trim minor vegetation to gain access to the drain system.
- Fill or plug unneeded drain sections.
- Acquire needed property or easements.

Decommissioning the drain is expected to be a relatively simple; however, the drain was installed to prevent groundwater flooding of cabin sites. Currently, this drain serves only a few structures in this development. The remaining non-developed parcels may be acquired by a land trust, which may need funding assistance to complete the acquisition. Project managers are coordinating with the landowners to test and determine if plugging the drain would flood the existing structures. If flooding occurs during testing, a section of the drain system may need to be maintained to prevent flooding, while decommissioning the unneeded sections. Project construction is expected to cost less than $50,000.

**Figure 3-4. Concept design for the Gold Creek Drain Decommissioning project.**



### 3.1.4 **Heli's Pond Reconfiguration**

The objective of the Heli's Pond Reconfiguration is to restore historical groundwater flow into Gold Creek. The pond contributes to drawing groundwater flow away from the creek during certain times of the year. Filling and reconfiguring the pond in strategic locations would reduce groundwater draw away from the creek. Project tasks will include the following:

- Develop and assess pond and levee restructuring options; design the preferred configuration.
- Restructure the pond, outlet channel, and levee to reduce groundwater interception, improve habitat, and maintain flood protection benefits.
- Plant native vegetation in disturbed sites.
- Acquire real property or easements that may be required to facilitate this action.

These activities would potentially require additional 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 stable until natural channel stabilization mechanisms (e.g., native vegetation) are in place to provide adequate cover for Bull Trout. The existing levee may be moved or adjusted to improve habitat conditions and maintain flood control. Large land-based equipment would be needed for earthwork and placement of wood and rock.

Channel restoration and filling would require in-water work and would result in increased levels of turbidity and noise. Flows may need to be diverted, partially or completely, from the existing channel to allow 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 and the pond. 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 easement acquisition may be required where work occurs on privately owned lands. Acquisitions would be made with willing landowners. Assessment and design work is expected to cost approximately $50,000, and project implementation will cost about $100,000.

## 3.2 **Gold Creek USFS Bridge Replacement Assessment and Design**

The proposed project would include a geomorphic assessment to determine project benefits and provide funding to complete final project design. If the assessment determines that constructing a new bridge on Forest Service Road 4832 (Figure 3-6) would restore the Gold Creek floodplain and enhance connectivity between Gold Creek and Keechelus Reservoir without creating negative impacts associated with sediment transport, project support will be considered in Phase two.

The project site is located on the Okanogan-Wenatchee National Forest in Section 15, Township 22 North, Range 11 East, Willamette Meridian.

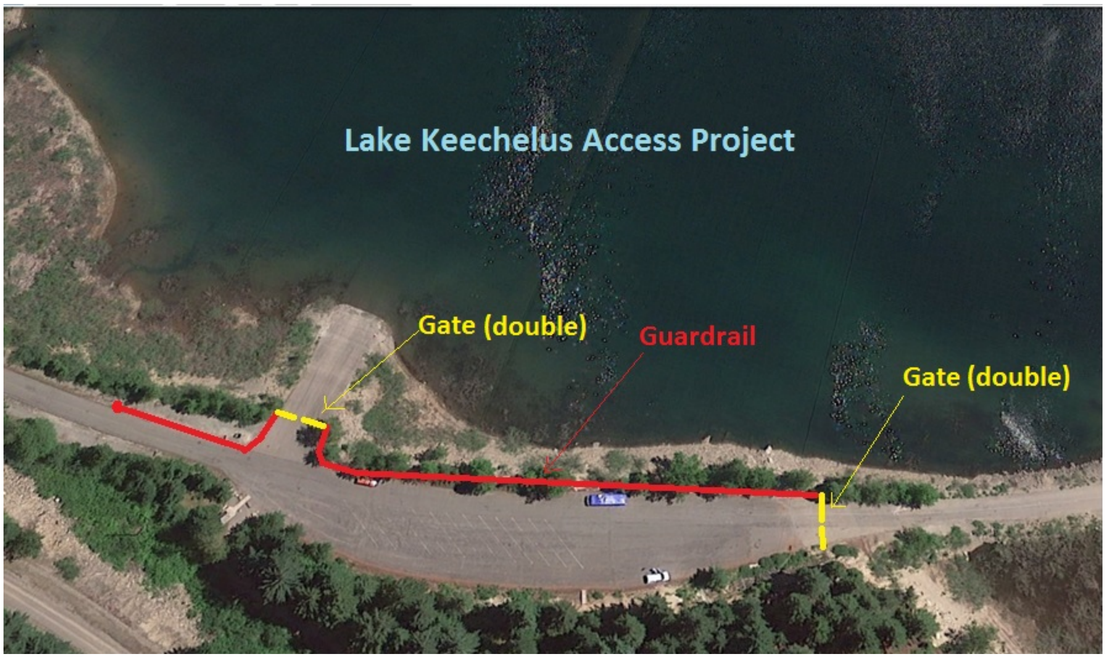



**Figure 3-5. Concept design for the Keechelus Reservoir and Lower Gold Creek Access Management project. Two gates (yellow) and approximately 1,900 feet of guardrail (red) would be installed to control reservoir access during low pool conditions.**


**Figure 3-6. Location of existing Forest Service Road 4832 bridge relative to I-90 and Keechelus Reservoir.**

When Interstate 90 (I-90) and Forest Service Road 4832 were constructed, it altered the hydrology and structure of Gold Creek. The original roads were constructed on fill across most of the historical floodplain, and the bridges confined Gold Creek to a single active channel (Figure 3-7). Borrow pits and staging areas were constructed on the floodplain along both sides of the highway. A large borrow pit upstream from Forest Service Road 4832 confined Gold Creek to the western margin of its historical floodplain. This created the Gold Creek Pond, which 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 USFS Gold Creek Bridge artificially constrains the floodplain and creek channel, resulting in scouring and sediment deposition patterns that prevent natural habitat processes from occurring (USDA 2011). I-90 has recently been reconstructed to span the Gold Creek floodplain, and the previous fill has been removed.

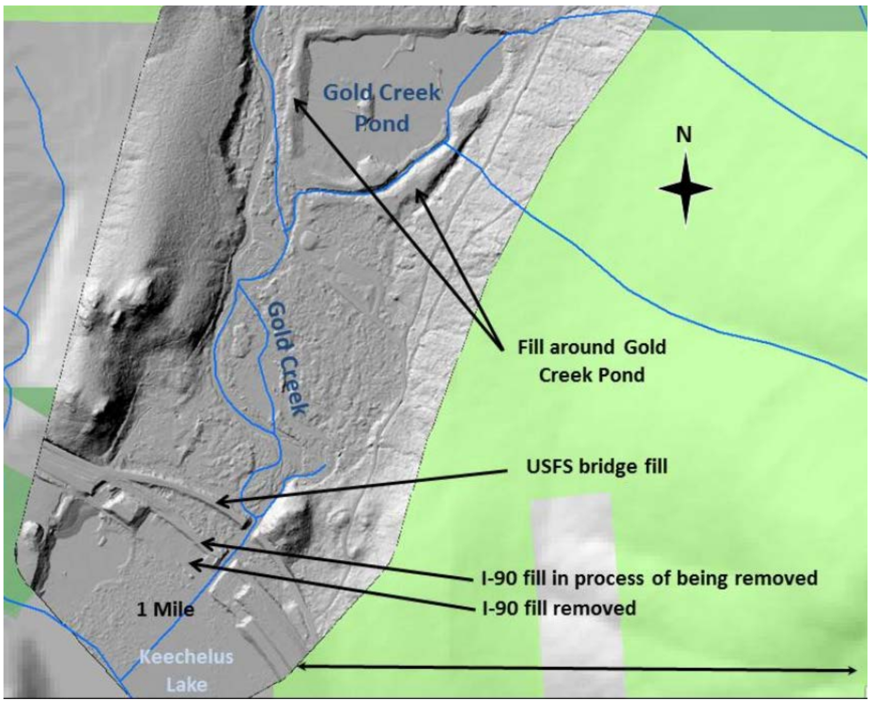



**Figure 3-7. LiDAR Image of Gold Creek floodplain depicting areas of fill along Forest Service Road 4832 that constrict the channel migration zone and reduce floodplain functions. All I-90 fill has been removed (Source: William Meyer, WDFW).**

A new Gold Creek USFS Bridge would span the floodplain of Gold Creek (approximately 725 feet) and may provide the following benefits: improved hydrologic connectivity, lower stream velocities, improved channel migration, restored floodplain, restored capacity for sediment transport, reduced sediment and temperature, and improved groundwater flow (USDA, 2011). To determine if these benefits would be realized a geomorphic analysis will be conducted.

Engineered designs developed by Sargent (2011) identify several options for replacing the bridge and recommend a preferred design alternative (Figure 3-7 and Figure 3-8). 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. Piling installation 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.
- 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).

In general, the bridge replacement would require very large equipment. The construction of the shafts would require large drilling machines that would occupy an area larger than that provided by the existing road. It is likely that the contractor would access the piers via the existing creek floodplain area, which would require the removal of existing vegetation and the placement of a rock work-pad (Sargent, 2011). Construction would occur over 2 to 3 years and only in the months of April through October.

Bridge and foundation installation would require in-water work, which would result in increased levels of turbidity and noise that would temporarily disturb Bull Trout in the construction area. Flows may need to be diverted, partially or completely, 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 project 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 National Environmental Protection Act (NEPA) environmental assessment (USDA, 2011a). A Decision Notice and Finding of No Significant Impact were issued by the Cle Elum Ranger District on August 10, 2011 (USDA, 2011b). The project has undergone initial design review and preliminary costing (Sargent, 2011). The estimated cost of the geomorphic analysis is \$100,000, while cost for final design is estimated to be about \$40,000. Providing support for bridge construction will be considered during Phase Two

This page intentionally blank

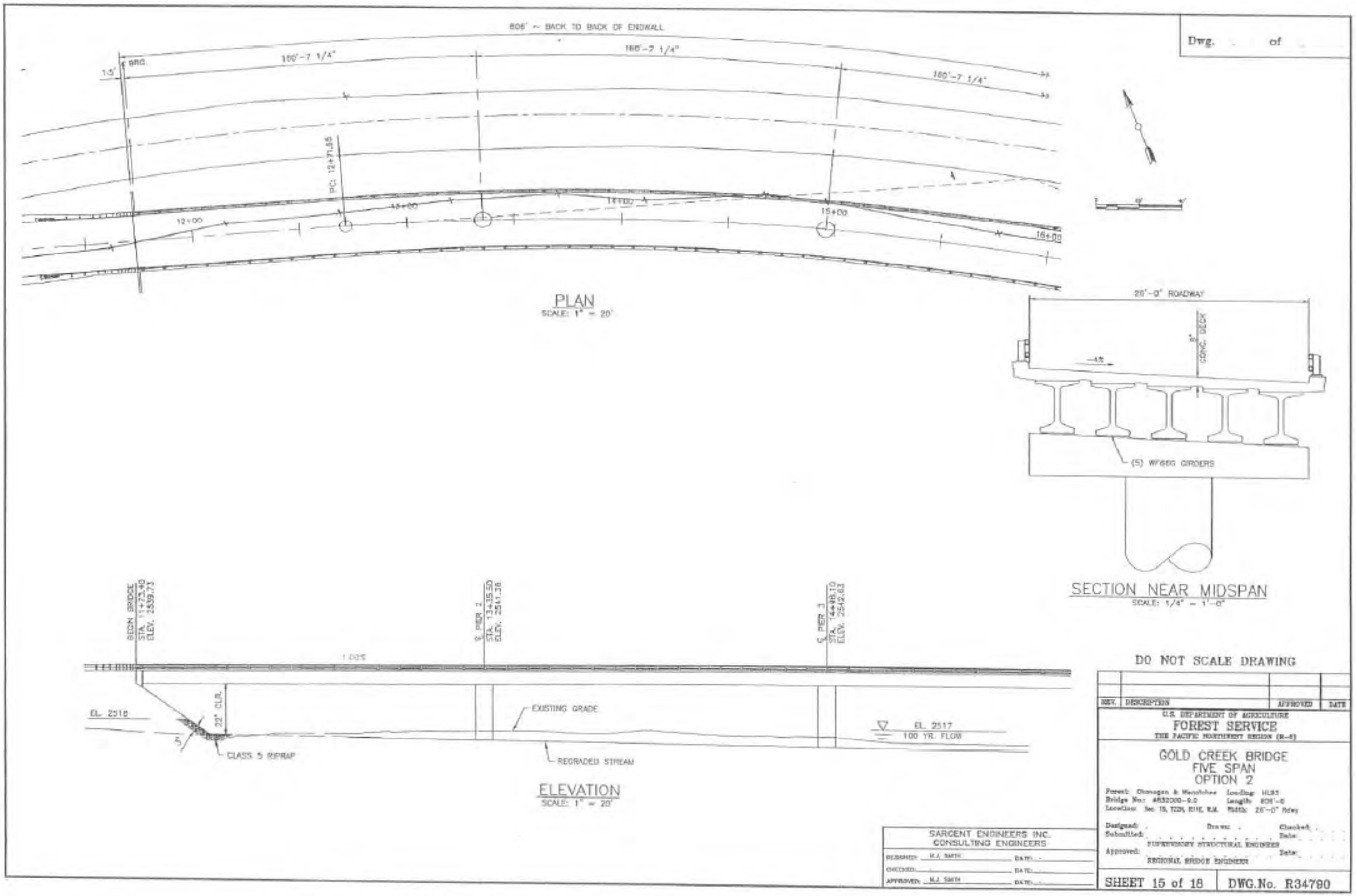



**Figure 3-8. Recommended Gold Creek USFS Bridge Replacement Design Sheet 15 (drawing obtained from Sargent, 2011).**

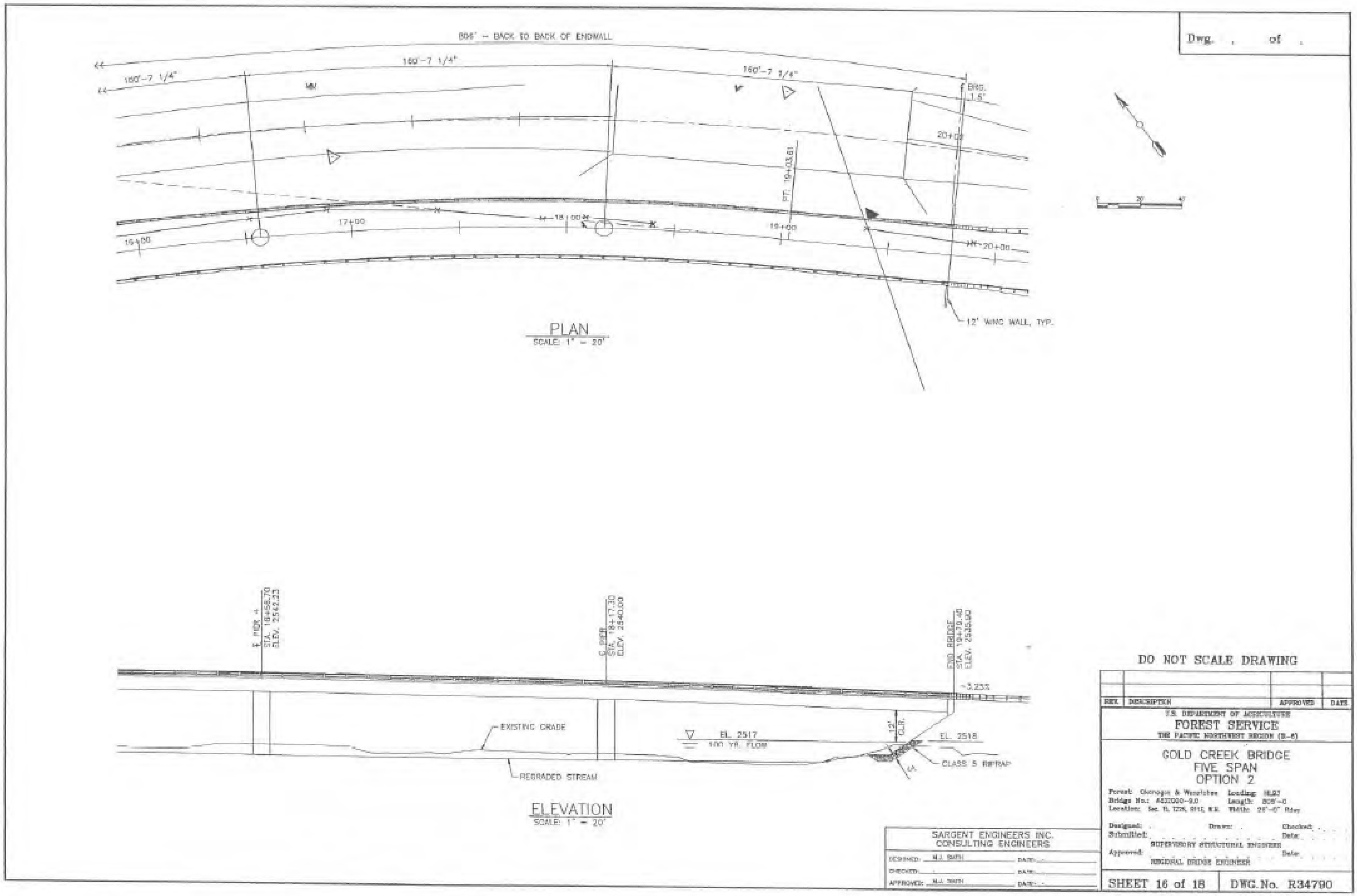



**Figure 3-9. Recommended Gold Creek USFS Bridge Replacement Design Sheet 16 (drawing obtained from Sargent, 2011).**

## 3.3 Cold Creek Habitat Assessment

This project would assess habitats within Cold Creek. Cold Creek (Figure 8-2) may provide a significant tributary habitat for Keechelus Reservoir Bull Trout (Reiss et al. 2012). The existing culvert crosses Cold Creek at the John Wayne Pioneer Trail and Iron Horse State Park. Access to Cold Creek is prevented by a perched culvert and an existing dewatered channel that occurs during low pool elevations (Figure 3-10 and Figure 3-11). A previous attempt to create passage was unsuccessful as high water destroyed the constructed improvements (Reiss et al. 2012).

**Figure 3-10. Existing passage barrier at Cold Creek culvert.**

**Figure 3-11. Existing Cold Creek channel condition downstream from the culvert.**

Cold Creek temperature and habitat suitability will be evaluated. If they are determined to be suitable and can support Bull Trout, project design will be evaluated in Phase 2 of the BTE. The estimated cost to evaluate stream temperature and habitat suitability in Cold Creek is $30,000.

## 3.4 Bull Trout Task Force

The Bull Trout Task Force (BTTF) project is a combination project that includes on-the-ground work, data collection, and outreach. The BTTF is a collaborative effort between multiple organizations in the Yakima River 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* (USFWS 2014) and in the *2012 Yakima Bull Trout Action Plan* (Reiss, et al. 2012). These threats include angling, the construction of recreational dams, riparian vegetation removal, streambank destruction, harassment during spawning, and poaching.

The 15 identified local Bull Trout populations in the Yakima River basin occupy a wide range of habitat (primarily forage and overwinter) in the mainstem rivers and reservoirs, and they spawn and rear in the headwater tributaries. Recreation also occurs in these areas. Threats to Bull Trout are both intentional and incidental actions taken by anglers and other recreationists. A priority objective of the BTTF is to identify and remove recreation dams. Constructed by hand, these recreational dams can span the entire channel of small tributary streams. They can impede Bull Trout passage, which may have long-term consequences for small populations. The BTTF plans to educate recreationists about the unintended consequences of recreation dams by posting informational signs in problems areas.

In addition to removing recreation dams, the BTTF will conduct direct outreach to anglers and recreationists regarding Bull Trout identification and conservation. Anglers will receive a Bull Trout vs. Brook Trout identification card. The BTTF will deploy, maintain, and retrieve temperature data loggers in Bull Trout inhabited streams throughout the Yakima River basin. The temperature data collection will assist with a multiagency, temperature-monitoring network that will fill temperature data gaps throughout the Yakima River basin and help guide future restoration work. The BTTF will work throughout the Yakima River basin to prevent direct take of Bull Trout and to educate the public about species protection.

The estimated cost of this project is approximately $150,000 for two years. The proposal is to implement this project through 2019.

## 3.5 Box Canyon Creek Passage

This project would significantly improve Bull Trout access to habitats within Box Canyon Creek, especially during low water years. When the lower portion of Box Canyon Creek (Figure 8-4) becomes dewatered (Figure 3-12), Bull Trout are delayed or prevented from moving upstream into spawning grounds and also exposes spawning adults or rearing juveniles to increased predation and desiccation risks.

In low water and drought years, Bull Trout passage issues worsen further by starting earlier and lasting longer. Generally, pool levels are low in most Yakima River basin reservoirs by the end of the irrigation season. When the Kachess Reservoir pool elevation drops below certain levels, it can cause Box Canyon Creek to flow subsurface in places, which creates a fish barrier in some years. Reclamation has contracted with the WDFW to monitor Box Canyon Creek and other reservoir stream flows for passage issues and to install temporary passage systems when necessary (Reclamation's Activity Plan #15- Bull Trout Passage Action Plan - R15PX01080).

The Box Canyon Creek Passage project surpasses temporary passage systems and provides a long-term solution for improving Bull Trout passage significantly during the fall and especially during low water and drought years. This project would include installation of a roughened channel using a substrate mix that would seal the bed at scour depth. It also includes installing channel and bank control structures using large rock and LWM. Project tasks will include the following:

- Construct temporary road to access construction site. Clear and grub vegetation where necessary.
- Establish a material (rock, LWM) and equipment (excavator and dozer) staging site on reservoir bed.
- Install a bypass channel on the reservoir bed to divert water from construction site.
- Conduct fish salvage operations prior to construction.
- Construct a roughened channel with grade and bank control structures (rock and LWM materials) from the mouth of Box Canyon Creek to the low pool elevation within Kachess Reservoir.
- Plant native vegetation in disturbed upland sites and streambanks where vegetation was removed to access the construction site.

Channel reconstruction and the placement of large wood and other structure 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 and downstream to the confluence with the reservoir at low pool elevation. Flows will be diverted from the existing channel to allow access to the channel bed during construction and to prevent fish from encountering major construction activities

**Figure 3-12. Fish cannot pass through Box Canyon Creek sections.**

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 minimal (very little vegetation is present in the construction area) and transient, as temporary roads and other disturbed areas would be regraded and revegetated with appropriate native plant species immediately following construction.

Construction will occur during reservoir drawdown between September and November. 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. Design work is expected to cost approximately $200,000, and project implementation would cost about $1,500,000.

## 3.6 Kachess River Assessment and Design

This assessment would identify opportunities to reduce or eliminate dewatering events in the Kachess River (Figure 8-3). After the assessment is complete, the design will be developed for project implementation in the BTE Phase 2. Currently, the lower portions of this tributary have experienced dewatering events that can prevent or delay Bull Trout from moving upstream into spawning grounds and stranding spawning adults or rearing juveniles, which exposes them to predation or desiccation.

Dewatering in the Kachess River occurs at two locations (Figure 3-13) extending from the first 0.25 to 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 from the high reservoir pool (i.e., upstream reach).

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 during a dry fall, these braided channels can go dry (Figure 3-15). In the upstream reach, the valley-bottom forest has been logged, and the river channel is destabilized.

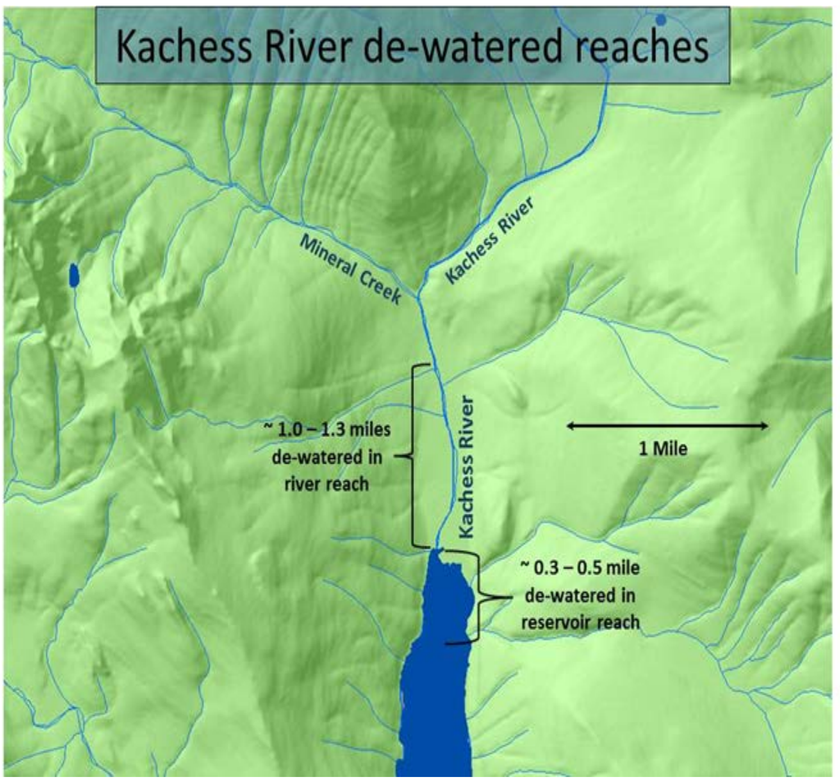



**Figure 3-13. There are two Kachess River reaches that experience dewatering.**

**Figure 3-15. Dewatered reach of lower Kachess River within the reservoir bed.**

**Figure 3-14. Dewatered section of Kachess River upstream from Kachess Reservoir (Photos by William Meyer, WDFW)**

As a result, the channel has become too wide, and sediments have eroded and redistributed, which contributes to shallow or subsurface flows and periodic dewatering (Figure 3-14).

The goal of the proposed Kachess River Assessment and Design 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 the stream. The Gold Creek investigation 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 in-stream structure. The evaluation would also examine how land and water management has influenced identified changes. The assessment would identify actions to reduce dewatering and provide project designs for subsequent construction. The estimated cost for the assessments and design work is $300,000.

Reclamation, Ecology, and participating agencies and entities intend to pursue and implement river channel and floodplain restoration projects to reduce dewatering to improve passage as guided by the results of the assessment and design process. The assessment and design work will provide needed information to adhere to local, State and Federal regulatory requirements.

The specific approach for reducing dewatering events in the Kachess River has not yet been determined. When the assessments and designs are completed, the projects will be implemented as part of BTE Phase 2. Channel reconstruction and the placement of large wood require in-water work that would likely cause increased levels of turbidity and noise; Bull Trout would be temporarily disturbed for about 1.6 miles, from the upstream extent of the project and downstream to the confluence with the reservoir at low pool elevation (Figure 3-15). Partial or completely diverted flows from the existing channel would 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 will be regraded and revegetated with appropriate native plant species immediately following construction activities. Erosion and sediment control plans would be implemented to reduce the risk of upland sediments entering the creek.

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.

## 3.7 **Box Canyon Passage Assessment – Peek-a-Boo Falls**

A set of natural, impassable waterfalls (Peek a-Boo Falls), approximately 1.6 miles upstream from the confluence with Kachess Reservoir, restricts Bull Trout access to the upper reaches of Box Canyon Creek (Reiss et al. 2012). This assessment would determine if fish passage over two natural-barriers is biologically sound. It would also address any limiting factors for Bull Trout within Kachess Reservoir (Figure 8-4).

Specifically, 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 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 Bull Trout

Enhancement Population Enhancement evaluation (Section 3.11), 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 supports expanding habitat access upstream from the falls, fish passage design and project construction would be completed as part of BTE Phase 2.  The assessment and design work would provide the information needed to adhere to local, State and Federal regulatory requirements. Reclamation, Ecology, and participating agencies and entities intend to pursue and implement a passage project at Peek-a-Boo Falls that is guided by the results of this assessment.

## 3.8 USFS Kachess Watershed Health

The Okanogan-Wenatchee National Forest Cle Elum Ranger District has identified several projects that would improve hydraulic conditions (rate and duration of runoff and seepage); increase stream shading; and reduce fine sediment delivery to Bull Trout habitat in the Kachess River watershed.  Streams that would benefit from the identified projects include Box Canyon Creek, Gale Creek, Mineral Creek, and Upper Kachess River.

### 3.8.1 Box Canyon and Gale Creeks Restoration

There are 13 riparian restoration and 12 road projects identified (Figure 3-16 and Table 6 ) that would reduce fine sediment delivery and restore riparian vegetation to Box Canyon and Gale creeks.  Actions would include road decommissioning, control infrastructure and maintenance, campsite and trail improvements to limit disturbance, and planting native vegetation.

Box Canyon / Gale Creek - Watershed Restoration Sites

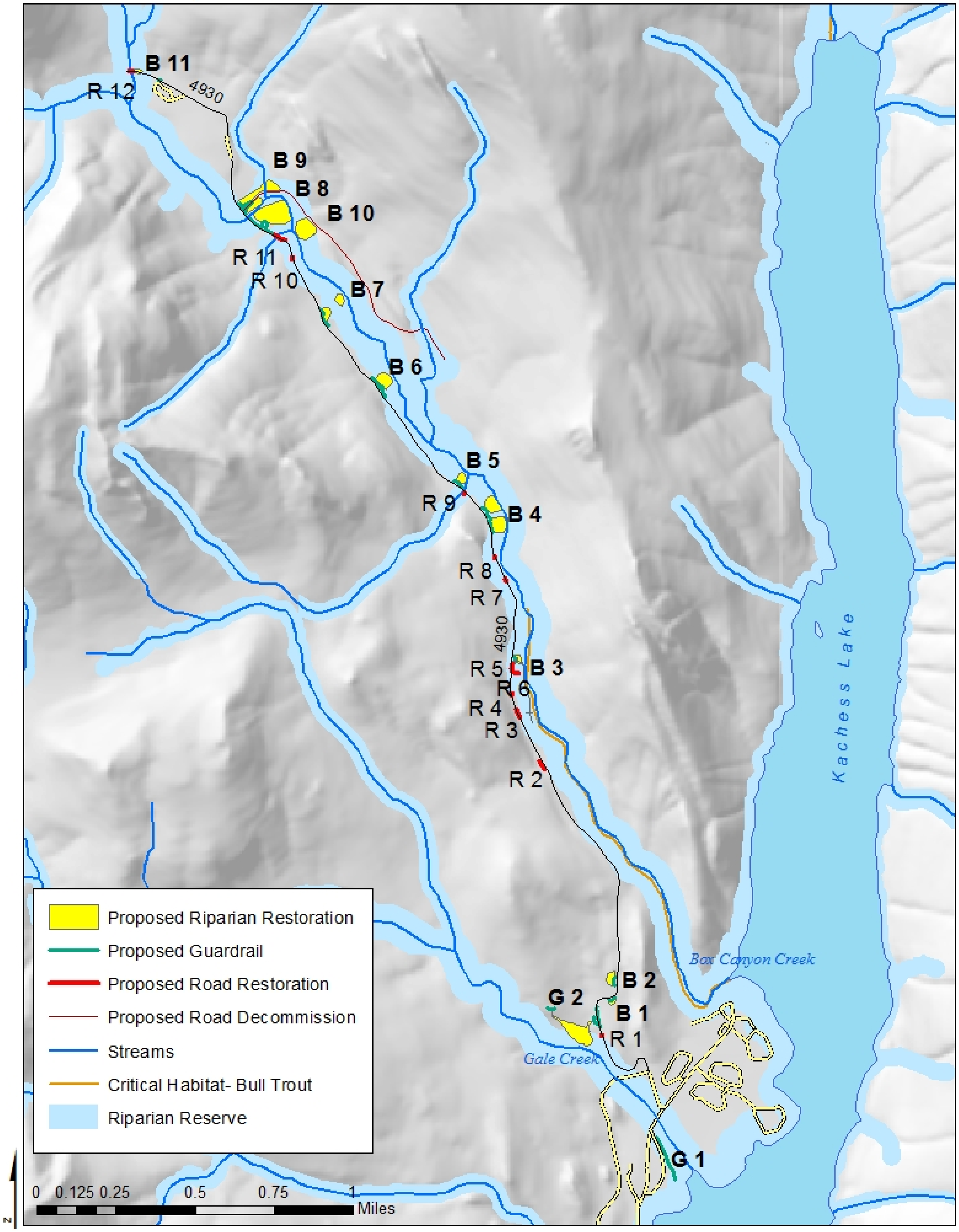



**Figure 3-16. Twelve locations of restoration work along Box Canyon Road. Roadwork areas are highlighted in red, and proposed revegetation sites are highlighted in yellow.**

Box Canyon Road is 3.9 miles long; a 1.8-mile stretch (45 percent) is within the riparian reserve. This classifies the Box Canyon drainage as impaired. The Forest Service Watershed Condition Class framework classifies watersheds with greater than 25 percent of road or trail length located within the riparian reserve as impaired. Public use in Box Canyon has further increased the amount of disturbed land located within the riparian reserve. This reduces growth of riparian vegetation and increases the amount of sediment delivered to Box Canyon Creek. Dispersed campsites have expanded outward, particularly toward the direction of the stream. In addition to the expansion of dispersed campsites toward the stream, users have removed live trees and other vegetation along the streambanks, which has reduced shade over the stream. The condition of Forest Service Road 4930 and the drainage problems along the roadway are also sources of stream sedimentation.

**Table 6. Descriptions of the 13 riparian restoration and 12 road projects Figure 3-16 that would reduce fine-sediment delivery and restore riparian vegetation to Box Canyon and Gale creeks.**

| Site ID | Site Description | Restoration Action |
|---|---|---|
| **G 1** | Gale Creek is eroding into the developed Kachess Campground. | Install bucking rail fence to ensure public safety and reduce unnatural erosion. Remove existing infrastructure from this erosional area. |
| **G 2** | Dispersed camping | Due to the lack of appropriate pullouts, the large area in need of restoration, and the effects of sedimentation in Gale Creek, it is proposed that this site be closed to dispersed camping. The Kachess Campground is available less than a half kilometer away.<br>• Place barrier at campsite entrance.<br>• Scarify the landscape to de-compact the soil.<br>• Mulch areas located outside the floodplain.<br>• Use native plants and cuttings to revegetate the landscape.<br>• Place signs to discourage visitors from disturbing the new vegetation. |
| **B 1**<br>**B 2**<br>**B 3**<br>**B 4**<br>**B 5**<br>**B 6**<br>**B 7**<br>**B 8**<br>**B 9** | Dispersed camping | • Install barriers to define vehicle pullouts.<br>• Place gravel on the pullout pad.<br>• Temporarily close the area to recreational use.<br>• Scarify the landscape to de-compact the soil.<br>• Mulch areas located outside the floodplain.<br>• Use native plants and cuttings to revegetate the landscape.<br>• Place signs to discourage disturbance of the new vegetation.<br>• Allow re-entry once the vegetation is established. |
| **B 10** | FSR 4930-118 and dispersed camping | • Decommission 118, reconnecting hydrologic features associated with nearby meadow.<br>• Install barriers to define vehicle pullouts.<br>• Place gravel on the pullout pad.<br>• Temporarily close the area to recreational use.<br>• Scarify the landscape to de-compact the soil.<br>• Mulch areas located outside the floodplain.<br>• Use native plants and cuttings to revegetate the landscape.<br>• Place signs to discourage visitors from disturbing the new vegetation.<br>• Allow re-entry once the vegetation is established. |
| **B 11** | Rachel Lakes Trailhead Parking | • Install barriers to define developed parking.<br>To restore parking encroachment into vegetated areas:<br>• Scarify the landscape to de-compact the soil.<br>• Mulch areas located outside the floodplain.<br>• Use native plants and cuttings to revegetate the landscape.<br>• Place signs to discourage visitors from disturbing the new vegetation. |

| Site ID | Site Description | Restoration Action |
|---|---|---|
| **R 1** | Erosion channels on roadway | Clean ditch |
| **R 2** | Large erosion near culvert exit, about to encroach on roadway | Re-install culvert to match slope of hill |
| **R 3** | Wood clogging ditch | Public collects wood or it is removed within reasonable time period |
| **R 4** | Erosion encroaching on road | Additional culverts along roadway to handle flows |
| **R 5** | Wood clogging ditch | Public collects wood or it is removed within reasonable time period |
| **R 6** | Blowout on stream side of roadway | Additional culverts along roadway to handle large flows, Properly decommission old camp two-track |
| **R 7** | Wood clogging ditch | Public collects wood or it is removed within reasonable time period |
| **R 8** | Wood clogging ditch | Public collects wood or it is removed within reasonable time period |
| **R 9** | Some sediment leading from culvert | Clean culvert |
| **R 10** | Erosion encroaching on road | Additional culverts along roadway to handle flows |
| **R 11** | Large roadway erosion | Convert this area to armored ford, OR clean culverts, add additional culverts, clean ditches, restore area uphill of roadway |
| **R 12** | Erosion along sides of large culvert crossing Box Canyon Creek (above confluence with West Fork) | Decommission stream crossing, remove culvert and re-grade stream banks |

### 3.8.2 **Upper Kachess River Project –Trailhead Restoration**

This project will reduce road erosion and sediment delivery to Kachess River and reduce the risk for large debris flows. Forest Service Road 4600 provides access to the current trailhead for the Mineral Creek Trail. The lower section of this road parallels an intermittent drainage to Upper Kachess River. There is currently erosion occurring along this section of road (Figure 3-17) and it is at risk for larger debris flows, which could deliver large sediment loads to the river affecting access for upstream migrating adults. It is proposed to move the trailhead higher on the hillside, decommission the lower trailhead parking lot, and lower the section of road leading to the parking lot.

**Figure 3-17. Erosion along lower section of Forest Service Road 4600.**

Two cleared helicopter landings are located on the hill above the current parking lot (Figure 3-18). These landings are good options for new trailheads. Short (0.2 or 0.3 mile) decommissioned roads would be reopened to provide access to the landings, which will be developed as new trailheads. Using this decommissioned road would keep the entire roadway higher on the hillslope, and the current road could be decommissioned before it reaches the ephemeral drainage and floodplain sections of the Mineral and Upper Kachess river system. This project will be coordinated with the Kachess River Assessment and Design (Section 3.6) to limit impacts, reduce costs, and improve overall restoration value.

This section addresses road and public access impacts and improvement projects that will protect overall watershed health, enhance water quality, reduce fine sediment delivery, and enhance riparian conditions in critical Bull Trout habitat. The cost to implement the USFS Kachess Watershed Health project is approximately $800,000. This project should follow the completion or the Kachess Assessment and Design and the Box Canyon Passage projects.

Mineral Creek / Upper Kachess- Trailhead Restoration

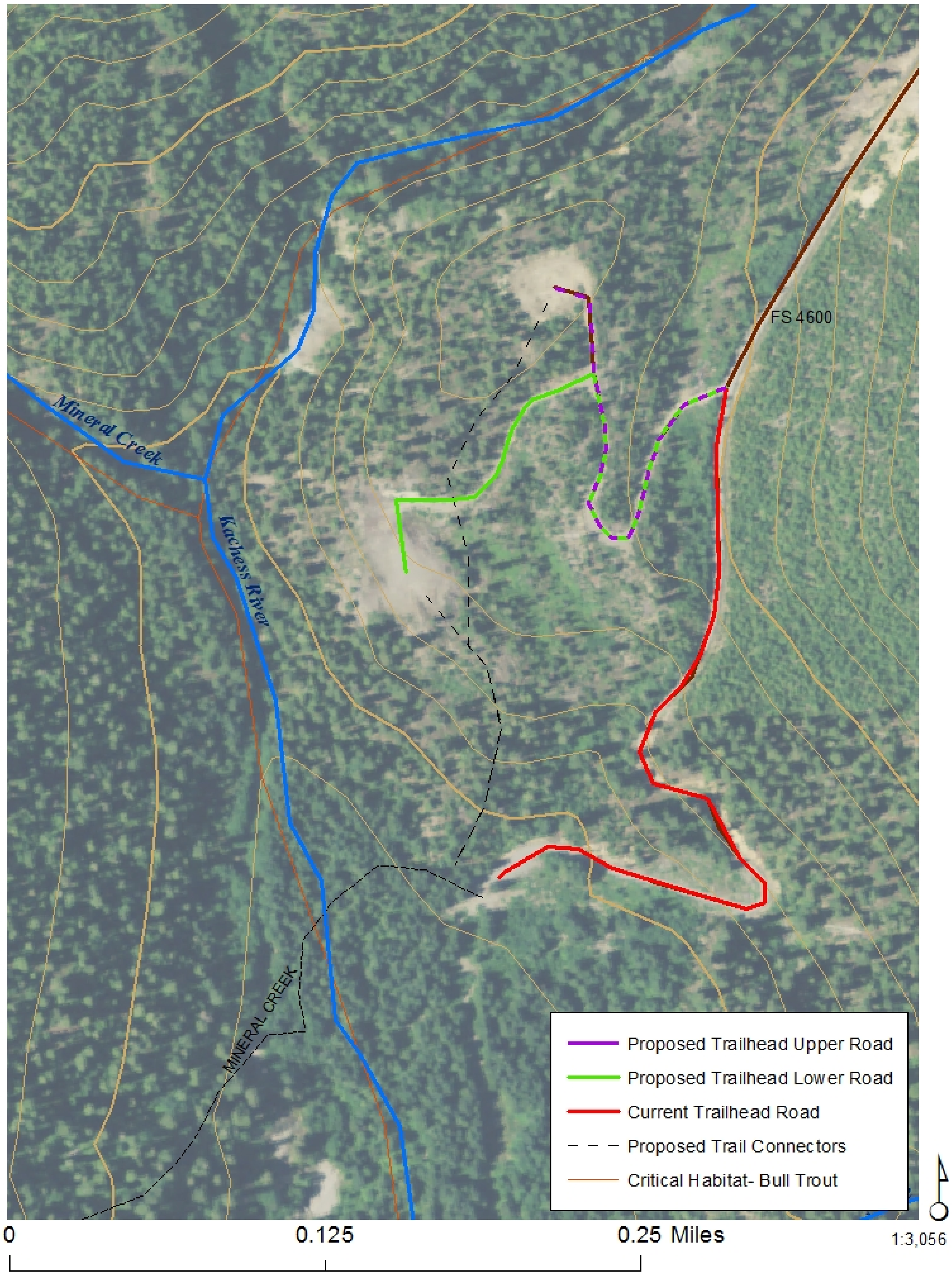



**Figure 3-18. Imagery showing current trailhead, current trailhead roadway (red), helicopter landing areas, and potential roads to landing areas (purple, green).**

## 3.9 South Fork Tieton River Passage Assessment, Design, and Construction

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 3-19). A waterfall begins to form at this location when the reservoir draws down below 131,000 acre-feet. It is believed to become impassable for Bull Trout migrating 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, land in a shallow pool, and descend the shallow-braided channel to return to the reservoir.

Improved passage into the river is important for the South Fork Tieton River Bull Trout population and may also benefit populations in Kachess and Keechelus reservoirs. In addition to passage benefits in the South Fork Tieton River, this project would provide flow management options that could reduce drawdown impacts on the upper Yakima reservoirs. In addition, this project could provide increased flexibility 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 rivers.

The assessment would examine passage solutions, habitat conditions, and reservoir operations with the goal of improving passage into the South Fork Tieton River (Figure 8-5); reducing potential passage issues in Kachess Reservoir; and reducing risk of injury to downstream migrants. Following fish passage engineering and design, the project would be constructed during BTE Phase 1 if funding is obtained.

This project will reestablish passage through the historical channel while maintaining the existing channel. Project tasks will include the following:

- Construct temporary roads to access construction sites. Clear and grub vegetation where necessary.
- Establish staging sites for construction materials and equipment
- Implement erosion and sediment control plans to reduce the risk of upland sediments entering the creek.
- Remove fill from historical channel, install flow control weir, construct a roughened channel with grade and bank control structures (rock and LWM materials) from the flow control weir to outlet of the historical channel connection with reservoir bed.
- Install an appropriate-sized bridge to cross over the restored historical channel using cranes and other heavy equipment.
- Plant native shrubs and trees in all disturbed sites.
- Close the Tieton Reservoir Road during project construction.
- Plan construction activities after reservoir drawdown, between late September and early November.

The estimated cost of the passage 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 is $100,000. The estimated cost of engineering and design is approximately $250,000, and the estimated cost for project construction about $3,000,000.

**Figure 3-19. Rimrock Reservoir drawdown resulting in a passage barrier at the South Fork Tieton River below Forest Service Road 1200 (Photo by William Meyer, WDFW).**

## 3.10 **Clear Creek Dam Passage Assessment and Design**

The Clear Creek Dam Passage Assessment and Design action will evaluate passage options at the Clear Creek Dam (Figure 3-20 and Figure 3-21) or the Clear Lake Spillway (Figure 3-20 and Figure 3-22). This project would restore access to high-quality habitat for North Fork Tieton River Bull Trout. Upon the completion of the assessment, a fish passage option will be chosen, and project engineering and design will be completed. Clear Creek Dam impounds a small reservoir (Clear Lake) on the North Fork Tieton River. The dam was built in 1914 without fish passage. During reconstruction of the dam in 1992, two fish ladders were added to the adjacent spillway channel, the only migration route past the dam. These ladders were not designed to fish-passage criteria, and uncertainty remained over the ability of fish to migrate past the dam, especially adult Bull Trout (Thomas and Monk 2016). A study was initiated to address this uncertainty and determine if passage through the spillway was effective. Results of the study found that Bull Trout were not successful at passing over the spillway, except for one, out of 26, tagged Bull Trout. The study also found that seven Bull Trout attempted to pass through the spillway but failed (Thomas and Monk 2016). A combination of factors affects the ability of Bull Trout to migrate successfully up the spillway channel. High water temperatures in the spillway during key migration periods deter spillway use; also, cool water released from Clear Creek Dam attracts migrating fish into Clear Creek Dam stilling basin. The number of North Fork Tieton River Bull Trout currently isolated below Clear Creek Dam is significant, perhaps equaling or exceeding the number that currently spawn above it (Thomas and Monk 2016). The study confirmed ineffective passage over the spillway for Bull Trout that migrate downstream from Clear Lake causes a significant threat to the North Fork Tieton River population.


**Figure 3-20. Map of Clear Lake showing the location of the Clear Lake Spillway and Dam.**

**Figure 3-21. Clear Creek Dam on the downstream side of the dam.**

**Figure 3-22. Clear Creek spillway on the downstream side of the spillway.**

The North Fork Tieton River Passage Assessment and Design action will evaluate different passage approaches such as trap and haul, Whoosh™ or pressurized tube transport, conventional fish ladders, and other options. The estimated cost of the assessment and design is $1,500,000. Following the assessment, a passage option will be chosen and project engineering and design will be completed. The cost of project construction will be determined after the passage approach is chosen and design is completed. The assessment and design work will provide needed information to adhere to local, State and Federal regulatory requirements. Reclamation, Ecology, and participating agencies and entities intend to pursue passage improvements identified as beneficial in the assessments, subject to environmental review and permitting.

## 3.11 Bull Trout Salvage and Population Enhancement Assessment

The Bull Trout Population Enhancement Assessment would evaluate the efficacy of directly increasing the abundance and diversity of Yakima River basin Bull Trout populations using translocation, supplementation, and salvage methods. Translocation moves Bull Trout from a healthy population and places them into a population in need of enhancement or reintroduces them into habitat where they have been extirpated. For example, Bull Trout could be moved from a healthy external population to habitats within Keechelus and Kachess reservoirs or the Teanaway watershed (likely an extirpated population). High-risk populations will be evaluated to determine suitability for enhancement; healthy populations will be evaluated to determine suitability to serve as a donor population; and habitat that once supported a population will be evaluated to determine suitability for reintroduction.

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 in 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 their former occupied habitats. 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 further evaluation. Translocation of even a few fish from another population may have significant impacts on the genetics of a small population.

The key to successful translocation efforts is understanding 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, meta-population dynamics, genetic analysis, extinction risk, and donor-recipient sensitivity analysis.

Supplementation is another approach to population enhancement that will be evaluated. Supplementation differs from translocation in that Bull Trout would be bred in a controlled environment (e.g., a hatchery) to increase juvenile survival rates; 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 decision-making framework that will ensure the priority and efficacy of subsequent population enhancement efforts. The assessment will play an important role in determining whether population enhancement is congruent with available habitat capacity and genetic risks. To ensure coordination and consultation requirements are timely, the project will use existing proposal information developed by key stakeholders and managers, including WDFW, Yakama Nation, the USFWS, USGS, USFS, and Yakima Basin Fish and Wildlife Recovery Board (e.g., Conley et al. 2014). The results from this assessment will inform where habitat capacity may be limited; therefore, it will be useful in 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, the translocation and supplementation actions will likely occur in BTE Phase 2.

Bull Trout salvage may also enhance populations. Sometime fish are trapped in locations that increase their chances to be killed or prevent their access to spawning habitat, eliminating their ability to reproduce. For example, Bull Trout may become stranded below a fish barrier or in a dewatered reach of a stream. Salvage entail capturing and moving trapped fish to a safer environment, which can effectively increase their ability to reproduce.

Seasonal stream dewatering in Gold Creek and Kachess River is known to cause significant mortality for fry, juvenile, and adult Bull Trout (Craig & Wissmar 1993; Meyer, 2002; Bunce, 2016). Both streams routinely become dry in discreet segments as streamflow decreases in the summer. As flows decrease, fish can become trapped and likely die from predation or dewatering. Bull trout can also be impinged below dams if they travel over spillways or through water-release outlets. Fish trapped below dams cannot migrate to spawning grounds to reproduce.

Salvaging Bull Trout in the short to medium term would bolster and buy time for these populations until medium- to long-term habitat restoration projects can be implemented. BTE Phase 1 includes conducting pilot study to implement salvage operations, assess the scope the problems, and determine salvage feasibility; if shown to be effective, a program would be developed to conduct salvage on an annual basis at a cost of approximately $50,000 per year for 10 years ($500,000 over 10 years).

### 3.1.2 **Nutrient Enhancement to Increase Ecological Productivity**

The goal of this project is to add nutrients to both the Keechelus and Kachess tributaries that support Bull Trout and to study and assess if adding nutrients will increase ecological productivity and increasing food supply for Bull Trout (other reservoir tributaries may be added to the study). These tributaries, Gold Creek, Box Canyon Creek, and Kachess River, are oligotrophic (unproductive) environments and adding nutrients is expected to increase ecological productivity, translating into an increase in food supply for Bull Trout at different life stages.

Providing nutrient enhancement in the tributaries and the reservoirs (e.g., salmon carcasses, carcass/analogs) 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 used by primary producers (e.g., 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 that would functionally recreate the historical 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 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. 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 with heat to kill any pathogens that may be present prior to hauling and placement. Carcasses will be placed in tributaries that are historical spawning streams including Gold Creek, Box Canyon Creek and Kachess River. Carcasses will be placed when spawning would have historically occurred during the fall, late September through November. Impacts on 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).

# Chapter 4. Benefits and Threats Addressed

All the proposed enhancement projects and assessments address significant population threats identified in the YBTAP (2012) and are consistent with recommended actions therein (Table 1 through 5). The potential benefits of each project and assessment relative to the primary threats addressed are summarized in Table 7.

The Gold Creek Passage and Habitat Improvement actions will directly address threats posed by dewatering and seasonal passage barriers within the Gold Creek tributary. This project, possibly in conjunction with Bull Trout population salvage and 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 Cold Creek Assessment, Box Canyon Creek Passage, Box Canyon Passage Assessment, South Fork Tieton River Passage and Clear Creek Passage enhancement actions would remove fish barriers (full and partial barriers) and some will address threats posed by dewatering that currently eliminate or limit Bull Trout access to historical critical habitat. These actions, possibly 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 Assessment and Design has the potential to address directly the threats posed by dewatering and seasonal passage barriers within the Kachess River. The effectiveness of this action will be dependent upon the results of the assessment and design, and whether habitat improvements are implemented in BTE Phase 2. Successfully addressing stream dewatering would improve access to spawning and rearing habitat and reduce losses caused by predation and desiccation.

The USFS Kachess Watershed Health project would improve water quality by providing vegetative shading and significantly reducing fine sediment delivery to critical Bull Trout habitat in the Kachess watershed. These actions would provide synergistic benefits when added to the Box Canyon Creek and Reservoir Passage and the Kachess River Assessment and Design projects.

Conducting Bull Trout salvage may significantly increase juvenile survival and strengthen Bull Trout populations over time while conducting the Bull Trout Population Enhancement Assessment will provide baseline data to inform decisions related to Bull Trout translocation, supplementation, and other population management actions. The assessment will ensure that enhancement activities are well-aligned with available habitat capacity, consider population genetic risks, and provide a decision-making 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 BTE Phase 2.

**Table 7. Summary of enhancement projects and assessments and the primary threats addressed for Bull Trout populations.**

| Enhancement Projects, Assessments, and Designs | Low Abundance Threats | Passage Barrier Threats | Dewatering Threats | Limited Habitat Threats | Prey Base Threats |
|---|---|---|---|---|---|
| Gold Creek Passage and Habitat Improvement | | | | | |
| • Gold Creek Instream Restoration | X | XXX | XXX | XXX | X |
| • Gold Creek Pond Assessment | X | XXX | XXX | X | |
| • Gold Creek Drain Decommissioning | X | XXX | XXX | X | |
| • Heli's Pond Assessment and Design | X | X | X | X | |
| Gold Creek USFS Bridge Assessment and Design | X | X | X | X | |
| Keechelus Reservoir and Lower Gold Creek Access Management | | X | | X | |
| Cold Creek Habitat Assessment | X | XXX | | XXX | X |
| Bull Trout Task Force | X | XXX | | | |
| Box Canyon Creek Passage | X | XXX | | X | |
| Kachess River Assessment and Design | X | XXX | XXX | XXX | X |
| Box Canyon Passage Assessment - Peek-a-boo falls[1] | X | | | XXX | X |
| USFS Kachess Watershed Health | | | | | |
| • Box Canyon and Gale Creek Restoration | X | | X | X | |
| • Upper Kachess River – Trailhead Restoration | X | | X | X | |
| South Fork Tieton River Passage Assessment, Design, and Construction | X | XXX | X | XXX | |
| Clear Creek Passage Assessment and Design | X | XXX | | | |
| Bull Trout Population Enhancement Assessment and Salvage | XXX | | | | |
| Nutrient Enhancement to Increased Ecological Productivity & Study | X | | | | XXX |

The XXX symbol denotes substantial benefit. The X symbol denotes minor benefit

[1] Assumes results of assessment support future project implementation

The Gold Creek Passage and Habitat Improvement actions will directly address threats posed by dewatering and seasonal passage barriers within the Gold Creek tributary. This project, possibly 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 Assessment and Design project will provide funding for assessment and final design. This project supports the goal of increasing abundance through improving connectivity with important spawning and rearing habitats.

The Cold Creek Passage Habitat Assessment, Box Canyon Creek and Reservoir Passage, Box Canyon Passage Assessment, South Fork Tieton River Passage and Clear Creek Passage enhancement actions would remove fish barriers (full and partial barriers) and some will address threats posed by dewatering that currently eliminate or limit Bull Trout access to historical critical habitat. These actions, possibly 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 Assessment and Design has the potential to address direct threats posed by dewatering and seasonal passage barriers within the Kachess River. The effectiveness of this action will be dependent upon the results of the assessment and design, and whether habitat improvements are implemented in BTE Phase 2. Successfully addressing stream dewatering would improve access to spawning and rearing habitat and reduce losses caused by predation and desiccation.

The USFS Kachess Watershed Health project would improve water quality by providing vegetative shading and significantly reducing fine sediment delivery to critical Bull Trout habitat in the Kachess watershed. These actions would provide synergistic benefits when added to the Box Canyon Creek and Reservoir Passage and the Kachess River Assessment and Design projects.

Conducting the Bull Trout Population Enhancement Assessment will provide baseline data to inform decisions related to Bull Trout translocation and supplementation. The assessment will ensure that enhancement activities are well-aligned with available habitat capacity, consider population genetic risks, and provide a decision-making 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 BTE Phase 2.

Improving reservoir and tributary productivity and availability of food resources using nutrient enhancement has the potential to improve Bull Trout prey base. The associated study will address if nutrient enhancement benefited Bull Trout.

Overall, the proposed habitat improvements, Bull Trout population salvage and enhancement efforts, and prey base enhancements have the highest potential benefit when combined. The expected incremental improvements in habitat function, the increase in abundance of Bull

Trout, and the 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 River basin—low abundance, passage barriers, dewatering, limited habitat, and prey base.

# Chapter 5. Phase I Estimated Costs

Estimated costs for each project, assessment, or design action are summarized in Table 8. Each proposed project or action will require funding and authorization prior to implementation. The total estimated cost to implement all projects and actions is expected to be greater than $14,810,000 (construction estimates for some projects will need to be determined). Future project actions based on the assessment and design work completed in The BTE Phase 1 would require additional funding as part of BTE Phase 2; these additional costs are not included in the table.

**Table 8. Summary of estimated project costs for BTE Phase 1.**

| Project | Assessment and Design Costs | Construction and Implementation | Total |
|---|---|---|---|
| Gold Creek Passage & Habitat Improvements | | | |
| • Gold Creek Instream Restoration | $250,000 | $4,000,000 | $4,250,000 |
| • Gold Creek Pond Out Reach and Design | $300,000 | TBD | $300,000 |
| • Gold Creek Drain Decommissioning | N/A | $50,000 | $50,000 |
| • Heli's Pond Assessment and Design | $50,000 | $100,000 | $150,000 |
| Gold Creek Bridge Replacement Assessment and Design | $130,000 | TBD | $130,000 |
| Cold Creek Habitat Assessment | $30.000 | $TBD | $30,000 |
| Bull Trout Task Force | N/A | $150,000 | $150,000 |
| Box Canyon Creek Passage | $200,000 | $1,500,000 | $1,700,000 |
| Kachess River Assessment and Design | $300,000 | TBD | $300,000 |
| Box Canyon Passage Assessment - Peek-a-Boo Falls | $200,000 | TBD | $200,000 |
| USFS Kachess Watershed Health | N/A | $800,000 | $800,000 |
| South Fork Tieton River Passage Assessment, Design, and Construction | $550,000 | $3,000,000 | $3,550,000 |
| Clear Creek Passage Assessment and Design | $1,500,000 | TBD | 1,500,000 |
| Bull Trout Population Enhancement Assessment (2 years of Salvage operations) | $1,000,000 | TBD | $1,000,000 |
| Nutrient Enhancement to Increased Productivity | $200,000 | $500,000 | $700,000 |
| | | Grand Total | $14,810,000 |

# Chapter 6. Bull Trout Enhancement Phase 2

Bull Trout Enhancement Phase 2 includes implementation of the results of each assessment listed in Phase 1 with the possible construction of other projects not implemented in Phase 1 (e.g. Construction of the Gold Creek Forest Service Bridge Replacement). Assessment and design work will provide the information needed to complete NEPA and other permitting requirements for these projects. Reclamation and Ecology will prioritize the work with the assistance of the Yakama Nation and other fish agencies. Anticipated projects and actions include the following:

- Construct Gold Creek Pond project
- Construct Keechelus Reservoir & Lower Gold Creek Access Management
- Construct Cold Creek passage (if determined that habitat is suitable for Bull Trout)
- Construct passage and habitat restoration for Kachess River.
- Construct Box Canyon passage at Peek-a-boo falls (if determined sound and beneficial).
- Construct North Fork Tieton River passage restoration (Clear Creek Dam Passage).
- Implement Bull Trout population enhancement actions (e.g. translocation, supplementation, and other population management actions).

# Chapter 7. Memorandum of Understanding

A Memorandum of Understanding (MOU) has been entered into by the Yakama Nation, the USFWS, WDFW, USFS, Ecology, and Reclamation to define their respective roles in the development and the implementation of the Bull Trout Enhancement actions. Specifically, these agencies have agreed to implement Bull Trout recovery actions and projects within the Yakima River basin to achieve self-sustainable, healthy, harvestable populations of native Bull Trout, currently listed with the USFWS as a threatened species pursuant to the Endangered Species Act of 1973, as amended (64 FR 58910; November 1, 1998).

The purpose of the MOU is to provide a framework 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 reservoir fish passage, and habitat/watershed protection and enhancement elements contained in the *Yakima River Basin Integrated Water Resource Management Plan Final Programmatic Environmental Impact Statement*. Objectives of the MOU include using Integrated Plan processes and committees to ensure proposed recovery actions are most effective at achieving Bull Trout recovery in the Yakima River basin. The *Yakima Bull Trout Action Plan* (Reiss, et al. 2012) and the USFWS's *Bull Trout Recovery Plan* (Whitesel, et al. 2004) are examples of resource protection and enhancement plans that will be used to inform decisions for the Integrated Plan.

This page intentionally blank

# Chapter 8. Maps

This page intentionally Blank

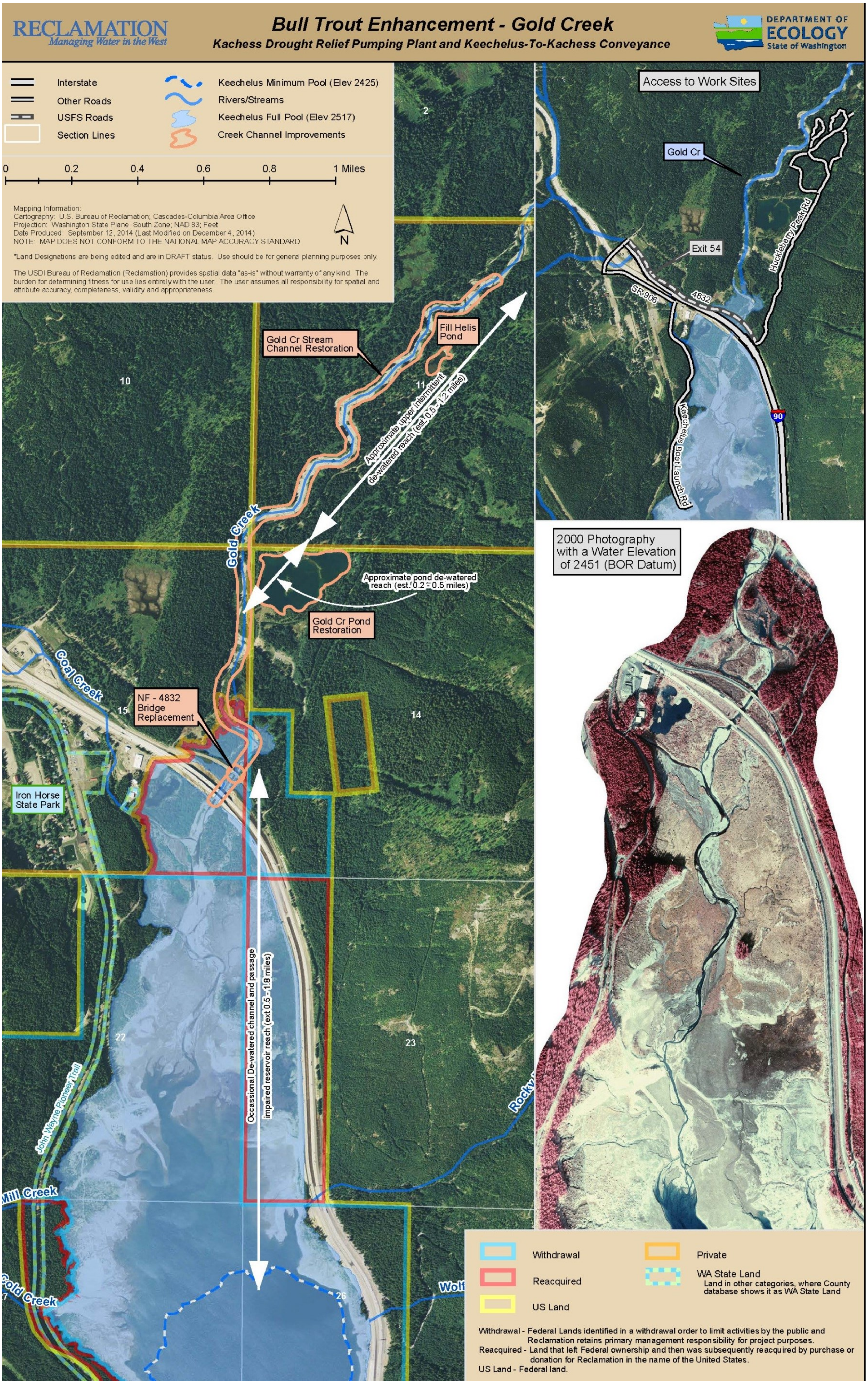



**Figure 8-1. Gold Creek project area depicting Gold Creek, Keechelus Reservoir, and adjacent land ownership.**

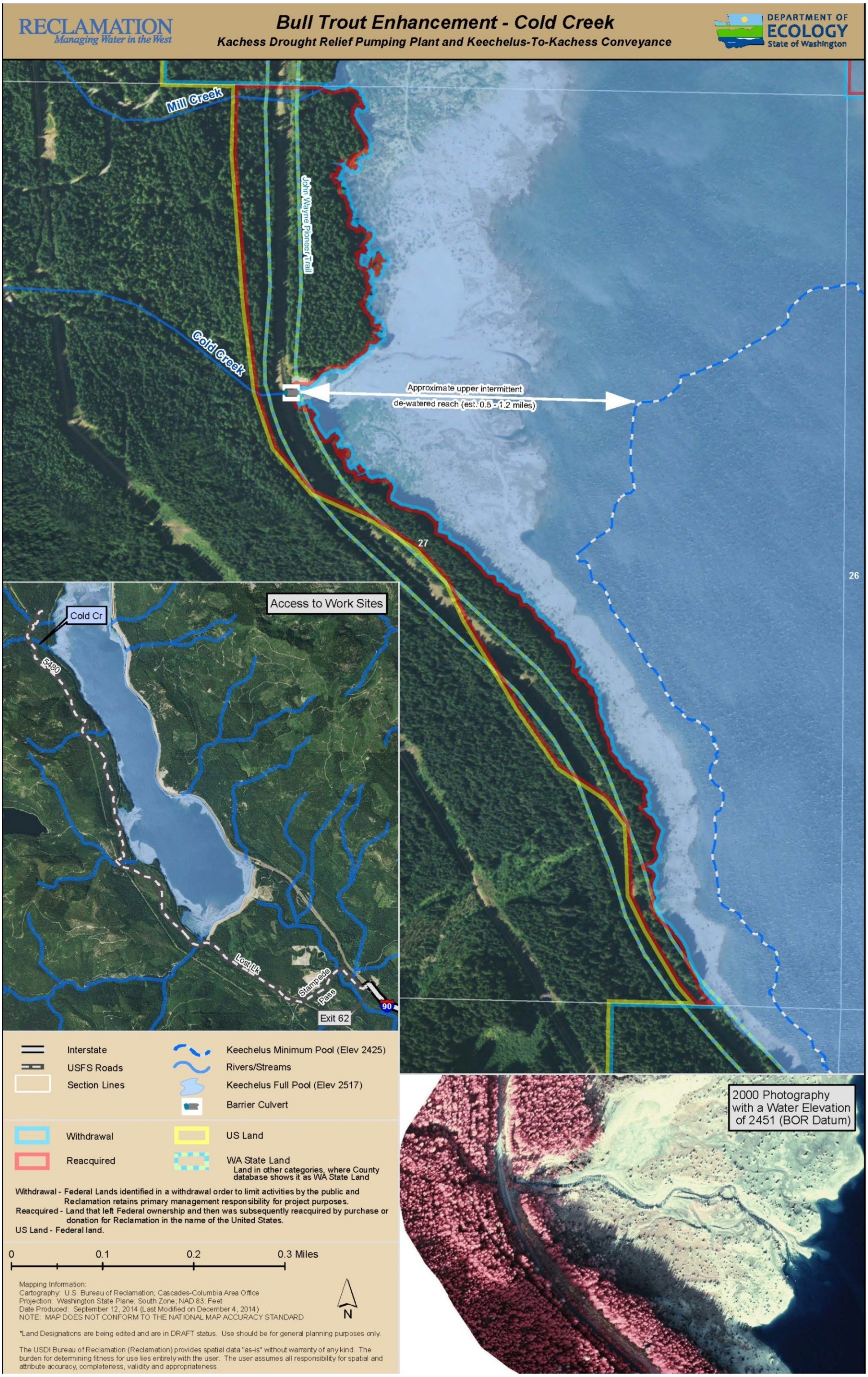



**Figure 8-2. Cold Creek project area depicting Cold Creek, Keechelus Reservoir, and adjacent land ownership**

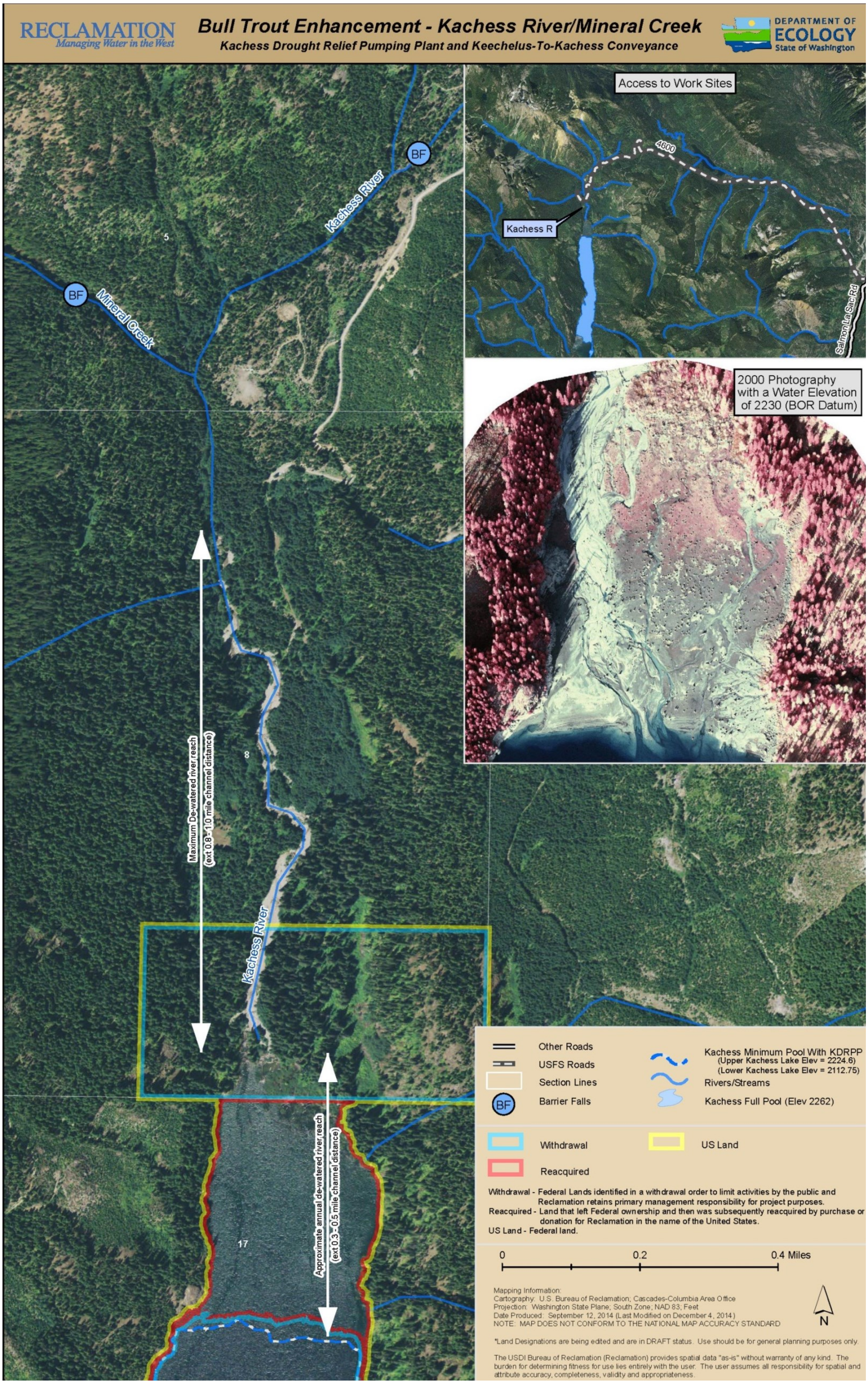



**Figure 8-3. Kachess River project area depicting Kachess River, Mineral Creek, Kachess Reservoir, and adjacent land ownership.**

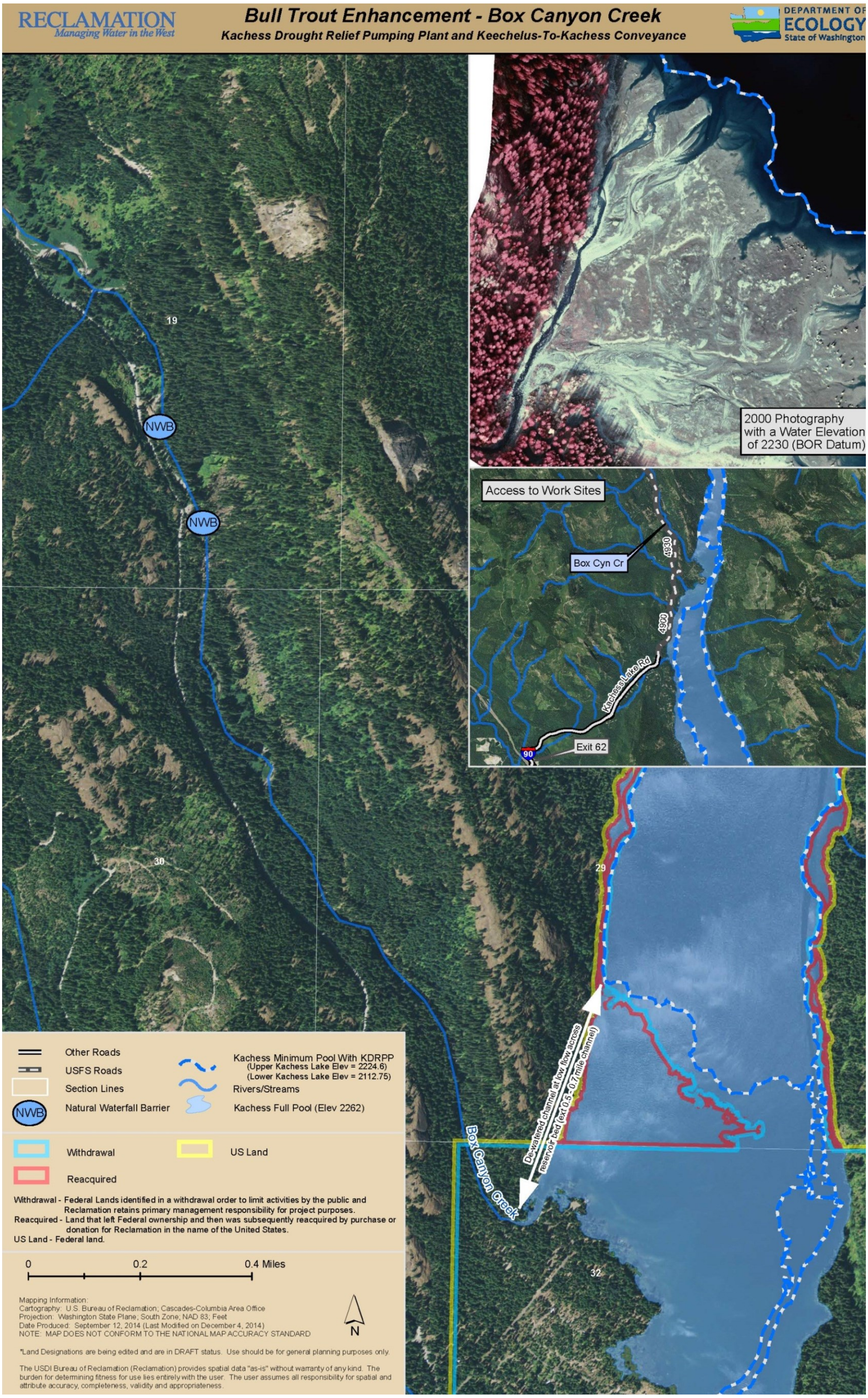



**Figure 8-4. Box Canyon Creek project area depicting Box Canyon Creek, Kachess Reservoir, and adjacent land ownership.**

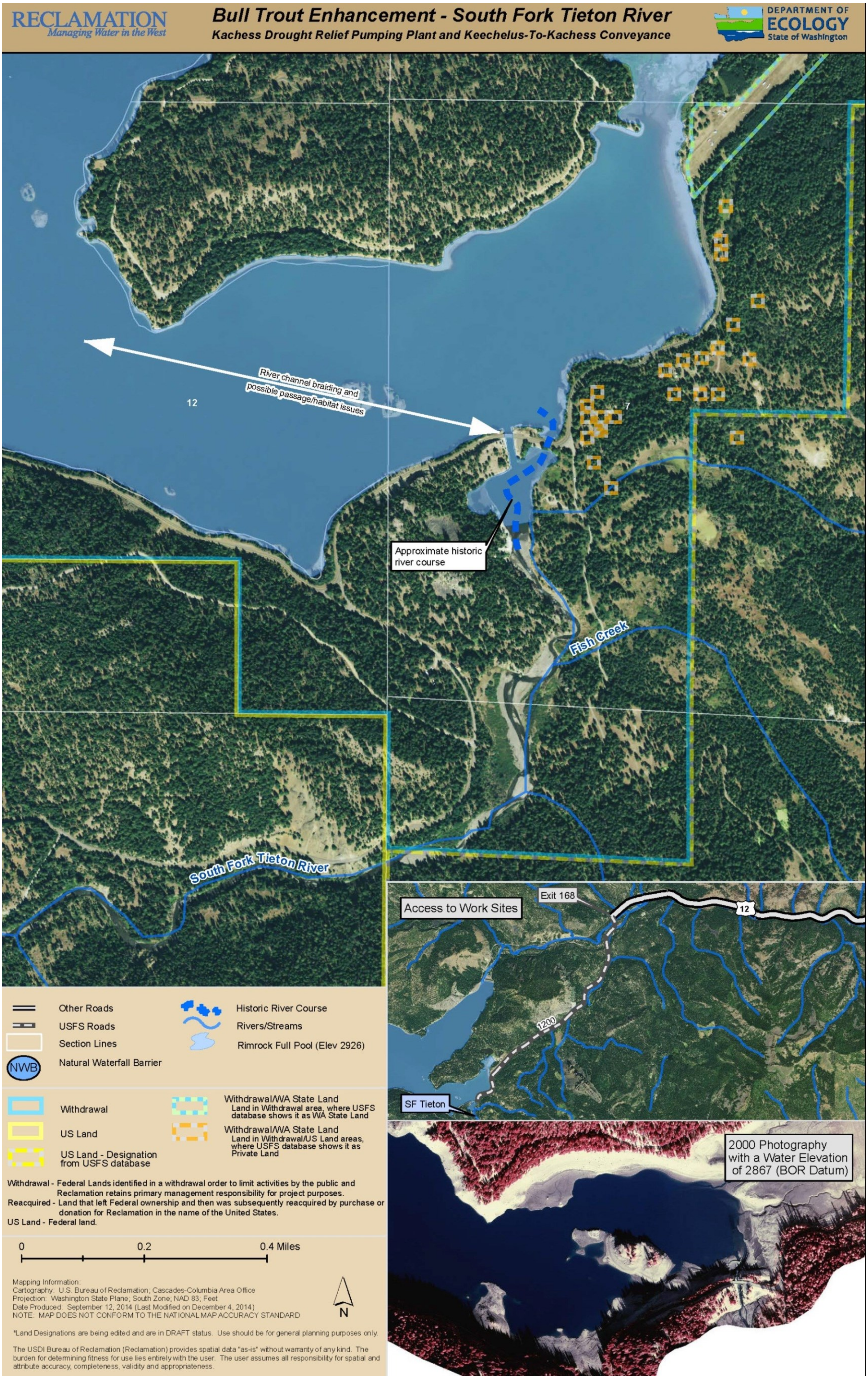



**Figure 8-5. South Fork Tieton River project area depicting South Fork Tieton River, Rimrock Reservoir, and adjacent land ownership.**

# References



| Citation | References |
|---|---|
| Anderson, 2014 | Anderson, Eric.  Personal Communication, 2014 |
| Barry et al. 2014 | Barry, P., Hudson, J.M., Williamson, J.D., Koski, M.L., Clements, S.P. 2014.  *Clackamas River Bull Trout Reintroduction Project, 2013 Annual Report*.  Oregon Department of Fish and Wildlife and U.S. Fish and Wildlife Service, 46 pp. |
| Conley et al. 2014 | Conley et al.  2014.  Proposal: Feasibility Assessment to Restore Yakima Basin Bull Trout Populations. |
| DeHaan and Bernall 2013 | DeHaan, P.W., Bernall, S.R.  2013.  Spawning Success of Bull Trout Transported above Main-Stem Clark Fork River Dams in Idaho and Montana.  *North American Journal of Fisheries Management* 33, 1269–1282. doi:10.1080/02755947.2013.839971 |
| Dunham et al. 2011 | Dunham, J., K., Gallo, D. Shively, C. Allen, B. Goehring.  2011. Assessing the Native Fish Reintroductions: A Framework Applied to Threatened Bull Trout.  *North American Journal of Fisheries Management* 31: 106-155. |
| Fraley and Shepard 1989 | Fraley, J.J. and B.B. Shepard (1989).  Life History, Ecology and Population Status of Migratory Bull Trout (*Salvelinus confluentus*) in the Flathead Lake and River System, Montana, *Northwest Science* NOSCAX 63(4): 133-142. |
| Hoelscher and Bjorn 1989 | Hoelscher, B. and T.C. Bjornn. 1989.  Habitat, density and potential production of trout and char in Pend Oreille Lake tributaries. Project F-71`-R-10, Subproject III, Job No. 8.  Idaho Department of Fish and Game. Boise, Idaho. |
| Leary et al. 1993 | Leary, R.F., Allendorf, F.W., Forbes, S.H.  1993.  Conservation Genetics of Bull Trout in the Columbia and Klamath River Drainages. *Conservation Biology* 7, 856–865.  doi:10.1046/ j.1523-1739.1993.740856.x |
| Mastin 2008 | Mastin, M.C.  2008.  *Effects of potential future warming on runoff in the Yakima River Basin, Washington*: U.S. Geological Survey Scientific Investigations Report 2008-5124, 12 p. |
| Meyer 2014 | Meyer, W. Personal Communication, September 11, 2014. |
| Natural Systems Design 2013 | Natural Systems Design. 2013.  Draft Gold Creek Hydrologic Assessment memo provided to Kittitas Conservation Trust.  December 5, 2013. |

| Citation | References |
|---|---|
| Pearsons et al. 2007 | Pearsons, T.N., Roley, D.D., Johnson, C.L. 2007. Development of a Carcass Analog for Nutrient Restoration in Streams. *Fisheries* 32, 114–124. doi:10.1577/1548-8446(2007)32 [114:DOACAF]2.0.CO;2 |
| Pratt 1992 | Pratt, K.L. 1992. "A review of Bull Trout life history." Pages 5 - 9 in Howell, P.J. and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain Bull Trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon. |
| Reclamation and Ecology 2011 | Bureau of Reclamation and Washington State Department of Ecology 2011. *Yakima River Basin Study, Proposed Integrated Water Resource Management Plan – Volume 1*. Contract No. 08CA10677A ID/IQ, Task 11. Prepared by HDR Engineering, Anchor QEA, ECONorthwest, ESA Adolfson, and Golder Associates. April 2011. |
| Reiss et al. 2012 | Reiss, Y., J. Thomas, E. Anderson, J. Cummins. 2012. *Yakima Bull Trout Action Plan.* Yakima Basin Fish and Wildlife Recovery Board, Yakima, Washington. |
| Rieman and McIntyre 1993 | Rieman, B.E. and J.D. McIntyre (1993). *Demographic and habitat requirements for conservation of Bull Trout*. Ogden, Utah (324 25th St. Ogden 84401). U.S. Dept. of Agriculture, Forest Service, Intermountain Research Station. |
| Rieman and McIntyre 1995 | Rieman, B.E. and J.D. McIntyre (1995). "Occurrence of Bull Trout in Naturally Fragmented Habitat Patches of Varied Size." Transactions of the American Fisheries Society. 124(3):285. |
| Reiman and Allendorf 2001 | Rieman, B.E., Allendorf, F.W. 2001. Effective Population Size and Genetic Conservation Criteria for Bull Trout. *North American Journal of Fisheries Management* 21, 756–764. doi:10.1577/1548-8675(2001)021<0756:EPSAGC>2.0.CO;2 |
| Reiman et al. 1997 | Rieman, B. E. and D. L. Myers (1997). Use of Redd Counts to Detect Trends in Bull Trout (*Salvelinus confluentus*) Populations. *Conservation Biology* 11(4): 1015-1018. |
| Sargent 2011 | Sargent, 2011. *Gold Creek Bridge and Gold Creek Wildlife Crossing Design Report*. Prepared by Sargent Engineers Inc. Submitted to U.S. Forest Service, Pacific Northwest Region. |
| Sedell and Everest 1991 | Sedell, J.R. and F.H. Everest. 1991. Historical Changes in Pool Habitat for Columbia River Basin Salmon Under Study for TES Listing. Draft USDA Report. Pacific Northwest Research Station. Corvallis, Oregon. |
| USFWS 2014 | U.S. Fish and Wildlife Service 2014. Revised Draft Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus*). Portland, Oregon. xiii + 151 pp |

| Citation | References |
|---|---|
| Small et al. 2009 | Small, M. P., D. Hawkins, and J. Von Bargen. 2009. *Genetic Analysis of Yakima Basin Bull Trout (Salvelinus confluentus) Final Revised Repor*t, June 17, 2009. Federal Contract E-1-81. Washington Department of Fish and Wildlife. Genetics Lab. Olympia, Washington. |
| Tappel 2012 | Tappel, P. 2012. Cold Creek Fish Passage Project Memorandum. Submitted February 1, 2012, to David Gerth, Kittitas Conservation Trust. |
| Thomas 2017 | Thomas, J. 2017. Fisheries Biologist, U.S. Fish and Wildlife Service, Personal Communication. Yakima, Washington. |
| Thomas and Monk 2016 | Thomas, J.A. and P. Monk. 2016. *Final Report for the Clear Creek Dam Fish Passage Assessment*. U.S. Fish and Wildlife Service, Mid-Columbia River Fishery Resource Office, Yakima Sub-Office. Yakima, WA. |
| USDA 2011a | U.S. Department of Agriculture Forest Service. June 2011. *Gold Creek Bridges and F.S. Road #4832 Reconstruction Environmental Assessment*. Cle Elum Ranger District, Okanogan-Wenatchee National Forest. Kittitas County, Washington. |
| USDA, 2011b | U.S. Department of Agriculture Forest Service. August 2011. *Gold Creek Bridges and F.S. Road #4832 Reconstruction Decision Notice/Finding of No Significant Impact.* Cle Elum Ranger District, Okanogan-Wenatchee National Forest. Kittitas County, Washington. |
| Watson and Hillman 1997 | Watson, G. and T.W. Hillman. 1997. Factors affecting the distribution and abundance of Bull Trout: and investigation at hierarchical scales. *North American Journal of Fisheries Management* 17:237-252. |
| Whitesel et al. 2004 | Whitesel, T.A. and seven coauthors. 2004. *Bull Trout Recovery Planning: A Review of the Science Associated with Population Structure and Size.* Science Team Report #2004-01. USFWS Regional Office, Portland, Oregon. |

*(This page intentionally left blank)*

Appendix D

# SPECIES LISTS

*(This page intentionally left blank)*

**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

*(This page intentionally left blank)*

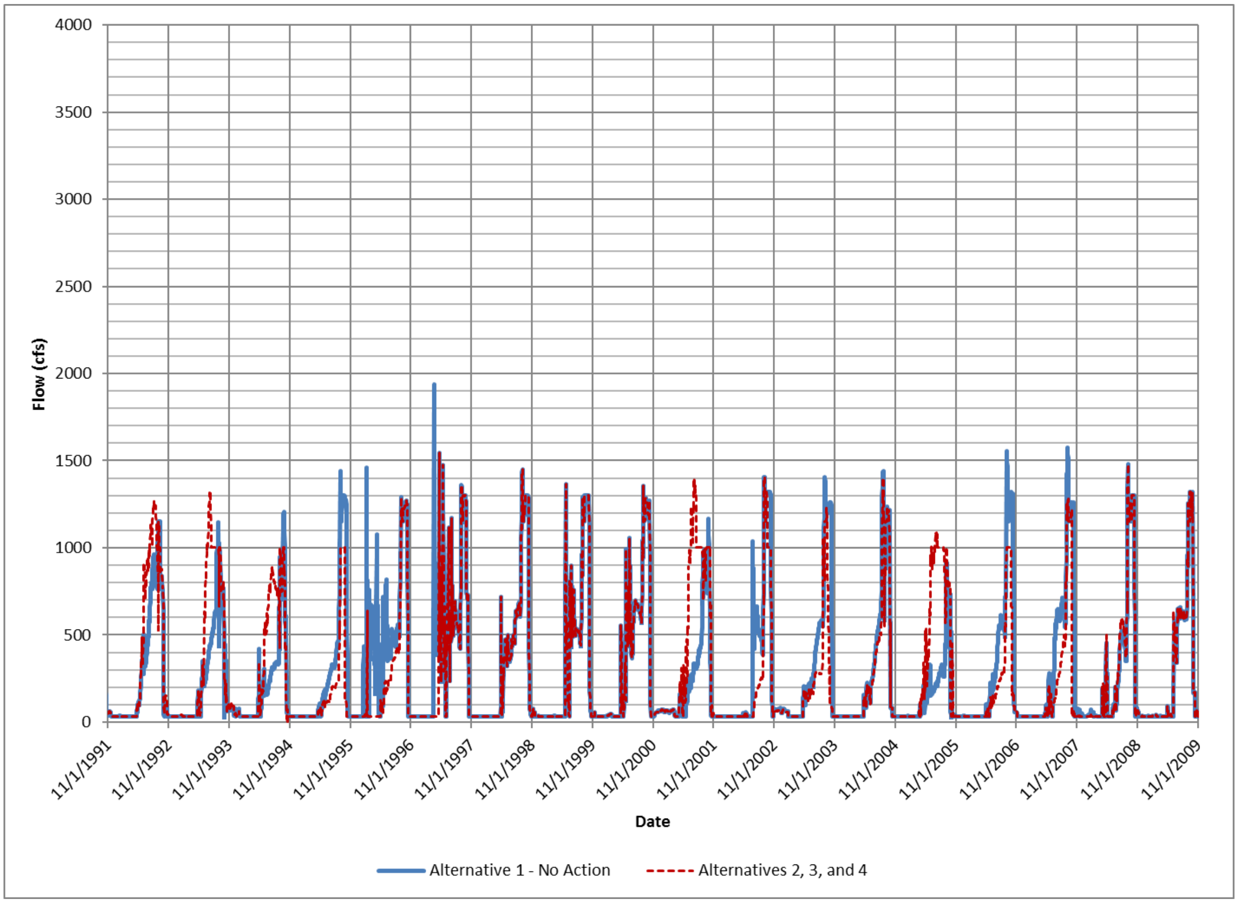



Figure E-1. Kachess River Flow under Alternatives 2, 3, and 4 compared to Alternative 1 – November 1991 to October 2009

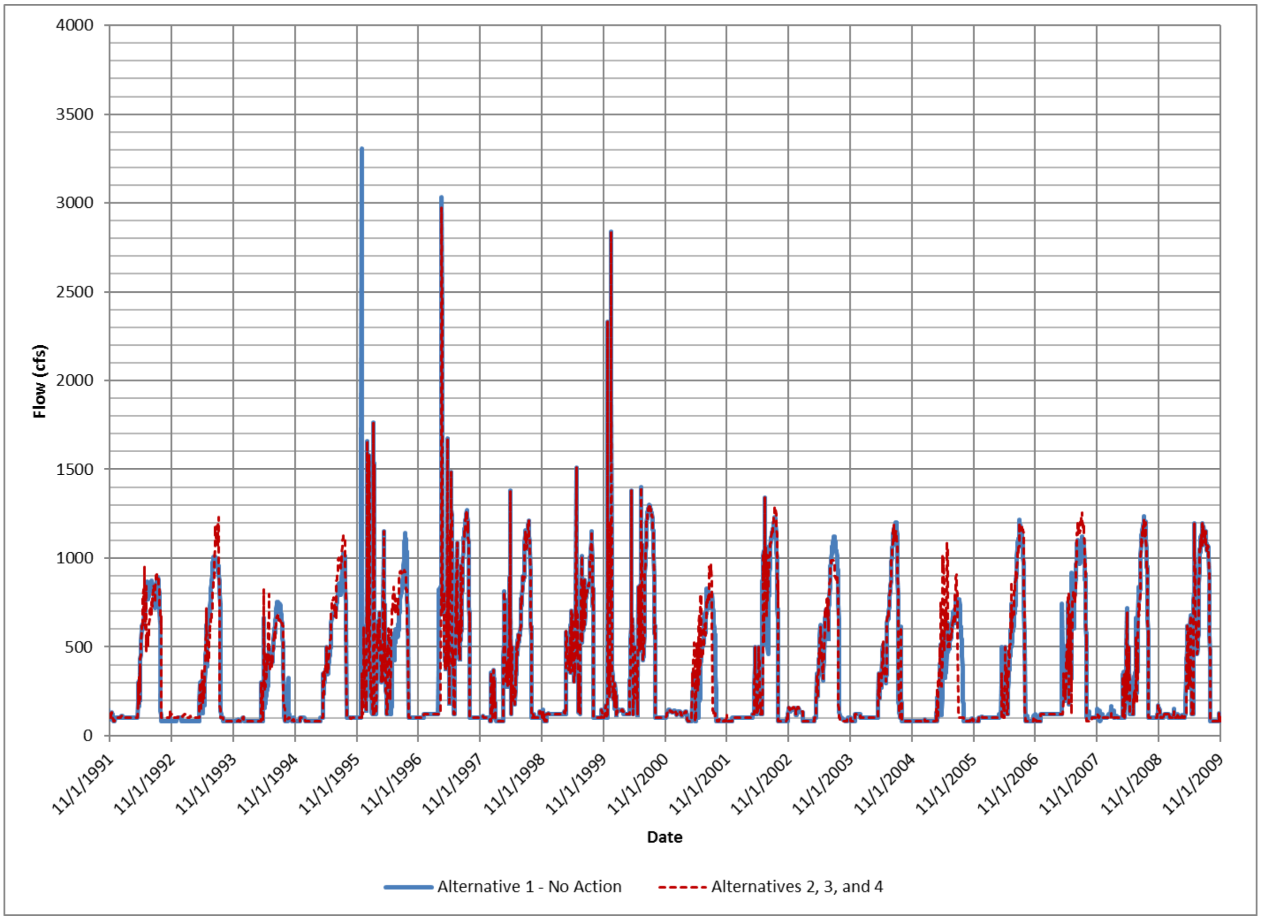



Figure E-2. Keechelus Reach Flow under Alternatives 2, 3, and 4 compared to Alternative 1 – November 1991 to October 2009

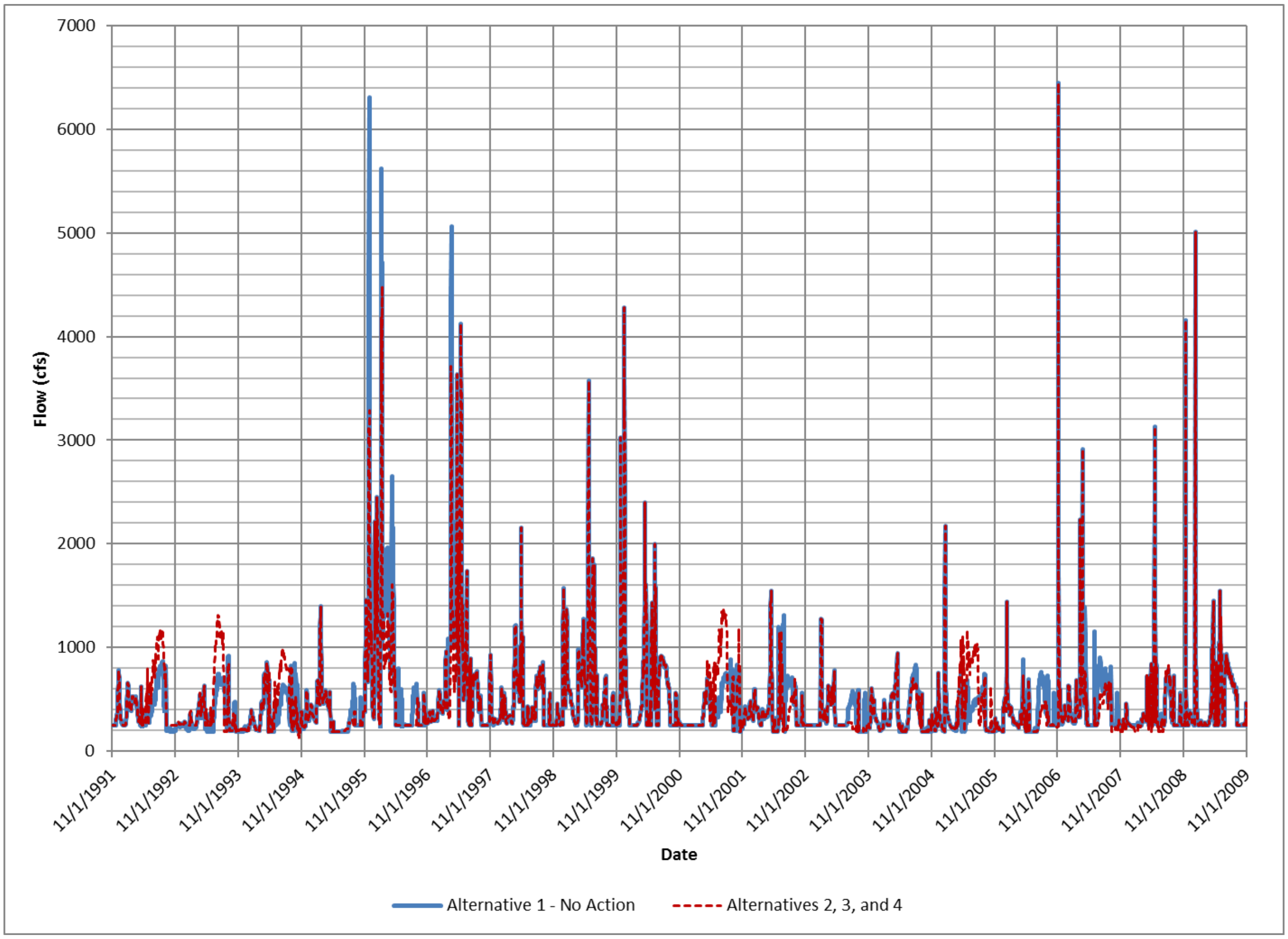



Figure E-3. Easton Reach Flow under Alternatives 2, 3, and 4 compared to Alternative 1 – November 1991 to October 2009

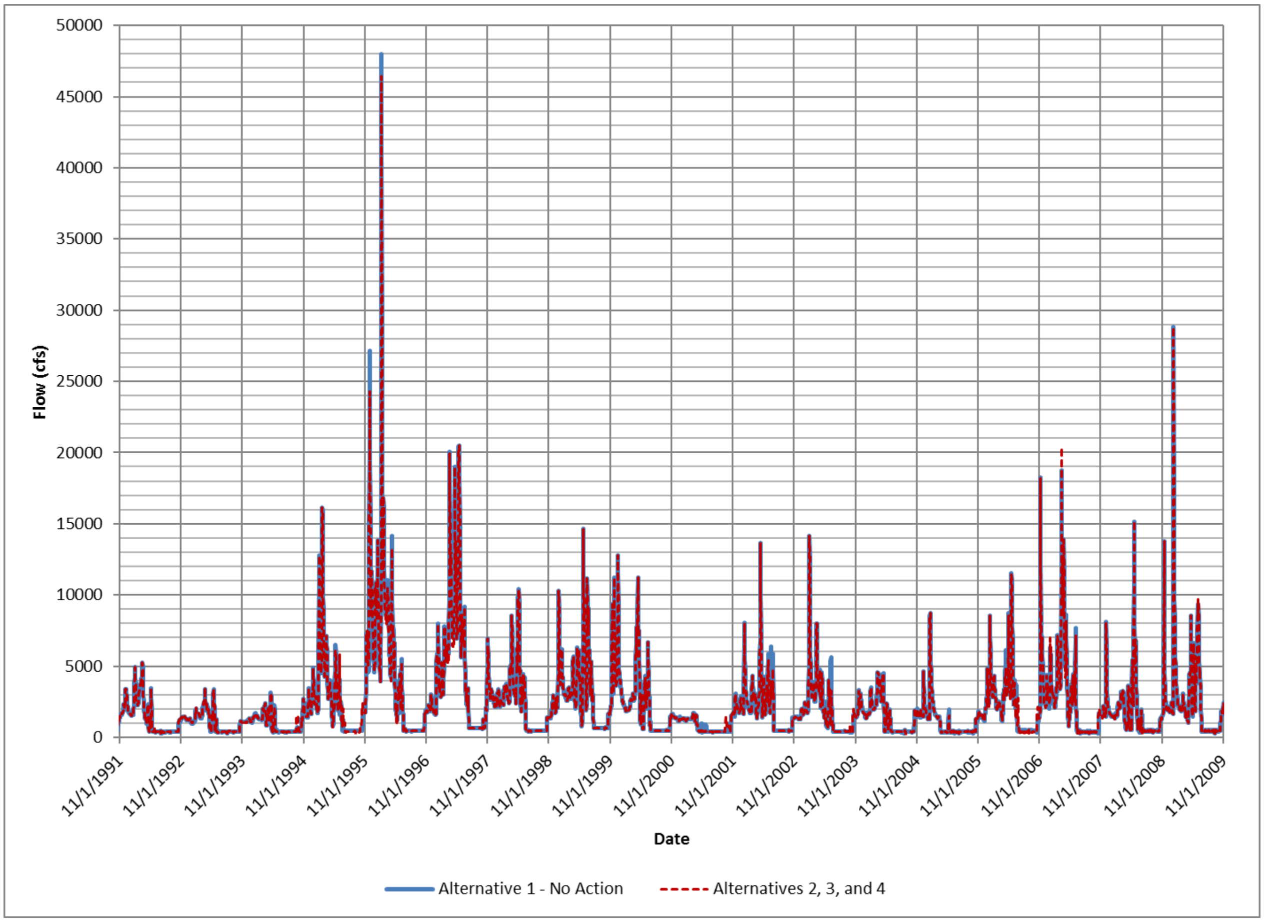



Figure E-4. Wapato Reach (Parker Gage) Flow under Alternatives 2, 3, and 4 compared to Alternative 1 – November 1991 to October 2009

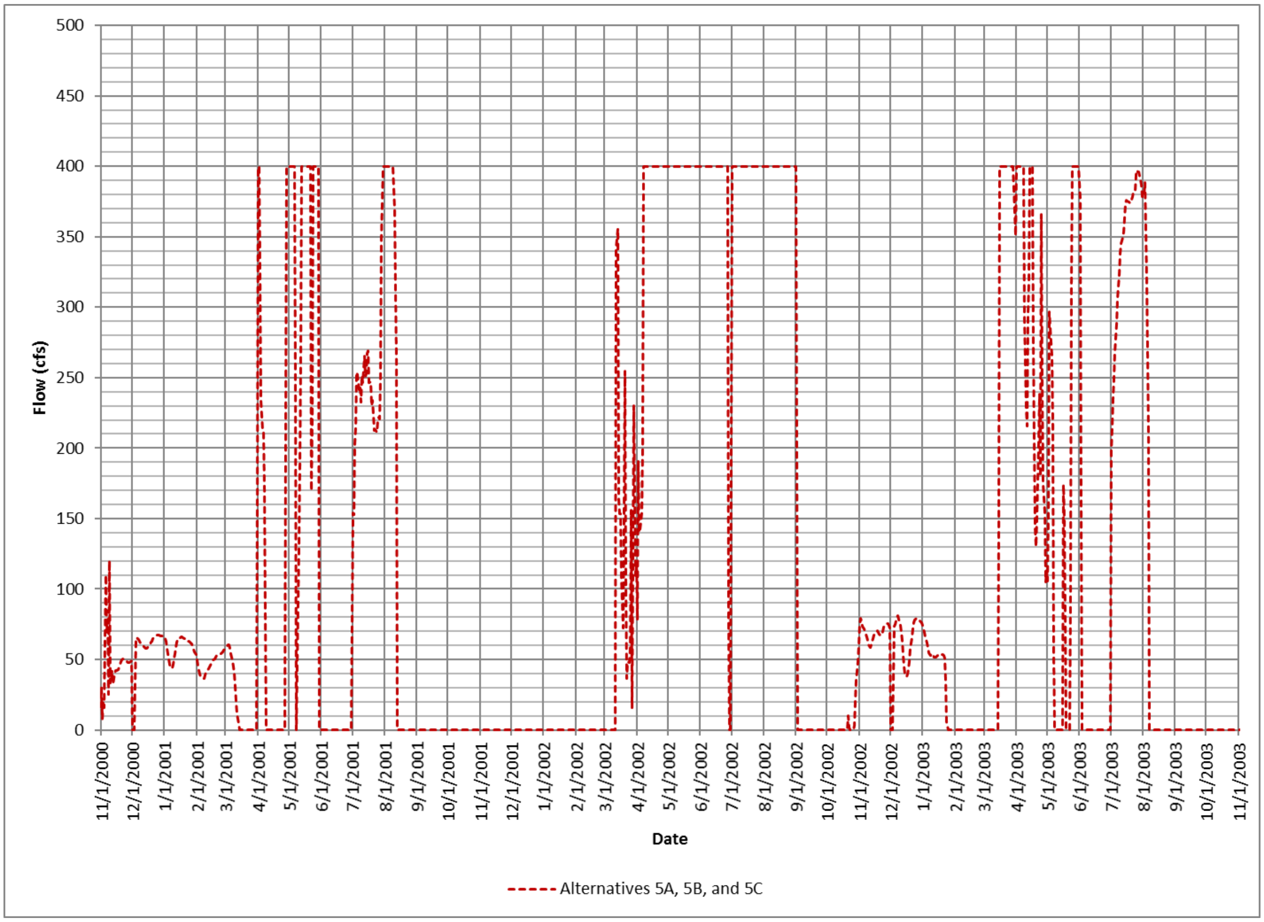



Figure E-5. Flow Transferred through KKC under Alternatives 5A, 5B, and 5C – November 2000 to October 2003

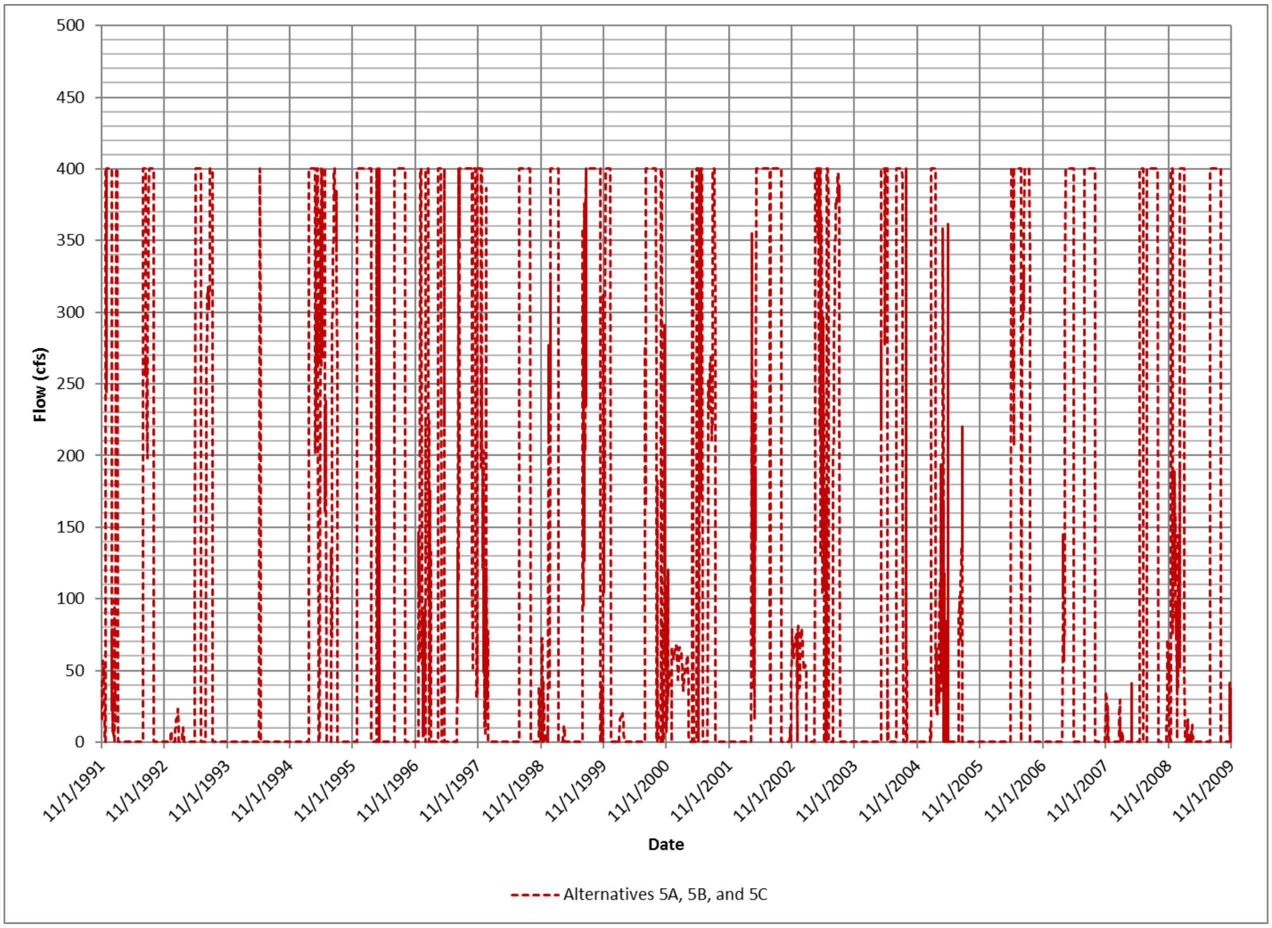



Figure E-6. Flow Transferred through KKC under Alternatives 5A, 5B, and 5C – November 1991 to October 2009

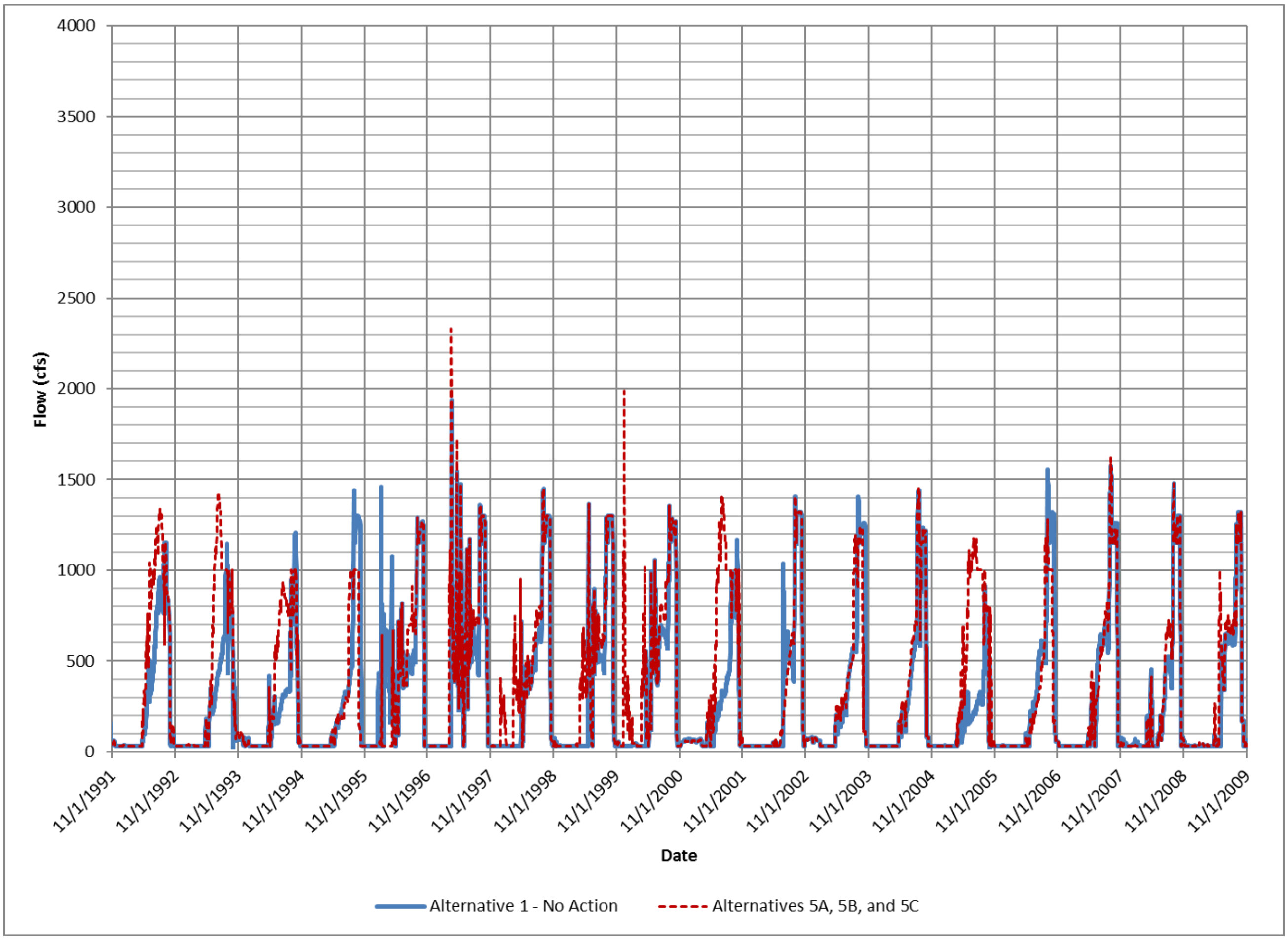



Figure E-7. Kachess River Flow under Alternatives 5A, 5B, and 5C compared to Alternative 1 – November 1991 to October 2009

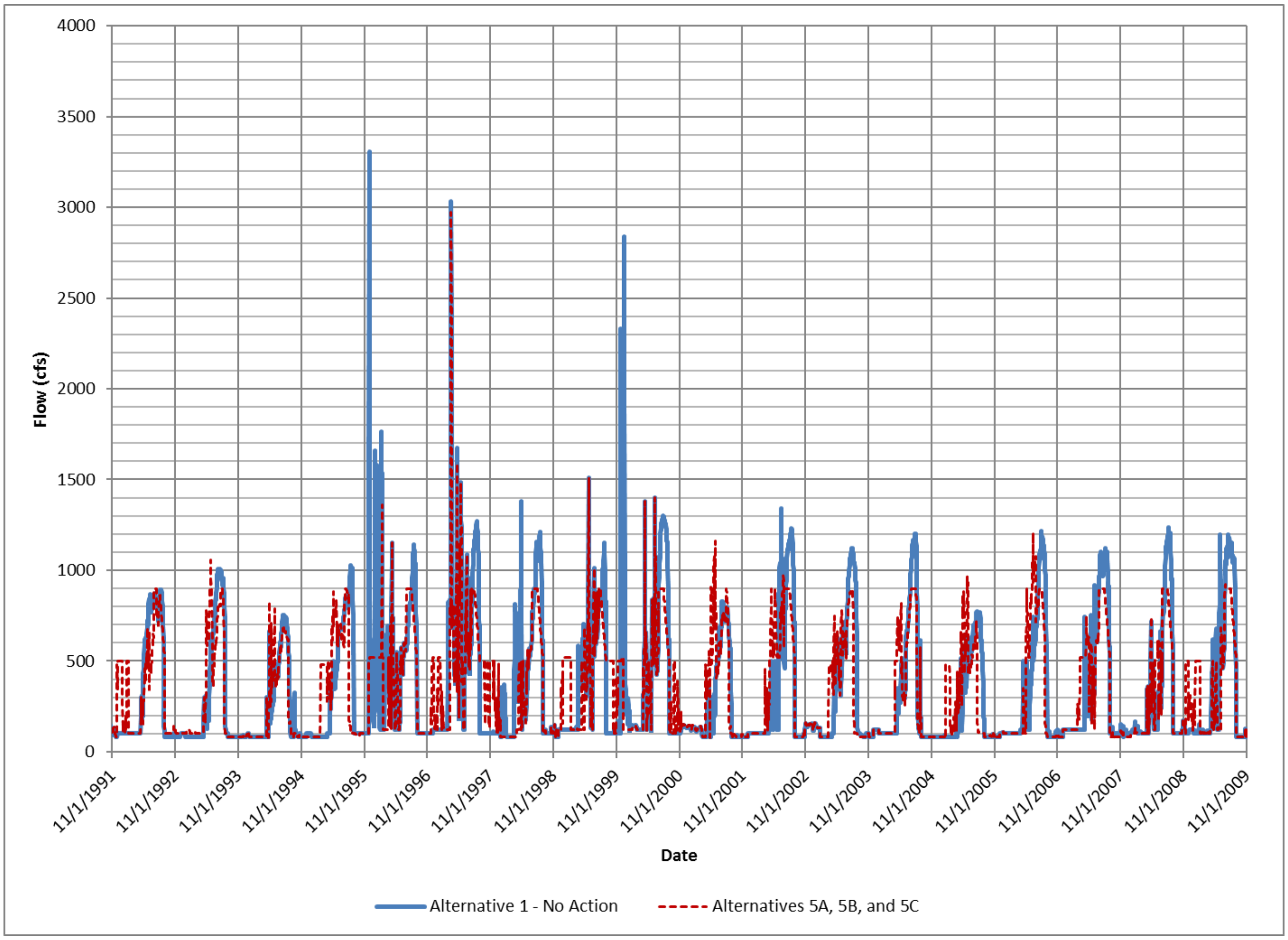



Figure E-8. Keechelus Reach Flow under Alternatives 5A, 5B, and 5C compared to Alternative 1 – November 1991 to October 2009

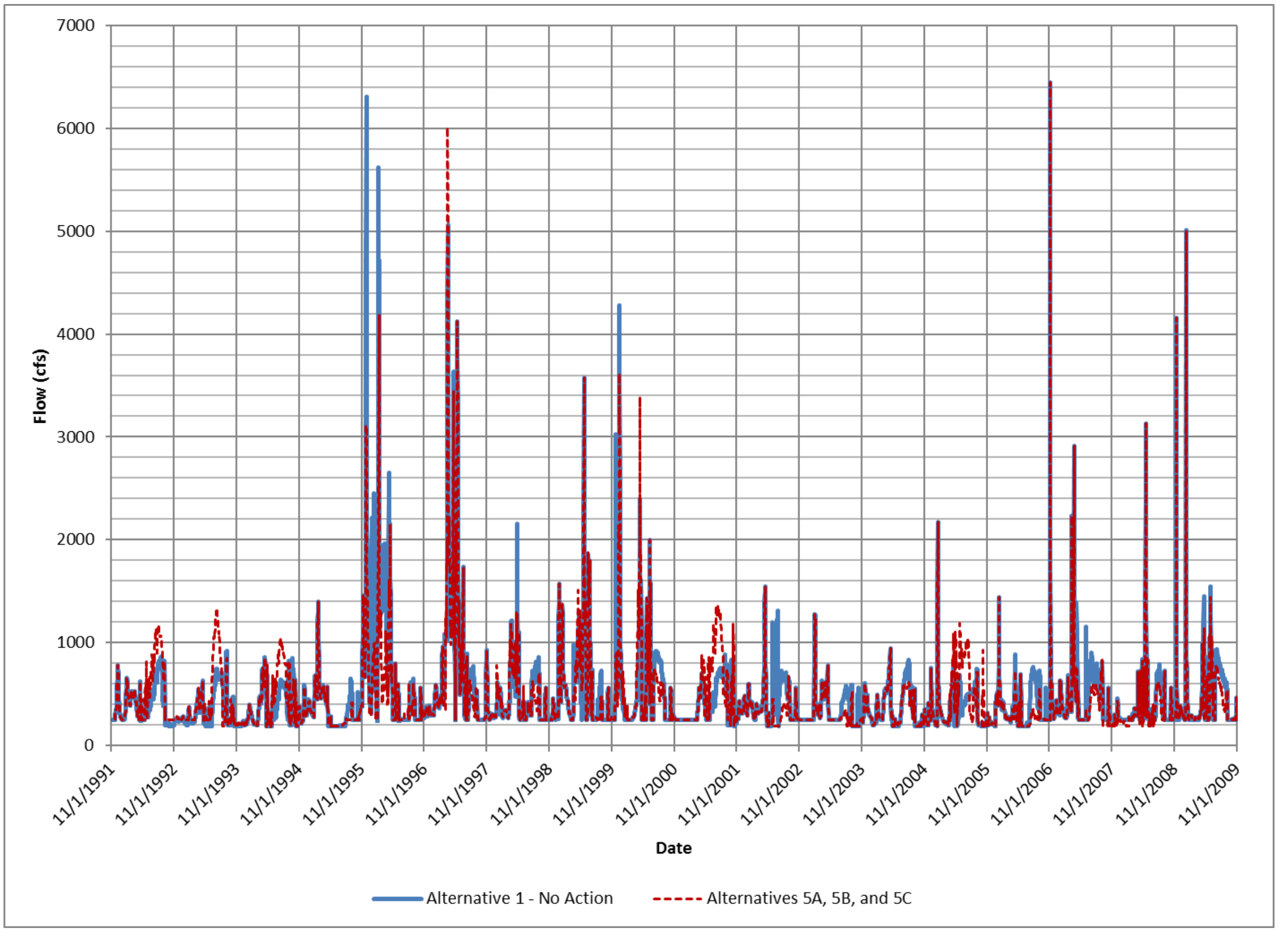



Figure E-9. Easton Reach Flow under Alternatives 5A, 5B, and 5C compared to Alternative 1 – November 1991 to October 2009

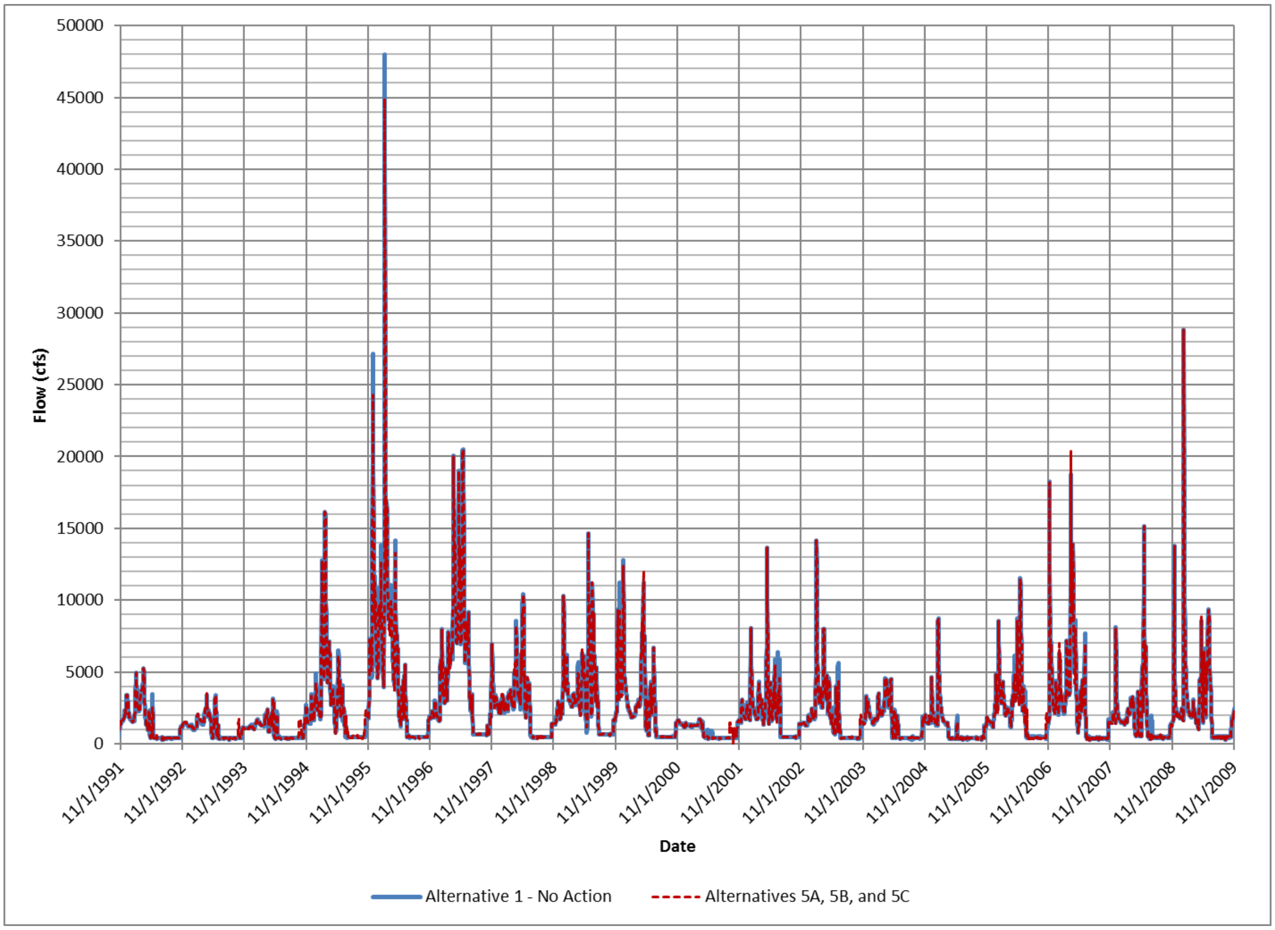



Figure E-10. Wapato Reach (Parker Gage) Flow under Alternatives 5A, 5B, and 5C compared to Alternative 1 – November 1991 to October 2009

Appendix F

# FREQUENTLY ASKED QUESTIONS ON WATER USE, OPERATIONS AND HYDROLOGY FOR THE PROPOSED KACHESS DROUGHT RELIEF PUMPING PLANT (KDRPP)

*(This page intentionally left blank)*

## Frequently Asked Questions
## on Water Use, Operations and Hydrology for the Proposed
## Kachess Drought Relief Pumping Plant (KDRPP)
## August 2018

***Q. If KDRPP is constructed, who will receive the water pumped from Kachess Reservoir?***

Under the Preferred Alternative listed in the FEIS, Roza Irrigation District (Roza) would receive water from KDRPP. Roza would also fund, design, construct, operate and maintain KDRPP. The FEIS anticipates that other Proratable Entities may also receive water from KDRPP. To be eligible to receive water, the additional Proratable Entities would need: 1) to have proratable water rights from the Yakima Project, and 2) to enter into a cost-reimbursement agreement with Roza to share the costs associated with KDRPP. The most likely parties that could receive water in addition to Roza are Kittitas Reclamation District (KRD), Wapato Irrigation Project (WIP), and Kennewick Irrigation District (KID). The FEIS includes modeling of water deliveries to Roza, KRD and WIP. Based on its historical operations, KID was modeled as receiving return flows from use by the other three entities, but KID could also be eligible to participate in KDRPP in partnership with the other participating Proratable Entities.

***Q. Who will pay for constructing, operating and maintaining KDRPP?***

The federal government, Washington State government, and local governments do not plan to pay for KDRPP. In a written exchange with Reclamation and Ecology in June 2016 Roza indicated its interest in participating in the project, including funding the project. In a comment letter on the SDEIS dated June 11, 2018 Roza reiterated this commitment stating it is willing to fully fund, construct, operate and maintain Alternative 4 – the Floating Pumping Plant.

The FEIS identifies Alternative 4 as the Preferred Alternative. If the Preferred Alternative is recommended in a Reclamation Record of Decision, Roza's Board of Directors would make a final determination on whether to proceed with this project. Roza could seek partnerships and cost-sharing with other Proratable Entities. However Roza has indicated it has the financial capacity to undertake the project even without other Proratable Entities.

Under any of these circumstances, taxpayers at large will not bear the cost of KDRPP, either directly or indirectly.

***Q. Who will decide when water can be pumped from Kachess Reservoir with KDRPP?***

If KDRPP is constructed, the participating Proratable Entities would decide when to pump from the inactive pool of Kachess Reservoir, subject to specific conditions that would be defined by Reclamation and Ecology. The participating Proratable Entities could begin pumping water from Kachess Reservoir in any year when Yakima Project proratable supplies fall below 70% of proratable entitlements. During a year when this occurs, the participating Proratable Entities would begin pumping after Kachess reservoir has been drawn down to the level of the existing gravity outlet. Based on modeling of the project, during a moderate drought, pumping may not begin until late summer. During a severe drought or late in a multi-year sequence of droughts, pumping could begin as early as June.

After pumping begins and until Kachess Reservoir refills, the participating Proratable Entities would be required to continue pumping when necessary to provide water to senior and proratable irrigators and to maintain instream flows in the Kachess River below Kachess Dam.

***Q. What is the relationship among Kachess Reservoir, Big Kachess, and Little Kachess?***

Prior to completion of Kachess Dam in 1912, there were two natural lakes impounded by glacial deposits along the Kachess River. They were known as Big Kachess Lake and Little Kachess Lake. Construction of Kachess Dam enabled Reclamation to store additional water from the Kachess River "on top" of the natural lakes, and to control releases through the dam (see Attachment 1). As with its other reservoirs in the Yakima River basin, Reclamation manages releases to support agricultural irrigation in the lowland farming areas of Kittitas, Yakima and Benton Counties, while also meeting legal obligations for protection of stream flows as well as responsibilities for controlling damaging floods downstream.

Since the dam permits storage of water for economic and other purposes, Reclamation refers to the modern water body as a whole as "Kachess Reservoir." A reservoir is defined as "a large natural or artificial lake used as a source of water supply". The "balance" between runoff entering the reservoir and releases at the dam over a period of time determine the reservoir pool level. The managed pool level fluctuates over the course of the year, between elevations of 2193 and 2262, a vertical range of approximately 70 feet. During current operations any time the pool level falls below an elevation of approximately 2220 feet, Big Kachess and Little Kachess become separated once again, in the area called "The Narrows". Under these conditions, water flows from Little Kachess into Big Kachess through a natural stream channel.

***Q. Will the full 200,000 acre-feet be pumped every time KDRPP is used?***

In years when drought conditions cause Proratable Entities to receive less than 70% of their water supply entitlement, the participating Proratable Entities would decide how much water should be pumped within the limitation of the 70% prorationing level. They would not necessarily pump up to this limit in every drought year. Their choice of how much to pump would likely be influenced by business decisions related to costs and benefits of pumping in that year. These include: 1) the severity of the drought and effect on farmers within the participating Proratable Entities' service areas; 2) how far advanced the irrigation season is by the time pumping begins; 3) the cost of power in relation to the value of agricultural products during a particular drought year; and 4) the value of holding water within Kachess Reservoir as "insurance" against a drought extending into the following year. Because of these factors, the participating Proratable Entities may choose to pump much less than 200,000 acre-feet in a particular drought year.

If Roza is the only participating Proratable Entity, it is unlikely that Roza would pump the full 200,000 acre-feet in the first year of a drought because, in the worst drought on record, Roza would only need 75,000 acre-feet to reach 70% supply.   In this case, use of the full 200,000 acre-feet would likely be necessary only during a drought of at least 3 years duration.

In addition, the FEIS does not consider how pumping choices would be affected in future years if the additional projects in the Final Programmatic EIS for the Integrated Plan are also developed.  Development of additional projects together with KDRPP would further improve operational flexibility of the Yakima Project system as a whole, and could result in less pumping from KDRPP in some drought years and in subsequent refill years.

***Q. Will Kachess Reservoir be empty when the water is pumped out?***

No, Kachess Reservoir would not be pumped entirely empty and the proposed project would not be capable of doing so.  At least 385,000 acre-feet would always remain in Big Kachess and 59,000 acre-feet in Little Kachess.  Kachess reservoir contains a total of about 883,000 acre-feet of water when it is full.  Of this, 239,000 acre-feet is stored in the "active pool" that can currently be managed by gravity release operations through the existing outlet works at Kachess Dam.  The inactive pool of Big Kachess below the level of the Kachess Dam outlet holds 585,000 acre-feet, and Little Kachess holds 59,000 acre-feet (see Attachment 1).  Under current operations without KDRPP, in years when the reservoir reaches its maximum pool level, the active pool of 239,000 acre-feet can be released for water users and instream flows, leaving the remaining 585,000 acre-feet in Big Kachess and 59,000 acre-feet in Little Kachess.

The proposed KDRPP would enable a maximum of 200,000 additional acre-feet to be pumped from Big Kachess.  In years when the maximum quantity is pumped out, 385,000 acre-feet of water would remain in Big Kachess (65 percent of the current minimum volume).  In years when pumping is activated but does not require the full, additional 200,000 acre feet, water remaining in Big Kachess would be between 385,000 acre-feet and 585,000 acre-feet.

When full, the modern reservoir is 430 feet deep at its deepest point. Current operations are capable of drawing the reservoir down by approximately 70 feet, although drawdown rarely exceeds 60 feet.  Operation of KDRPP would enable the reservoir to be drawn down an additional 80 feet.  At the new minimum-pool level, the reservoir would still be 280 feet deep at its deepest point.  Modeling of future operations of KDRPP shows that the minimum pool level would occur only occasionally (for example, see FEIS Figure 4-3 where modeling shows the minimum pool level would have been reached only once in the 18 years from 1991 to 2009, which include a 3-year drought and 2 1-year droughts).  In most years, and in most months of any year, pool levels would remain well above the minimum level.  In many years, pool levels would be similar to current conditions.

Little Kachess would not be affected by pumping from KDRPP, because its minimum depth is controlled by the original, natural topography at "The Narrows" between Little Kachess and Big Kachess.  The proposed project, including the volitional fish passage at the Narrows, would not change the original topography controlling hydraulic conditions at the Narrows, and KDRPP would not pump water from Little Kachess.  When Big Kachess is drawn down by KDRPP pumping, Little Kachess would continue to hold at least 59,000 acre-feet, the same amount as under current conditions.

***Q. In the years following a drought, how will Kachess Reservoir refill?***

After an irrigation season when drought-relief pumping has occurred, the amount of runoff from rain and snow in the Kachess River drainage area would determine how quickly the pool in Kachess Reservoir refills. Rain and snow vary from year to year, so the rate of the pool recovery would also vary. The length of time that pool levels stay below current conditions would depend on: 1) how much water was pumped out during the drought and 2) how quickly the pool level rises in response to runoff.

Under conditions where the reservoir returns to its pre-KDRPP pool levels during the first winter following a drought, pumping would not resume until another drought occurs. This includes years when the reservoir does not rise to its maximum pool level, but rises high enough that Reclamation can meet the subsequent year’s supply requirements, in combination with its other Yakima Project reservoirs.

Under conditions where runoff is inadequate in the first winter following a drought, the reservoir would not rise to its pre-KDRPP pool levels. Or it may rise to the pre-KDRPP operating range, but not high enough to meet subsequent-year water-supply obligations. In these cases, pumping would be needed again in the subsequent year to provide water to senior and proratable irrigators and to meet stream flow obligations. The amount of pumping needed in the subsequent year would depend on how high the pool level rises prior to the next irrigation season (beginning in April of the subsequent year), the amount of water stored in other Yakima Project reservoirs, and the amount of snowpack accumulated over the winter months in the Yakima River basin as a whole.

If low runoff conditions occurred again in the second year or additional years following a drought, then the need for refill-operations pumping could be prolonged into additional irrigation seasons. Pumping operations will still be limited to the KDRPP’s 80-foot drawdown capacity, and water would still remain in Kachess Reservoir below that level at all times.

Records of water levels, reservoir releases and stream flows are available from a 90-year period, and this enables analysis of how frequently conditions can be expected to be either favorable or unfavorable for refilling Kachess Reservoir. Reclamation and Ecology used these records to model KDRPP operations in drought years, refill years, and all other years. Results are reported in the FEIS.

Since the participating Proratable Entities would pay for power necessary to pump water at pool levels below the existing gravity outlet, they would have an incentive to refill Kachess Reservoir as fast as possible following a drought year. This incentive may lead them to use less water than their full entitlement during non-drought years while refill is in progress. For example, they could choose to use 85 percent of their entitlement rather than 100 percent in a refill year. This would tend to raise pool levels during refill and shorten the duration of drawn-down conditions. The model results presented in the FEIS are conservative, in that they do not account for this operational flexibility. In addition, if all of the projects and programs included in the Final Programmatic EIS for the Integrated Plan are implemented, the amount of water needed from KDRPP would be reduced during moderate droughts because the other projects would also contribute to raising prorationing to 70%. (Full pumping by KDRPP would still be needed during more severe, multi-year droughts.) The model results presented in the FEIS are conservative, in that they show operations without those future projects and programs in place.

***Q. How will minimum flows for fish in the Kachess River below Kachess Dam be maintained? What will happen if the pumps fail or the power goes out?***

During periods when the pool level in Kachess Reservoir remains above the existing gravity outlet, Reclamation would continue to maintain minimum flows for fish in the Kachess River by releasing water through the dam outlet. During periods when the pool level in Kachess Reservoir is below the existing gravity outlet, the method of maintaining minimum flows for fish in the Kachess River would vary depending on the Alternative. For the East Shore and South Alternatives, the participating Proratable Entities would pump water from Kachess Reservoir into the discharge pool immediately below Kachess Dam to maintain minimum flows for fish. The proposed pumping plants for these two alternatives have dedicated pumps specifically for maintaining minimum instream flow (including both a primary and a back-up pump). A backup power supply is included in the design so the pumps could continue to operate even during a power failure. These features would enable pumping to occur continuously at all times when the reservoir level is below the elevation of the gravity outlet works; including the winter and spring seasons when water is not being released for irrigation supply.

For the Floating Pumping Plant Alternative, the water pumped into the outlet channel would create a large pool of water that can be slowly released at the required flow rates through the existing gravity outlet works. This would be capable of maintaining minimum instream flows in the Kachess River between Kachess Dam and Lake Easton without the need for dedicated minimum instream flow pumps. The pool stored within the outlet channel would hold enough water to continue releasing minimum instream flows throughout a typical power failure.

***How will future changes in climate conditions affect operation of KDRPP?***

Climate change is projected to reduce storage of water in snowpack in the Cascade Range, including the headwaters of the Yakima and Naches River system. Since the Yakima Project depends, in part, on gradual melting of snowpack to supply agricultural irrigation, reduction in snowpack would put new stresses on the water supply system. Under climate change scenarios, the number of years when prorationing below 70 percent occurs is projected to increase, because the existing storage reservoirs are not large enough to capture all of the runoff from their watersheds.

Climate change is projected to increase the total amount of precipitation falling in the Cascade Range annually, although less of the precipitation would be stored in snowpack. Changes in runoff timing and flow levels, flood events, and other factors in the river system are likely to occur. Changes in cropping patterns by farmers in response to local conditions combined with changes in global commodity markets and prices may also occur. Farmers will be more able to compete with farmers in other regions (both nationally and internationally) to the extent their irrigation supply offers flexibility to respond to changing conditions.

If KDRPP is constructed, its value for providing drought relief would likely be higher with climate change than under current conditions.  However, the increased need for pumping is projected to increase the frequency and duration of drawdown below current minimum pool levels in Kachess Reservoir.  These factors would be altered somewhat once the remaining projects and programs included in the Final Programmatic EIS for the Integrated Plan are also implemented.

***Q.  What is Total Water Supply Available (TWSA)?  How will KDRPP affect TWSA?***

A 1945 consent decree issued by the District Court of Eastern Washington provides the legal basis for management of surface water in the Yakima River basin.  The consent decree requires Reclamation to calculate Total Water Supply Available (TWSA) each year.  In any given year TWSA is the sum of:

1) the estimated April through September natural runoff volume for the Yakima River near Parker, (Parker Gage, just downstream of Sunnyside Dam),
2) the amount of water stored in Reclamation's five reservoirs on April 1, and
3) an estimate of return flows from water users located upstream of the Parker Gage.

The quantity of TWSA each year determines the level of prorationing and determines flow targets for the Yakima River that must be met at the Parker Gage.  If KDRPP is constructed, Reclamation would adjust its calculation of TWSA to account for the additional withdrawal of water by participating Proratable Entities from Kachess Reservoir inactive pool.  The adjusted calculation will include pumping to meet the needs of other Yakima Project users, such that TWSA with KDRPP would be the same as it would have been without KDRPP.  This is necessary in order to protect Yakima Project users besides the participating Proratable Entities, and to assure Reclamation can provide required instream flows and target flow at Parker.

Kachess Reservoir's contribution to TWSA is currently calculated as the volume of water stored above the existing gravity outlet on April 1 of each year (the normal active conservation pool).  If KDRPP is constructed, then an adjustment to the calculation would be made to account for the participating Proratable Entities' use of water below the gravity outlet. This adjustment would apply following a year that KDRPP was used and the Kachess pool has not fully recovered. The adjusted calculation would be designed to ensure that TWSA with KDRPP will be the same as it would have been without KDRPP.   In brief, the calculation would use the change in Kachess Reservoir storage from the end of the previous irrigation season to April 1, up to a maximum of 239 KAF, as the Kachess Reservoir's contribution to TWSA instead of the using the actual observed volume in the normal active conservation pool.

If KDRPP is constructed, then Reclamation's operating agreement with Roza and/or other participating Proratable Entities would require that they pump water when needed to assure that Kachess Reservoir's contribution to TWSA can be fulfilled.  This would sometimes require pumping during periods when Kachess Reservoir remains in a low-pool condition following drought-relief operations.  Reclamation would coordinate with Roza and other users of Yakima Project supplies to manage Kachess Reservoir and the other four reservoirs as a system to meet contractual water delivery obligations and instream flow needs.

***Q.  What is prorationing?***

Under the 1945 consent decree issued by the District Court of Eastern Washington, water rights can be categorized in priority order as: 1) senior water rights (often called non-proratable) that existed prior to development of the Yakima Project; 2) proratable water rights (often called junior water rights) that share the priority date the United States government obtained for the Yakima Project on May 10, 1905, and 3) post-1905 water rights established after May 10, 1905 (also called junior water rights).  Senior water rights have the highest priority for receiving water deliveries.  Historically, TWSA has always been sufficient to fully supply the senior water rights. In years when the TWSA is not sufficient to provide both senior and junior water rights holders with their full entitlements the shortage is shared proportionately among the junior (proratable) water rights after the senior entitlements are met.  This equal sharing in the shortage is called prorationing.  Post-1905 water rights have the lowest priority and are curtailed when prorationing is in effect.

Some of the irrigation districts served by the Yakima Project have a mixture of senior and proratable rights; and others have only proratable water rights.  Those with the highest proportion of proratable water rights are hit hardest by drought conditions.  These include KRD, Roza, WIP and KID.

***Q. How will prorationing be used to determine when pumping can occur?***

The Final Programmatic EIS (FPEIS) for the Yakima Basin Integrated Water Resource Management Plan established a goal of raising the prorationing level to at least 70% in any year.  The water storage and water management projects and programs contained in the Integrated Plan FPEIS Preferred Alternative are designed to achieve this goal when fully implemented.

KDRPP would not be operated for drought-relief purposes in years when there is no prorationing, or in years when prorationing occurs but is 70 percent or higher.  Participating Proratable Entities would be allowed to pump water for drought-relief purposes using KDRPP only in years when prorationing falls below 70 percent.

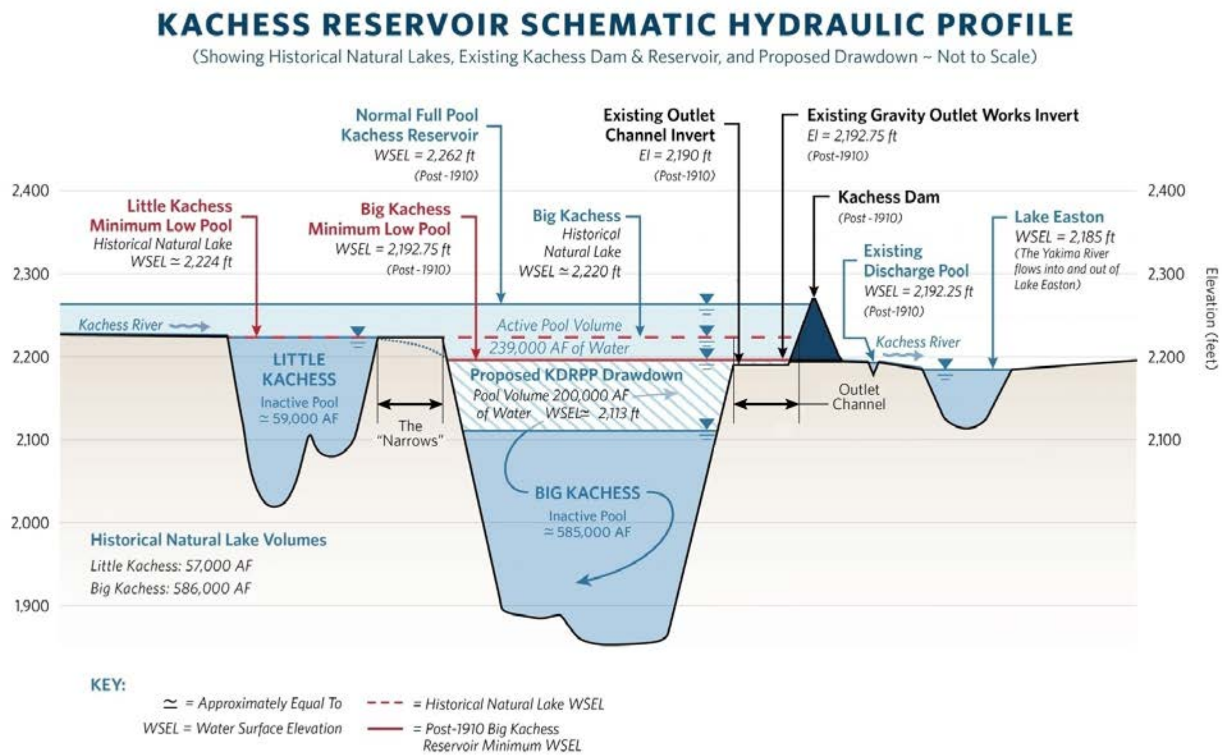
(As noted above, participating Proratable Entities would also need to pump water during refill operations following a drought.)

***Q.  How will operations for other Yakima Project users be affected?  Will they receive water from Kachess Reservoir when the reservoir is being refilled?***

Since the calculation of TWSA with KDRPP would produce the same TWSA as the calculation without KDRPP, the amount of water available for most Yakima Project users would not change. Roza and any other participating Proratable Entities would be required to pump water to satisfy TWSA requirements.

KID is a proratable district, but has historically relied upon return flows from upstream users instead of taking a prorated supply.   If KID continues this practice, their supply would continue to be based upon return flows, and may be different with KDRPP than without KDRPP.  During drought years when participating Proratable Entities pump water from KDRPP, their return flows would be higher than without KDRPP, so KID would potentially receive a higher supply than without KDRPP.  During refill years, return flows could be the same or less depending on choices made by the participating Proratable Entities, so in those years KID's supply could also be the same or less than without KDRPP.  Each increment of supply has a higher value to irrigators during drought years than during non-drought years, so the improvements in KID supply from return flow during drought years would likely offset the supply reductions from return flow during Kachess refill years.

**Attachment 1**



*(This page intentionally left blank)*

Appendix G

## DEPARTMENT OF ARCHAEOLOGY & HISTORIC PRESERVATION LETTER OF DETERMINATION

*(This page intentionally left blank)*

dahp
protect the past, shape the future

Allyson Brooks Ph.D., Director
State Historic Preservation Officer

September 5, 2018

Ms. Dawn A. Wiedmeier
Columbia-Cascades Area Office
Bureau of Reclamation
1917 Marsh Road
Yakima, Washington 098901-2058

RE: Kachess Drought Relief Pumping Plant Project
Log No.: 082014-06-BOR

Dear Ms. Wiedmeier:

Thank you for contacting our Department. We have reviewed the professional archaeological survey report you provided for the proposed Kachess Drought Relief Pumping Plant Project and the Kachess Narrow s Volitional Fish Passage Project in Kittitas County, Washington.

We concur with your Determinations of National Register Eligibility as detailed in the Table of Page 2 of your letter and documented in the Wissaard.

We concur with your Determination of Adverse Effect. We look forward to further consultations and the development of a Memorandum of Agreement (MOA) to address the immediate impacts and the associated long term impacts from the Project.

We would appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

In the event that archaeological or historic materials are discovered during project activities, work in the immediate vicinity must stop, the area secured, and this department notified

These comments are based on the information available at the time of this review and on the behalf of the State Historic Preservation Officer in conformance with Section 106 of the National Historic Preservation Act and its implementing regulations 36CFR800. Should additional information become available, our assessment may be revised. Thank you for the opportunity to comment and a copy of these comments should be included in subsequent environmental documents.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 890-2615
email: *rob.whitlam@dahp.wa.gov*

*(This page intentionally left blank)*