RECLAMATION

Managing Water in the West

Biological Assessment on the Operations and Maintenance of the Yakima Project

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
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Acronyms and Abbreviations

BA	Biological Assessment
BIA	Bureau of Indian Affairs
BMPs	Best Management Practices
Board	Washington Forest Practices Board
BPA	Bonneville Power Administration
CCWUA	Cowiche Creek Water Users' Association
CFHMP	Comprehensive Flood Hazard Management Plan
cfs	cubic feet per second
CSF	Community Salmon Fund
DPS	Distinct Population Segment
Ecology	Washington Department of Ecology
EIS	Environmental Impact Statement
ENSO	El Nino Southern Oscillation
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCRPS	Federal Columbia River Power System
FEMAT	Federal Ecosystem Management Assessment Team
FMO	foraging, migratory, and overwintering
Forest Plan	Forest Land and Resource Management Plan
Gap to Gap	Gap to Gap Floodplain Restoration and Enhancement Plan

GMA	Growth Management Act
HIP	Habitat Improvement Programmatic
HUC	hydrologic unit code
ICTRT	Interior Columbia Basin Technical Recovery Team
IFTAG	Instream Flow Technical Advisory Group
Integrated Plan	Yakima Integrated Water Resource Management Plan
IOP	Interim Comprehensive Basin Operating Plan
KAF	thousand acre-feet
KCFCZD	Kittitas County Flood Control Zone District
KCT	Kittitas Conservation Trust
KID	Kennewick Irrigation District
KRD	Kittitas Reclamation District
LWD	large woody debris
MAF	million acre-feet
MCR	Middle Columbia River
MiSA	minor spawning area
MPG	Major Population Group
MSA	major spawning area
MWhrs/yr	megawatt hour per year
NOAA Fisheries	NOAA's National Marine Fisheries Service
NPCC	Northwest Power and Conservation Council
NPDES	National Pollutant Discharge Elimination System
NRM	Northern Rocky Mountains
O&M	operation and maintenance

OWSA	October water supply available
PCE	primary constituent element
PHABSIM	physical habitat simulation modeling
Reclamation	U.S. Bureau of Reclamation
RID	Roza Irrigation District
RM	river mile
RPA	reasonable and prudent alternative
RSBOJC	Roza-Sunnyside Board of Joint Control
SCoRE	Salmon Conservation Reporting Engine
Services	NOAA Fisheries and USFWS
SMA	Shoreline Management Act
SOAC	System Operation Advisory Committee
SOP	Standing Operating Procedures
SR	spawning/rearing
SRFB	Salmon Recovery Funding Board
SVID	Sunnyside Valley Irrigation District
TMDL	Total Maximum Daily Loads
TN	total nitrogen
TP	total phosphorus
TSS	total sediment solids
TWSA	total water supply available
USFWS	U.S. Fish and Wildlife Service
VSP	Viable Salmonid Population
WDFW	Washington Department of Fish and Wildlife

WSDOT	Washington State Department of Transportation
Yakima Flood District	Yakima County Flood Control Zone District
YBJB	Yakima Basin Joint Board
YKFP	Yakima/Klickitat Fisheries Project
YRBWEP	Yakima River Basin Water Enhancement Project
YTAHP	Yakima Tributary Access and Habitat Program
YTID	Yakima-Tietin Irrigation District

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Chapter 1 Introduction

This document contains the Bureau of Reclamation's (Reclamation) Biological Assessment (BA) on the potential effects of the operation and maintenance (O&M) of the Yakima Project on threatened and endangered species and their designated critical habitats under the Endangered Species Act (ESA), and the operational information and technical analysis relevant to those assessments.

Section 7 (a) (2) of the ESA requires federal agencies to consult with the U.S. Fish and Wildlife Service (USFWS) or NOAA's National Marine Fisheries Service (NOAA Fisheries) on actions that may affect listed species or their designated critical habitats. Where an action may affect a species or critical habitat, Reclamation prepares a BA to determine whether those effects are likely or not likely to be adverse. Where a BA determines the proposed action is not likely to adversely affect the species or their critical habitat, Reclamation requests concurrence of that determination from USFWS or NOAA Fisheries. Where a BA determines an action is likely to adversely affect the species or their critical habitat, Reclamation initiates formal consultation with USFWS or NOAA Fisheries, and requests a biological opinion and incidental take statement.

The remainder of this introduction summarizes the Proposed Action, defines the action area, identifies those listed species addressed in this document, describes the consultation history, and briefly explains the organization of the remainder of the document.

1.1 The Yakima Basin

The 214-mile Yakima River and its tributaries drain a 6,150 square mile watershed that runs from the crest of the Cascade Mountains (over 8000 feet in elevation) to the Columbia River 333 miles upstream of the Pacific Ocean (340 feet in elevation). The Yakima River basin is comprised of several major tributaries: Satus Creek, Toppenish Creek, the Naches River, and the upper Yakima River. The Yakima River and its tributaries run through landscapes that range from the forested, mountainous terrain of the Cascades to the dry, shrub-steppe hills of the Columbia River Basin. Average annual precipitation in the basin ranges from over 120 inches near the Cascade Range crest to 7 inches in the lower Yakima Valley. The basin includes parts of four counties (Kittitas, Yakima, Klickitat, and Benton) and has a population of about 300,000 people. The largest towns in the basin are Ellensburg, Yakima, and parts of Richland and Kennewick.

1.2 Summary of Proposed Action

The Proposed Action is the continued O&M of federally-owned facilities in the Yakima Project. Actions authorized under the Yakima River Basin Water Enhancement Project (YRBWEP) are included when they are associated with ongoing project O&M. The Yakima Project provides irrigation water to approximately 465,000 acres of eligible lands in the Yakima River basin in central Washington. Reclamation or its contractors operate and maintain a system of federally-owned storage reservoirs, irrigation diversions and divisions, hydropower generation facilities, fish passage and protection facilities, and stream gaging stations to meet authorized project purposes. Irrigation water supply, hydropower production, flood control, fish and wildlife, and recreation are authorized purposes of the Yakima Project. Reclamation also provides water for municipal and industrial purposes pursuant to Reclamation law authorizing such use.

The Yakima Project is comprised of a federally-operated Storage Division and six water delivery divisions: Kittitas, Tieton, Sunnyside, Roza, Kennewick, and Wapato. The Proposed Action includes the O&M of the Storage Division, the storage and delivery of water to five of the six irrigation divisions, and maintenance activities undertaken by irrigation districts to maintain federally-owned facilities in the Kittitas, Tieton, Sunnyside, Roza, and Kennewick Divisions (Table 1-1).[1]

The Proposed Action also includes hydropower operations associated with project facilities and the delivery of water outside of the project divisions under supplementary water supply contracts (Appendix A). A more comprehensive review of water rights and contract quantities associated with the Yakima Project is referenced in Lentz (1974), the Final Catalogue of Water Rights Claimed in the *Acquavella* Adjudication by the U.S. Department of the Interior, Bureau of Reclamation (2006), and the Yakima River Basin Water Rights Adjudication Volume 56A (2006).

[1] The Proposed Action does not include the O&M of the Wapato Division because another federal agency, the Bureau of Indian Affairs (BIA), is responsible for O&M of these facilities. The BIA submitted a Biological Assessment to USFWS and NMFS for the continued O&M of the Wapato Irrigation Project (BIA 2009).

Table 1-1. Summary of the five irrigation divisions within the Yakima Project included as part of the Proposed Action (Reclamation 2006a).

Irrigation Division	River Diversion Point	Adjudicated Water Right (acre-feet)	Natural Flow Right (acre-feet)	Acreage Identified in Purpose of Use
Kittitas Division	Easton Diversion Dam (Yakima River @ RM 202.5)	336,000	–	59,122.29
Roza Division	Roza Diversion Dam (Yakima River @ RM 127.9)	375,000	-18,000	72,600
Sunnyside Division	Sunnyside Diversion Dam (Yakima River @ RM 103.8)	435,422	12,000	103,570
Tieton Division	Tieton Diversion Dam (Tieton River @ RM 14.2)	106,290[1]	–	27,900
Kennewick Division	Prosser Diversion Dam (Yakima River @ RM 47.1) Wanawish Dam (Yakima River @ RM 18)	102,674		20,201[2]

[1] Tieton also has a water right for 908 AF on NF Cowiche Creek
[2] Number incorporates 1995 land reclassification.

Reclamation operates and maintains the Yakima Project to the satisfaction of congressional authorizations, state water rights, and contracts with water users, flood control requirements, and facility limitations. The *Interim Comprehensive Basin Operating Plan* (IOP) describes how Reclamation operates the Yakima Project to meet these requirements (Reclamation 2002). Reclamation maintains each facility consistent with that facility's standing operating procedures (SOP).

As part of the Proposed Action, Reclamation proposes additional refinements to the O&M of the project to minimize incidental take, mitigate for adverse effects arising from future operations, or otherwise conserve listed species.

The Proposed Action only includes the continued O&M of those project facilities and operational requirements described in this document. The existing project facilities, water rights, contracts, flood control requirements, IOP, and SOP determine the basic, scope, duration, and timing of the Proposed Action. Unless explicitly described as part of the Proposed Action, Reclamation is not proposing to modify or construct a facility, or alter any water right or contract. As discussed further in Section 1.7, Reclamation will separately address such actions, including any associated with the *Yakima Integrated Water Resource Management Plan* (Integrated Plan) in a separate document and through a separate consultation if such actions occur and if needed.

1.3 Action Area

The Action Area is defined as all areas to be affected directly or indirectly by the Proposed Action, in which the effects of the action can be meaningfully detected, measured, and evaluated (50 CFR 402.02). Figure 1-1 shows the Action Area for continued O&M of the Yakima Project. The Action Area begins at the Yakima Project reservoirs, and includes the rivers below the reservoirs, the mainstem of the Yakima River to its confluence with the Columbia River, and the irrigation facilities of the five irrigation divisions (not including the Wapato Division, which is managed by the BIA). The inclusion of tributaries to the mainstem Yakima River is limited to those areas influenced by project O&M.

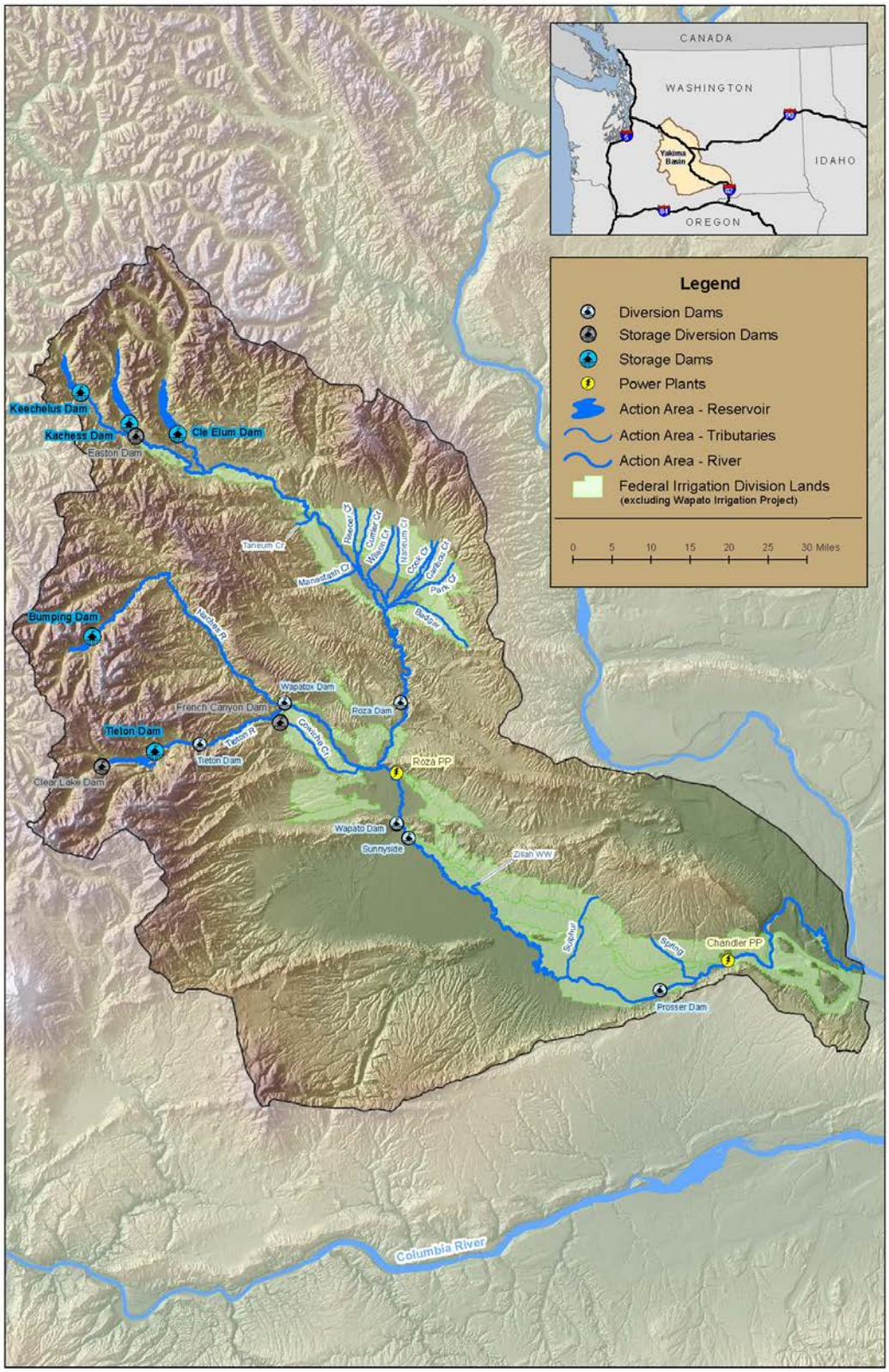

Figure 1-1. Action Area.

1.4 Listed Species and Designated Critical Habitat in the Action Area

Since the last draft of the BA was submitted to NOAA Fisheries and USFWS (the Services) in August 2000, the list of threatened and endangered species has changed slightly. Table 1-2 identifies the listed species and designated critical habitat that are addressed in this document. This table was obtained by reviewing the most current list of threatened and endangered plants and animals from the Services websites for Yakima, Kittitas, Klickitat, and Benton Counties in January 2014 and including those listed species that are known to be present in the Action Area.

Table 1-2. Listed species and critical habitat addressed in this BA.

Species	Status	Critical in Action Area	Chapter
Steelhead (*Oncorhynchus mykiss*), Middle Columbia River DPS	**Threatened** 64 FR 14517 (Mar. 25, 1999), reaffirmed, 71 FR 834 (Jan. 5, 2006)	**Yes** 65 FR 7764 (Feb. 16, 2000)	**Chapter 5**
Bull Trout (*Salvelinus confluentus*)	**Threatened** 64 FR 58910 (Nov. 1, 1999)	**Yes** 75 FR 63898 (Oct. 18, 2010)	**Chapter 6**
Gray Wolf (*Canus Lupus*)	**Endangered** 43 FR 9607 (Mar. 9, 1978), proposed for delisting 78 FR 35664 (Jun. 13, 2013)	N/A (no final designation for Critical Habitat)	**Chapter 7**
Canada lynx (*Lynx Canadensis*),	**Threatened** 65 FR 16052 (Mar. 24, 2000)	**No** 79 FR 54781 (Sep. 12, 2014).	**Chapter 8**
Grizzly Bear (*Ursus arctos horribilis*),	**Threatened** 40 FR 31734 (Jul. 28, 1975)	N/A (no final designation for Critical Habitat)	**Chapter 9**
Marbled murrelet (*Brachyramphus marmoratus*)	**Threatened** 57 FR 45328 (Oct.1, 1992)	**No** 76 FR 61599 (Oct. 5, 2011)	**Chapter 10**
Northern spotted owl (*Strix occidentalis*)	**Threatened** 55 FR 26114 (Jun. 26, 1990)	**Yes** 77 FR 71876 (Dec. 4, 2012)	**Chapter 11**

1.5 Consultation History

In August 2000, Reclamation provided the Services a BA for the continued O&M of the Yakima Project. In the 2000 BA, Reclamation determined the continued O&M of the Yakima Project was likely to adversely affect Middle Columbia River (MCR) steelhead and bull trout, not likely to adversely affect bald eagle and Ute ladies tresses, and would have no effect on gray wolf, Canada lynx, grizzly bear, marbled murrelet, northern spotted owl, and the Wenatchee Mountains checkermallow (Reclamation 2000, p. ES-4).

Shortly after receipt of the BA, NOAA Fisheries and Reclamation staff met to discuss the need for further information on the Proposed Action and a schedule for completion of consultation. By September 2001, Reclamation and NOAA Fisheries agreed to use a collaborative process to modify the Proposed Action and further mitigate potential adverse effects on listed fish. As part of this process, NOAA Fisheries and Reclamation agreed to develop separate white papers on the outstanding information requirements needed to complete consultation and the potential effects of the Proposed Action.

NOAA Fisheries submitted a draft white paper to Reclamation on June 26, 2002 (NOAA Fisheries 2002). Reclamation provided written comments to NOAA Fisheries the following month. This exchange of information revealed major differences between NOAA Fisheries and Reclamation regarding the effects of the Proposed Action. Reclamation and NOAA Fisheries attempted to resolve these differences and develop, through a collaborative process, an assessment of the effects of the Proposed Action. In February 2003, after a series of meetings in which Reclamation staff provided detailed descriptions of O&M activities, Reclamation and NOAA Fisheries abandoned the collaborative approach and agreed to develop separate documents analyzing the effects of the Proposed Action before initiating formal consultation.

In December 2003, NOAA Fisheries provided Reclamation a draft biological opinion. The opinion concluded that the continued O&M of the Yakima Project would jeopardize the continued existence of MCR steelhead and provided a reasonable and prudent alternative (RPA) containing 23 measures (NOAA Fisheries 2003, p. 198). These measures provided general requests of Reclamation to take a broad range of actions from addressing its annual operations in a series of plans, to other actions addressing habitat and research needs unrelated to the O&M of the Yakima Project.

While continued discussions were underway, USFWS designated critical habitat for bull trout (69 FR 59995, Oct. 6, 2004) and NOAA Fisheries designated critical habitat for MCR steelhead (70 FR 52630, Sept. 2, 2005). In response, Reclamation wrote two amendments to its 2000 BA to address the effects of project operations on these critical habitats. The first, in February 2005, addressed critical habitat for bull trout and was submitted to USFWS (Reclamation 2005). Reclamation did not receive a direct response from USFWS regarding this analysis. The second document was developed in June 2006 to address critical habitat for MCR steelhead but was not finalized and submitted (Reclamation 2006b).

In the fall of 2007, Reclamation initiated discussions with Yakama Nation, the Yakima Basin Joint Board, Yakima County, the Yakima Basin Fish and Wildlife Recovery Board, the Washington Department of Fish and Wildlife, NOAA Fisheries, USFWS, and the Kittitas Conservation Trust to further gather information on the effects of the Yakima Project and the feasibility of the proposed measures. In a series of meetings, Reclamation worked through this group to clarify issues with respect to project O&M. As an outcome of these series of meetings, Reclamation proposed a list of items for inclusion in a Proposed Action. Additionally, actions that Reclamation would like to pursue but were not able to commit to at the time were presented. Those convened provided feedback about priorities and any concerns about items listed.

Around this time, Reclamation and several stakeholders had formed the YRBWEP Workgroup which resulted in the development of the Integrated Plan. This plan identifies broad scale improvements to fish and wildlife habitat and water management infrastructure. Because this process had the potential to alter the future O&M of the Yakima Project, Reclamation and the Services decided to suspend activities in the present consultation until the components of the Integrated Plan were more refined.

Throughout the consultation, Reclamation had continued to improve its operations and reduce effects on listed species. These improvements include providing additional water for winter flows when possible, implementing freshet guidelines during the outmigration season, and working with System Operation Advisory Committee (SOAC) on the administration of conservation water for instream benefits.

Following the publication of the Final Programmatic Environmental Impact Statement (EIS) for the Integrated Plan, Reclamation and the Services met in October 2012 to identify a process for finalizing the Yakima Consultation. Rather than trying to craft a supplemental document which clearly explained which components of the 2000 BA were still accurate and which components had significantly changed, Reclamation and the Services decided that Reclamation would complete a new BA for the O&M of the Yakima Project. Over the following year, an interdisciplinary team met to review the best available scientific and technical data, evaluate operational constraints, and prioritize species needs. In November 2013, the Services and Reclamation met again to discuss constraints on Reclamation's discretion over project operations and attempt to identify measurable thresholds by which the

Services would review the Proposed Action. In January 2014, Reclamation and the Services again met to discuss progress in the development of a revised Proposed Action and identify a tentative schedule for the completion of consultation. Over the following months, Reclamation and the Services worked together to resolve some of the specific needs in developing and drafting the BA.

1.5.1 Previous Project Specific Consultations

A number of project-specific consultations have occurred between Reclamation and the Services when new actions were taken by Reclamation that had the potential to affect an ESA-listed species. The general nature of these projects is characterized as routine maintenance needs, facility modifications, and actions with the potential to affect water management. Specific consultations on facility modifications and water management are referenced in Chapter 2, where they provide background information and context for the Proposed Action currently under consideration. Consultations for past routine maintenance needs were used to inform the pertinent aspects of the Proposed Action presented in Chapter 3 and are referenced in this section.

1.6 Relationship to the FCRPS

The 2008, 2010, and 2014 NOAA Fisheries Biological Opinions on the Federal Columbia River Power System (FCRPS) addressed the hydrologic effect of several ongoing activities on the mainstem Columbia River, including the operation of the Yakima Project (NOAA Fisheries 2008, 2010, 2014). RPA 16 in the 2008/2010 FCRPS opinion required that Reclamation work with NOAA Fisheries to complete project-specific consultations for those tributary projects that have not yet completed ESA Section 7 consultation. The O&M of the Yakima Project is one such consultation.

Since the effects of Yakima Project storage, diversions, and return flows on listed species in the mainstem Columbia River were addressed in the 2008, 2010, and 2014 FCRPS Biological Opinions (NOAA Fisheries 2008, 2010, 2014), this BA defers to the detailed analysis of effects in the mainstem Columbia River developed in the 2008, 2010, and 2014 FCRPS biological opinions. Although the Proposed Action includes changes to instream flows to benefit species in the Yakima and Naches Rivers, Reclamation does not anticipate these changes to present substantially different effects to listed species in the mainstem Columbia River. The additional flows under the Proposed Action are relatively small when compared to the total flow at the confluence of the Yakima and Columbia Rivers. Additionally, proposed changes to operations are crafted to benefit targeted fish species.

1.7 Relationship to Actions under the Yakima Integrated Water Resource Management Plan

The Integrated Plan identified a host of actions designed to improve habitat conditions in the Yakima River while providing a sustainable water supply for agricultural, municipal, industrial, and power production purposes (Reclamation 2013). Because several components of the plan remain subject to uncertainties regarding authorization and funding, Reclamation addresses only those components it believes are reasonably certain to occur as part of the Proposed Action in this consultation. Because the Yakima Project may continue to operate absent integrated plan elements, Reclamation does not consider these actions interrelated or interdependent to the continued operation of the Yakima Project.

Currently, Reclamation is implementing four elements of the integrated plan. The Cle Elum Fish Passage project will construct and maintain a permanent fish passage facility at Cle Elum Dam. Because Reclamation completed consultation with the Services in 2010, this project has been included in the environmental baseline (NOAA Fisheries Tracking No. 2010/04694, USFWS Ref. No. 13260-2011-I-0002). The Cle Elum Pool Raise (CEPR) project proposes to increase the storage volume of Lake Cle Elum by modifying the radial gates of Cle Elum Dam (Reclamation 2014). Reclamation anticipates completing consultation on the CEPR after submission of this BA, but before completion of the Yakima Project O&M consultation. Accordingly, Reclamation has not included this project in the environmental baseline but may supplement the information provided in this biological assessment with additional information once consultation on the CEPR is completed.

Reclamation is also preparing feasibility studies and an associated EIS for the Kachess Drought Relief Pumping Plant (KDRPP) and Keechelus to Kachess Conveyance (KKC) projects (Reclamation 2015). KDRPP proposes to pump water from the inactive storage of Kachess Reservoir. KKC proposes a conveyance facility between Keechelus and Kachess reservoirs to improve the ability to capture Keechelus basin runoff while reducing high summer flows in the upper Yakima River between the reservoirs. Integrated into both projects is a Bull Trout Enhancement Project, which aims to improve habitat conditions for bull trout in the Kachess and Keechelus basins. Because Reclamation does not yet have authority to implement these projects, they are not included in the environmental baseline and Reclamation will consult on these projects individually.

When the Yakima Project O&M consultation is completed, the resulting biological opinion will become part of the environmental baseline. These baseline conditions will form the context in which Reclamation and the Services will evaluate the direct effects of future implementation plan elements, and if necessary, any resulting changes to project O&M.

1.8 How to Use this Document

Because several sections of this document are common to each species specific analysis, the document is divided into two parts: 1) a description and analysis of the Proposed Action (Chapters 1 through 4); and 2) a series of more specific assessments identifying potential effects to listed species, critical habitat, and essential fish habitat (Chapters 5 through 11).

Part 1 provides a description and analysis of the Proposed Action in Chapters 2, 3, and 4. Chapter 2 identifies the factors affecting the analyses in this document, such as the physical characteristics of the Yakima River basin; past human activities that have influenced the Action Area, reasonably certain future human activities, and climate change. Chapter 3 describes the Proposed Action in detail and explains the purpose, operational requirements, and rationale underlying individual components of the Proposed Action. Chapter 4 analyzes the individual components of the Proposed Action to determine their influence on individual habitat characteristics such as hydrology, water quality, temperature, sediment transport, and other relevant factors.

Chapter 4 does not include any conclusions with respect to the effect of the Proposed Action on listed species or their critical habitats. This is because not all changes in general habitat characteristics affect different species or critical habitat elements in the same manner. In other words, it is possible for a change in habitat conditions to have both beneficial and adverse effects on different species. To avoid confusion between the terms “affect” and “effect” which have specific regulatory meaning in the ESA, the synonyms “influence” and “change” are used throughout Part 1.

Part 2 (Chapters 5 through 11) assesses how the Proposed Action’s influence on habitat characteristics may affect listed species, critical habitat, or essential fish habitat. Chapters 5 and 6 provide Reclamation’s BA for MCR steelhead and bull trout. These chapters provide a detailed assessment based on the specific status and habitat requirements of each species. Chapters 7 through 11 provide a more general analysis of the potential effects to terrestrial species. In each of the chapters of Part 2, Reclamation provides species-specific descriptions of environmental baseline impacts, effects of the Proposed Action, and cumulative effects based on the information in Part 1.

The analysis of ongoing Reclamation project operations can often present confusing questions in how to measure the effects of continued O&M. While the influence of project operations on habitat conditions can have an ongoing and recurring effect on individual species or designated critical habitats, some historic impacts may not recur. The example of the latter case is the effect to fish populations resulting from the construction of a dam.

To identify an effect of the Proposed Action, Reclamation looks for a measureable response of individual members of a species, populations, or of critical habitat to the influence of the Proposed Action on habitat conditions. The following are evaluated:

- Exposure of individuals and primary constituent elements (PCEs) of Critical Habitat affected by the Proposed Action.
- The timing, duration, frequency, magnitude, intensity, and severity of effects.
- Direct and indirect effects, and any interrelated and interdependent actions.
- Effects to population(s) and Critical Habitat unit(s) affected, considering their resiliency and recovery rate.

In each of these assessments, careful attention is given to how current conditions in the basin affect individual, population, and critical habitat responses to operational influence. For example, despite influence of the Proposed Action on habitat characteristics in the Action Area, effects may not be likely where the species does not occupy the habitat in the location or at the time the action occurs. Similarly, where other baseline factors place additional constraints on habitat function or population dynamics, these factors are considered when assessing the influence of the Proposed Action. Where an individual, population, or critical habitat response is not likely within the foreseeable future, the influence is described as discountable.

1.8.1 Companion Documents

This document is intended to function as a companion to other documents that discuss the O&M of the Yakima Project in greater detail. The following companion documents are available on Reclamations website at http://www.usbr.gov/pn/programs/yrbwep/:

- The Yakima Project Interim Comprehensive Operating Plan
- The Yakima River Basin Water Enhancement Project EIS
- The Yakima Integrated Plan EIS

It is our intent to adapt this document to changes that have occurred both within the Action Area as well as to changes in critical habitat designations and species listings that have occurred since the initiation of consultation in 2000.

Chapter 2 Background of the Yakima Basin and Yakima Project

This chapter describes the factors in the Action Area relevant to the analyses in this BA. Generally, this chapter both identifies those actions and activities that make the Yakima basin what it is today, and identifies those factors likely to influence the Yakima basin in the future. This chapter begins with a brief overview of the geography, geology, climate, and hydrology of the Yakima River and its major tributaries: Satus Creek, Toppenish Creek, the Naches River, and the upper Yakima River. Next, this chapter summarizes the history of the irrigation development in the Yakima basin, beginning with pre-project irrigation development in the 19th Century and the first years of the 20th Century, through the development and historic operation of the federal Yakima Project over the 20th Century, including habitat improvements resulting from the YRBWEP. This chapter concludes with a discussion of those reasonably certain factors that are likely to affect the Yakima basin in the future.

The factors in this chapter inform both the general habitat analysis in Chapter 4, and the species specific analyses in Part 2. In species specific chapters, the factors below will inform the identification of the environmental baseline, the context for effects analysis, and cumulative effects. This approach differs slightly from that of the 2000 BA, which discussed individual actions in the environmental baseline. We found this approach somewhat confusing, because each of these factors may have or have had different baseline impacts and cumulative effects on different species. To resolve this confusion, these factors are discussed generally in this chapter, while providing a species specific explanation of how these factors affect the current and future status of the species later in Part 2.

2.1 Overview of the Yakima River Basin

The Yakima River basin is located in south-central Washington, 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 Yakima River originates in the Cascade Mountains near Snoqualmie Pass and flows southeasterly for about 215 miles to its confluence with the Columbia River near Richland, Washington. The Yakima River basin encompasses about 6,155 square miles and includes portions of Benton, Kittitas, Kickitat, and Yakima Counties (Reclamation 2012, pp. 1-13); three state Water Resource Inventory Areas (WRIAs 37, 38, and 39); part of the Yakama Nation Reservation; and the Cascades, Eastern Cascades, and Columbia Basin ecoregions (Vaccaro et al. 2009, p. 4).

At the highest elevations of the Naches and upper Yakima systems, streams flow through wide glacially carved valleys and glacial lakes that existed prior to the construction of reservoirs. At lower elevations and in other tributaries, stream channels have incised narrow canyons into the basalt and other bedrock. Valley floors near the towns of Ellensburg, Selah, Yakima, and Wapato contain deep alluvial floodplains composed of glacial outwash materials separated by geologic nickpoints consisting of bedrock outcroppings or anticlinal basalt ridges (e.g., Manastash, Umtanum, Yakima, and Ahtanum ridges). Below Granger, Washington, the Yakima River meanders atop broad floodplains composed of windblown soils and lacustrine silts from the Missoula Floods of the late Pleistocene (Bretz 1969, p. 517).

2.1.1 MAJOR SUBBASINS

Four tributary subbasins (Figure 2-1) make up the Yakima River basin: Satus Creek, Toppenish Creek, the Naches River, and the upper Yakima River. Satus and Toppenish Creeks originate on the Yakama Indian Reservation and enter the lower Yakima River basin below the Naches River. The Naches River is the largest tributary to the Yakima River with the Bumping River, Rattlesnake Creek, and the Tieton River as its major tributaries. The upper Yakima River basin begins at the confluence of the Naches and Yakima Rivers and extends approximately 100 miles to the northwest. Major tributaries to the upper Yakima basin include the Kachess, Cle Elum, and Teanaway Rivers.

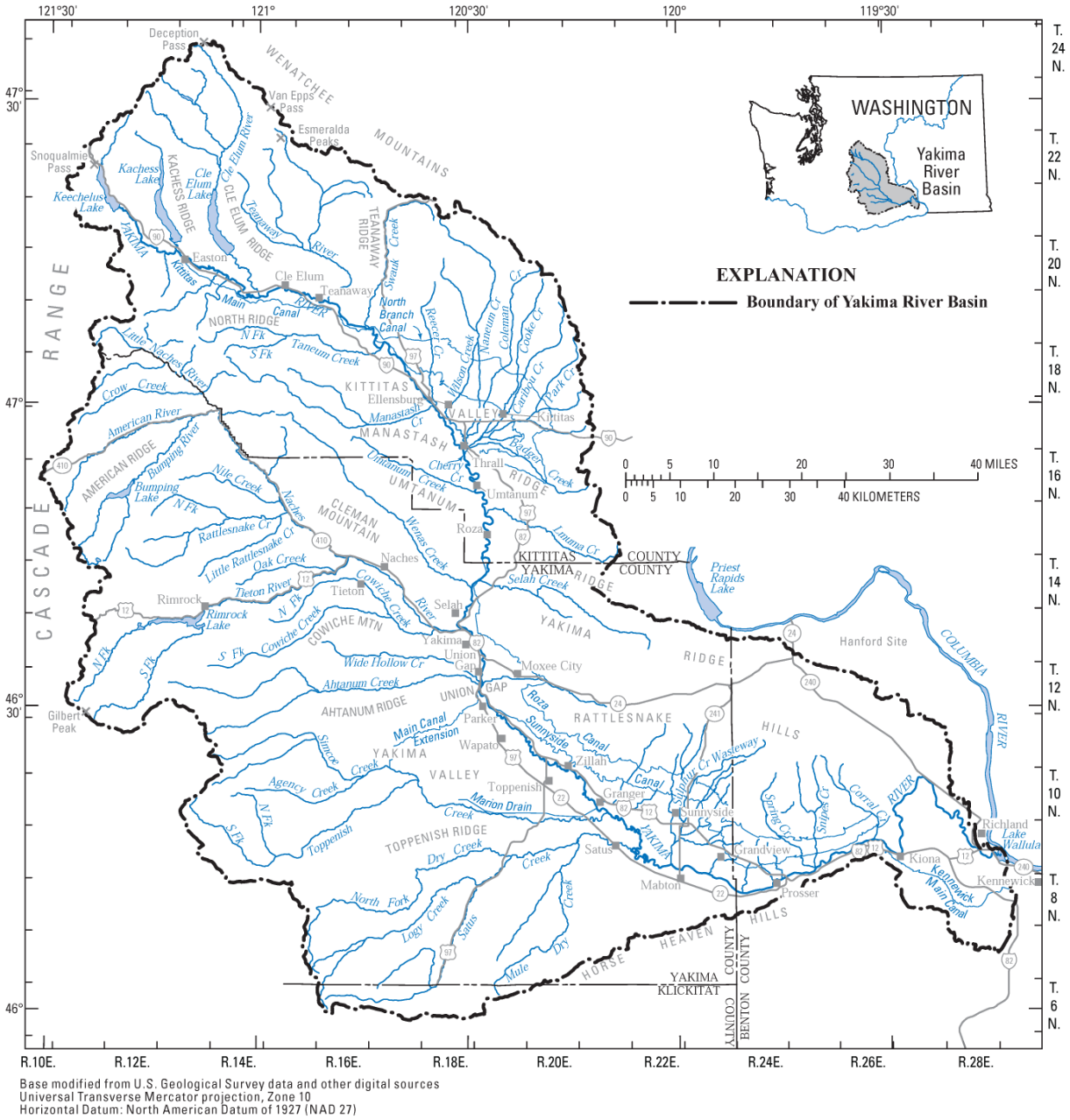

Figure 2-1. Yakima River basin, Washington (Vaccaro et al. 2009, p. 3).

SATUS CREEK

With a drainage area of 612 square miles, Satus Creek comprises 10 percent of the Yakima basin area. Many of the headwater streams in the Satus Creek watershed flow across plateaus bordered by wet meadows. As they flow generally eastward, the headwater streams cascade through narrow canyons toward the relatively broad Satus Creek canyon. Satus Creek exits the canyon at river mile (RM) 12.5 and flows eastward across the Yakima River floodplain to the confluence with the Yakima River. Most of the Satus Creek watershed is undeveloped.

TOPPENISH CREEK

The Toppenish Creek watershed, at 625 square miles, is similar in size to the Satus Creek watershed. Upper Toppenish Creek consists of three forks along with several smaller tributaries draining the Cascade foothills between Toppenish and Ahtanum ridges. These are all high gradient streams in narrow basalt canyons. Increasing gradients and coarsening substrates progressively limit anadromous fish habitat. Agency and Wahtum Creeks flow into Simcoe Creek, which joins Toppenish Creek at low elevation. A few miles downstream from the Simcoe Creek confluence, the Toppenish Creek channel historically assumed a branched appearance and flowed through an extensive network of wetlands for nearly 30 miles to the Yakima River. This network has a gradient of less than 0.1 percent. The complexity of this network has been significantly reduced.

NACHES RIVER

The Naches River drains some of the highest and wettest terrain in the Yakima basin. The Naches and Tieton Rivers are considerably steeper and naturally more confined than most of the upper Yakima River.

UPPER YAKIMA RIVER

The Yakima River above the Naches confluence is nearly 100 miles long, and drains nearly twice as much area as the Naches drainage. Much of the mainstem of the upper Yakima has relatively low gradient with extensive floodplains that once contained multiple channels and large areas of spawning and rearing habitat for salmonids, as around the towns of Easton, Cle Elum, Ellensburg, and Selah. Other reaches run through large bedrock canyons between Cle Elum and Ellensburg, and Ellensburg and Selah.

2.1.2 CLIMATE AND CLIMATE CHANGE

Mean annual precipitation in the basin ranges from 80 to 140 inches in the mountains to less than 10 inches in the lower Yakima valley. Sixty to 80 percent of annual precipitation falls between October and March. Air temperatures in the basin are generally inversely related to altitude. Minimum and maximum mean monthly temperatures occur in January and July, respectively (Reclamation 2002, p. 2/2).

Climate change models indicate significant changes in runoff in the Yakima River basin. Generally, the projected increased air temperatures would cause some precipitation to fall as rain instead of snow, which would increase winter and early spring runoff and reduce the volume of runoff from snowpack that occurs in the late spring and early summer. The net effect is anticipated to be a shift in the peak runoff period to earlier in the season, with a corresponding decrease in spring and summer (projected at 12 to 71 percent of existing runoff) and increase in fall and winter runoff (projected at an increase of 4 to 74 percent of existing runoff). Fall and winter inflow to reservoirs would increase, and the reservoir system may not be able to capture and hold the increased flow for release during the high-demand period (spring and summer). Additionally, a decrease in spring and summer supply would cause water stored in reservoirs to be depleted at a faster rate to meet demand. The combined effects would likely cause a decrease in overall supply during the high-demand period (Reclamation 2012, p. 1/12)

Climate change is expected to result in a decline in the quantity of freshwater habitat for salmonid populations across Washington State (Manuta, Tohver, and Hamlet 2010, p. 187). The Yakima River basin is a transient watershed, one that is dominated by a mix of direct runoff from fall rain and spring snowmelt. Simulations predict that this type of watershed would be most affected by climate change, with accompanying impacts to fisheries. Specific impacts to fish are expected to include:

- Increased air temperature would increase water temperature, negatively impacting fish habitat.
- Elevated stream temperatures would increase thermal barriers to migration.
- Increased winter flood frequency and intensity would cause a negative effect on juvenile coho, Chinook, steelhead, and bull trout survival and reduction of survival rates for incubating eggs and rearing parr.
- Reduced spring snowmelt and summer and fall streamflows would impact summer-run steelhead, sockeye, and summer Chinook migrations.
- Diminished flows in combination with increased water temperatures would increase pre-spawn mortality for summer-run and stream-type salmonids.

2.1.3 LAND OWNERSHIP AND USE

Land ownership in the Yakima basin is diverse, ranging from designated wilderness to intensive agriculture, to areas of urban development. At 1.4 million acres, private ownership totals 36 percent of the basin. Most of the federal land is in the Okanagan-Wenatchee National Forest in the upper portion of the basin, on the eastern slopes of the North Cascade Range. Other large federal land holdings include the U.S. Army National Training Center (200,000 acres), USFWS (over 80,000 acres), and Bureau of Land Management lands (over 45,000 acres). State, county, and local governments own over 400,000 acres. The Yakama Nation encompasses 890,000 acres of the basin (Reclamation 2012, p. 1/14).

Land use varies similarly throughout the basin. Nearly 40 percent of the basin is forested (YSFWPB 2004, p. 1/16). These forested areas tend to be in higher elevations and the primary uses are timber harvest, cattle grazing, fish and wildlife habitat, and recreation. Approximately one-fourth of this area is designated wilderness (Reclamation 2012, p. 1/13). Another 40 percent of the basin is rangelands (YSFWPB 2004, p. 1/16). These rangelands tend to be at middle elevations and are used for dry-land and irrigated agriculture, cattle grazing, wildlife habitat, and military training (Reclamation 2012, p. 1/13). Low elevations are primarily used for irrigated agriculture. About 18 percent of the basin consists of irrigated agriculture, with the remaining percent as urban areas (YSFWPB 2004, p. 1/16).

2.2 PAST HUMAN ACTIVITY IN THE YAKIMA BASIN

Non-Indian settlement in the Yakima River began in the mid-19th Century. The Northern Pacific Railroad provided access to outside markets, opening the door to commercial agriculture, logging, and a consequent population boom. By 1890, settlers had established the major cities in the basin: Yakima, Sunnyside, Prosser, Ellensburg, Cle Elum, and Roslyn (Reclamation 2002, pp. 2/19-20). Over the course of the late 19th and 20th Centuries, irrigated agriculture, grazing, logging, mining, transportation development, the introduction of non-native species, and recreational development transformed habitat conditions in the Yakima basin, with meaningful consequences for several species. This section provides a brief historic summary of these activities.

2.2.1 PRIVATE IRRIGATION DEVELOPMENT AND AGRICULTURAL ACTIVITY

Although small scale irrigated agriculture dates back to the 1860s, the Northern Pacific Railroad promoted irrigation as a means to sell "checkerboard" land tracts they had received from the Federal Government. Together with Walter Granger, the Northern Pacific Railroad and Canal Company built the original Sunnyside Canal. By 1905, several irrigation companies had constructed an irrigation system to provide natural flow of the Yakima River and its tributaries to 121,000 acres of land. Table 2-1 provides a selected history of private water resource development.

Table 2-1. Selected history of Water Resource Development Pre-federal Project (Perala 1990).

Year	Event
1872	Start of Ellensburg Water Co., Snipes and Allen Ditch, Manastash Ditch Co.
1878	Start of Konewock Ditch Co.
1880	Start of Fowler Ditch Co., Union Gap I.D., Naches Cowiche Canal Co., Piety Flat Ditch Co., Taneum Canal Co.
1884	Start of Selah Moxee I.D., Terrace Heights I.D.
1889	Start of Naches-Selah I.D., Westside I.D., Gleed Ditch Co., Moxee Ditch Co.
1894	Start of Yakima Valley Canal Co.
1896	WIP development 1896 - 1930
1903	Log Crib Dam at Kachess (CID)
1904	Start of Cascade Canal Co.
1904	Prosser Diversion Dam completed

TRIBUTARY AND GROUNDWATER USE

The earliest irrigation efforts tended to be directed at diverting water from the Yakima, Naches, and Tieton Rivers (Parker and Storey 1916, pp. 28-31). The Kittitas Valley was an exception to this pattern, as small ditches diverting from Manastash and Taneum Creeks were developed first. In 1885, the Ellensburg Water Company was formed and the first large canal project in Kittitas County was pursued to divert mainstem Yakima water.

The earliest groundwater irrigation efforts were limited to mostly shallow (10 to 40 feet deep) wells intended to serve Yakima basin households without access to surface water supply from streams (Vaccaro and Sumioka 2006, p. 11). Population growth after 1900 and a lack of unappropriated irrigation water from smaller tributaries during the flow period caused the number of wells to increase around the turn of the 20th Century. While records for the first half of the 20th Century are lacking, available information indicates that at least 200 wells were constructed by 1910 and that the pace of well construction generally mirrored population growth as time progressed. By about 2006, there were about 45,000 water wells, with about half of these wells less than 151 feet deep and the vast majority (90 percent) less than 456 feet deep (Vaccaro and Sumioka 2006, p. 11) (Figure 2-2). HDR Engineering estimated that within the Yakima basin, 60,368 acres are irrigated using non-federal surface water, and 47,161 acres are irrigated using primarily groundwater (HDR and Anchor 2011a, p. 31). The total annual water use for these areas was estimated to be 586,140 acre-feet annually. This analysis excluded acreage within federally-supplied irrigation districts, some of which may be supplied with a combination of federal and non-federal (for example, tributary) water sources.

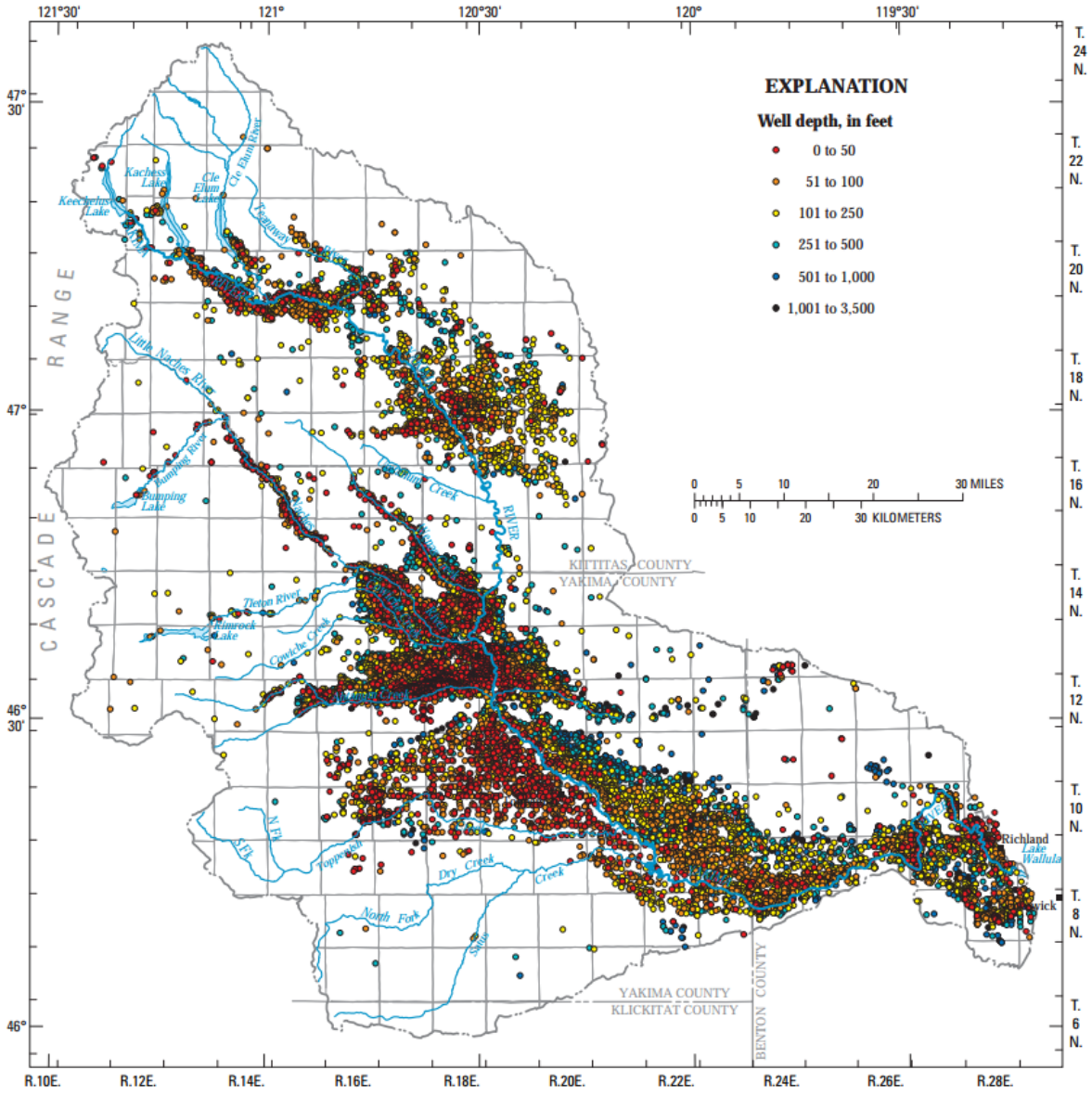

Figure 2-2. Distribution and depths of water wells, Yakima River basin, Washington (Vaccaro et al. 2009, p. 15).

Out of concern that groundwater pumping can diminish streamflow, in 2007 water rights holders in Kittitas County petitioned Washington Department of Ecology (Ecology) to place a temporary moratorium on new groundwater wells. In response, Ecology issued a series of Emergency Rules to manage groundwater in Kittitas County. In December 2010, Ecology issued a Ground Water Rule (Chapter 173 -539A WAC) that withdraws from appropriation all groundwater in upper Kittitas County with the exception of uses for structures for which a building permit was granted and vested prior to July 16, 2009, and uses determined to be water budget neutral. To assist homeowners and developers in acquiring water rights to meet the water budget neutral determination, Ecology has established the Kittitas Water Exchange to help water users sell or locate water available to buy.

PESTICIDES AND DDT

Private agriculture began the use of chemical pesticides, such as DDT, in the late 1940s (Johnson, Norton, and Yake 1988, p. 292). In 2000, there were an estimated 146 organic pesticides in use in the Yakima basin (Johnson H. M. 2007, p. 8). Once applied by a farmer, the transport of these pesticides to surface water is a function of the chemical characteristics of the pesticide, soil properties, slope, climate, application rate, and management factors (Ebbert and Embrey 2002, p. 39). Additionally, residual presence of banned pesticides or their metabolites, DDT, DDE, DDD, dieldrin, chlordane, and alpha-BHC, in soil and groundwater can be transported to streams throughout the year, especially during snowmelt or storm runoff (Johnson A. K. M. 2010, p. xvii; Ebbert and Embrey 2002, p. 19). These legacy chemicals, alongside continued use of insecticides endosulfan and chlorpyrifos contribute to the exceedance of Washington State water quality criteria (Ecology 2010).

2.2.2 LOGGING

Logging activity in the Yakima basin dates back to the 1870s. Initially, the mills were small and were located in the upper Wenas and Ahtanum Valleys, and in various canyons leading into the Kittitas Valley. Major logging operations were carried out in the early 1900s. Between 1900 and 1945, intensive logging activities occurred in the Teanaway and Swauk watersheds, and Taneum Canyon. Between 1950 and 1980, portions of the Cabin Creek watershed was clear cut. Portions of the Naches Pass were partially harvested from the 1970s to the 1990s. In addition to direct effects on the landscape, logging also resulted in other important effects on aquatic habitats. To facilitate access to timber, companies built railroads along several streams. From about 1880 to 1915, log drives were common in the Yakima basin. The construction of splash dams in several areas had long-term impact on the geomorphic characteristics of several streams (Reclamation 2002, pp. 2-19).

2.2.3 MINING

The Yakima River floodplain is one of the most heavily mined floodplains in Washington State (Haring 2001, p. 106). Specifically, avulsion of floodplain gravel pits can have adverse impacts on aquatic habitats through altering the benthic invertebrate community, increasing stream temperatures, and increasing sediment loads. Such avulsion events have occurred in the Yakima River at Parker and Selah Gap (Norman, Cederholm, and Lingley 1998). Historically, the discovery of gold led to extensive placer mining in Swauk Creek and likely downstream in the Yakima River (Haring, 2001, p. 18).

2.2.4 TRANSPORTATION INFRASTRUCTURE

Railway and road construction altered riparian ecosystems throughout the basin. Transportation infrastructure reduced backwater areas, sloughs, oxbows, and meandering features of the river systems by channelizing the streams, altered the stream channel through gravel extraction, and affected water quality. Early road development generally widened existing trails along the rivers and streams. For example, Snoqualmie Pass was extensively used by the Yakama and Snoqualmie Indian Tribes before it was converted into a wagon road in the 1860s. Over the next century, a number of road improvements were made to accommodate automobiles, and the road was incorporated into the Interstate Highway System. In 1883, the Northern Pacific Railroad started construction of its mainline up the Yakima Valley, following the south bank of the Yakima River from Kiona through Prosser and on to the west. More recently, the construction of Interstate 90 impacted habitat along the upper Yakima River through the construction of levees and through gravel excavations. At various locations along I-90, gravel excavation created ponds and lakes visible from the roadway. Similar construction created ponds along State Highway 10 in the 1930s, and along I-82.

2.2.5 INTRODUCTION OF NON-NATIVE FISH SPECIES

Introduction of non-native fish species began in the late 1800s with the completion of the railways. By the 1920s, those non-native species present today were pretty much established. Intense management for warm water species began with the coming of tournament bass fishing in the 1970s. Today the management objective for introduced game fish species is on maximizing long-term recreational benefits, while minimizing adverse impacts to native fish and wildlife and their habitats. Exotic species present today include: brook trout, lake trout, brown trout, largemouth bass, smallmouth bass, black crappie, white crappie, bluegill, pumpkinseed, green sunfish, walleye, yellow perch, channel catfish, brown bullhead, black bullhead, mosquitofish, goldfish, and carp. Hatchery strains of two native fish (rainbow and cutthroat trout) have been introduced to the basin from other states. Most warm water exotic species are located downstream from the city of Yakima and provide for viable recreation

opportunities including bass tournaments. Introduced salmonids are generally found in the cooler parts of the upper watershed including reservoirs and also provide for recreational fishing opportunities.

2.2.6 URBAN DEVELOPMENT

The City of Yakima began as a trading post and was incorporated as Yakima City on December 1, 1883, at the original site in Union Gap. In 1884, Northern Pacific Railway Company established a station 4 miles west and moved over 100 buildings from Yakima to the new site at no charge. The new settlement was called "North Yakima." The reason behind this was the Northern Pacific could not obtain the concession to operate from the existing "Yakima." North Yakima was incorporated and officially became the county seat in 1886. Sunnyside was recognized as the commercial center of the Yakima Valley in the early 1900s, with its history closely linked to the development of the early irrigation canals. Prosser was a recognized center due to its railroad access and surrounding irrigation developments. The Ellensburg townsite was established in 1875. Cle Elum and Roslyn were developed as mining towns in the 1880s, supplying coal to the railroads. The Ellensburg State Normal School (predecessor to Central Washington University) was established in 1890 (Reclamation 2002, pp. 2/19-20).

In 1998, about one-half of the population lived within incorporated cities. The larger cities (over 5,000 population) include Yakima, West Richland, Richland (part), Kennewick (part), Ellensburg, Sunnyside, Toppenish, Grandview, and Selah. The Yakima River basin includes 24 incorporated municipalities, of which 5 are in Kittitas County, 14 are in Yakima County, and 5 are in Benton County. There has been the rapid growth of diverse populations and the simultaneous development of urban and suburban areas in the three major counties of the watershed. For example, from 1990 to July 1, 1997, the populations of Kittitas, Benton, and Yakima Counties increased by more than 15 percent, or about 60,000 people. A detailed analysis of floodplain development in the area from Lake Easton to the Cle Elum River confluence found that five major subdivisions with 230 individual housing structures were built in the designated river floodplain between 1961 and 1970 (Johnson 1994, as cited in Haring 2001).

2.3 THE YAKIMA PROJECT

The project provides irrigation water for a strip of fertile land that extends for 175 miles on both sides of the Yakima River in south-central Washington (Figure 1-1). The irrigable lands, eligible for service under Reclamation's Yakima Project, total about 465,000 acres. Over 45,000 acres not included in the seven divisions are irrigated under supplemental water supply contracts with Reclamation. Other project features relevant to this BA include 420 miles of canals, 1,697 miles of laterals, 30 pumping plants, 144 miles of drains, 2

Reclamation owned and operated powerplants (Roza and Chandler), fish passage and protection facilities, and stream monitoring gages throughout the Yakima Project Action Area.

The Yakima Project is divided between the Storage Division and water delivery divisions: Kittitas, Tieton, Sunnyside, Roza, Kennewick, and Wapato (Table 2-2). Reclamation operates and maintains the Storage Division, those facilities needed to store and deliver water. In this capacity, Reclamation's Yakima Field Office has management responsibility over the Yakima River water supply, which includes natural river flow, return flow, and stored water. Pursuant to Reclamation law, Reclamation acquired water rights for project water supplies, and delivers those supplies under numerous contracts with different water users.

Table 2-2. Identification of location, major facilities, and operating of the seven divisions in the Yakima Project.

Division	Location	Major facilities (reserved facilities are underlined)	Operating entity
Storage	Naches and upper Yakima River Headwaters	Kachess, Keechelus, Cle Elum, Bumping, Tieton and Clear Creek Dams	Reclamation
Kittitas	Kittitas Valley near Ellensburg	Easton Diversion Dam, Main Canal, North and South Branch Canals, Easton fish ladder and screens	Kittitas Reclamation District
Tieton	Upper Yakima Valley	Tieton Diversion Dam, French Canyon Dam, Tieton Canal, YTID fish ladder and screens	Yakima-Tieton Irrigation District
Roza	Lower Valley north of Sunnyside Division	Roza Diversion Dam, Ridge Canal (reserved works include the section between the dam and powerplant),Roza powerplant, pumping plants, fish ladders and screens	Roza Irrigation District
Sunnyside	Lower Yakima Valley, east of river	Sunnyside Diversion Dam, Sunnyside Canal, pumping plants, fish ladders and screens	Sunnyside Valley Irrigation District and others[1]
Kennewick	Extreme lower Yakima Valley, Benton County	Prosser Diversion Dam, Chandler Canal (reserved works include the section between the dam and powerplant), Chandler powerplant, pumping plants, Kennewick Main Canal, fish ladders and screens	Kennewick Irrigation District
Wapato[2]	Lower Yakima Valley west of river	Wapato Diversion Dam, Main Canal, drainage works, fish ladders and screens	Bureau of Indian Affairs

[1] Includes Outlook, Granger, Snipes Mountain, Grandview, Benton, Home, Zillah irrigation districts; Piety Flat Irrigation Company, Konnewock Water Users, Special Warren Act Lands, and the cities of Sunnyside, Grandview and Prosser.

[2] Ahtanum and Toppenish-Simcoe Units (a small percentage of the total acreage of the Wapato Irrigation Project) are not dependent on Yakima Project storage.

This section provides the underlying background of the Yakima Project necessary to understand the Proposed Action. Subsection 2.3.1 provides a brief history of the project, outlining its authorization and construction, the development of the legal framework for project operations, and, ultimately, the more recent federal legislative framework to balance irrigation reliability and fish and wildlife needs. Subsection 2.3.2 through 2.3.5 describe the federal storage, diversion, carriage, power, and fish passage facilities that comprise the Yakima Project, their construction, and any relevant limitations those facilities place on O&M.

2.3.1 HISTORY OF THE YAKIMA PROJECT

AUTHORIZATION AND CONSTRUCTION

Conflicts between early irrigation companies in the late 19th Century made apparent the over appropriation of waters from the Yakima basin. To resolve this issue, the citizens of Yakima County petitioned the Secretary of the Interior for federal involvement in further development of irrigation in the basin. After favorable initial investigations, the Secretary of the Interior authorized the Tieton and Sunnyside Divisions in 1905, initiating the first portions in the development of the federal Yakima Project (Reclamation 1957). This plan included construction of the major storage reservoirs. Other components of the project were authorized throughout the 20th Century: the President approved the Benton, Kittitas, and Wapato Divisions in 1911, the Roza division in 1935, and Congress authorized construction of the Kennewick Division in 1948 (62 Stat. 382) and authorized its expansion in 1969 (83 Stat. 106).

Construction of the Tieton and Sunnyside units began in 1906, with the first water available to these lands in the 1907 irrigation season. Development of the water storage reservoirs progressed with the construction of Bumping Dam (1910), Kachess Dam (1912), Clear Creek Dam (1914), Keechelus Dam (1917), Tieton Dam (Rimrock Lake, 1925), and Cle Elum Dam (1933). Table 2-3 provides a selected history of facility development. By the 1970s, the Yakima Project contained 6 storage reservoirs with a total capacity of 1,070,000 acre-feet, 5 diversion dams, and 416 miles of canal. Together, these facilities provided irrigation service to approximately 464,000 acres (Department of the Interior 1981, pp. 1341-1343). The 1992 authorization and reconstruction of Clear Creek Dam were primarily based on recreation benefits. Given Clear Lake's primary use as recreation, the minimal water stored by Clear Lake, and operational practice to maintain maximum elevation at Clear Creek Dam throughout the year, the Yakima Project is described as having 5 main storage reservoirs.

Table 2-3. Selected history of Water Resource Development as part of the federal projects (Perala 1990; Reclamation 2002).

Year	Event	Year	Event
1905	Yakima Irrigation Project authorized	**1929**	Easton Diversion Dam completed
1907	Sunnyside Diversion Dam completed	**1931**	First Water to Kittitas R.D.
1908	Tieton Diversion Dam and Distr. System, Log Crib Dam at Cle Elum (UGID)	**1933**	Current Cle Elum Dam completed
1910	Bumping Lake Dam completed	**1939**	Roza Diversion Dam completed
1912	Kachess Dam completed	**1941**	First water to Roza Division
1914	Clear Creek Dam completed	**1956**	KID construction completed, Chandler Power/Pump Plant online
1917	Keechelus Dam completed	**1959**	Roza Powerplant On Line, First Water to Kennewick I.D.
1925	Tieton Dam completed	**1992**	Clear Creek Dam reconstructed

WATER RIGHTS, CONTRACTS, AND ASSOCIATED COURT CASES

A contemporaneous history of water rights is also important to understanding the legal underpinnings of the Yakima Project. Generally, three types of water rights are relevant to the operation of the Yakima Project: senior private rights, project rights, and Tribal rights. Prior to the development of the Yakima Project, private irrigators obtained private water rights to the Yakima River and its tributaries under state law pursuant to the doctrine of prior appropriation. With respect to operations, Reclamation must bypass sufficient flows at project facilities to satisfy senior private rights.[2]

Reclamation acquired project water rights to the Yakima River in two ways: through the acquisition of pre-project, private facilities, and water rights, and through the May 10, 1905 withdrawal of unappropriated waters of the Yakima basin. Reclamation distributes project supplies under contracts with irrigation districts, and in infrequent cases, with individual water users or municipalities. Allocation of project supplies must be consistent with the orders and ruling of the *Acquavella* Court (see *State of Washington, Department of Ecology v. James J. Acquavella, et al.*, Yakima County Superior Court Cause No. 77-2-01484-5

[2] As a condition to federal investment in the Yakima Project, the Secretary of the Interior required then existing water users to adjust conflicting claims to then over appropriated rivers in the Yakima basin (Hitchcock 1905). Approximately 50 appropriators entered into "limiting agreements" voluntarily limiting their diversions to maximum monthly quantities (Lentz 1974 p. 2).

("*Acquavella*"). Reclamation allocates the total water supply available (TWSA) from both natural flow and storage. In water short years, Reclamation will deduct the Pre-project water rights, including the Yakima Nation's time immemorial Treaty right, from the TWSA, and allocate the May 10, 1905 right on a pro-rata basis.

Tribal water rights originate from the treaty of 1855 between the Yakama Nation and the U.S. The Yakama Nation's treaty rights carry the most senior priority date in the Yakima basin. Among these rights are instream flows needed to maintain fishing rights (Ottem 2008).

Tribal rights play an important role in defining operations of the Yakima Project. The 1980 "Quackenbush decision" required Reclamation to release water to protect salmon redds in the upper Yakima River. In response to this decision, Reclamation initiated the "flip-flop" operation (described in History of Project Operations section below). The Quackenbush decision also required the formation of the System Operations Advisory Committee (SOAC), to advise the Yakima Project superintendent on how to best manage to protect fisheries resources. SOAC is an advisory board to Reclamation consisting of fishery biologists representing the USFWS, the YN, the Washington Department of Fish and Wildlife (WDFW), and irrigation entities represented by the Yakima Basin Joint Board.

All of the water rights above are subject to the ongoing *Acquavella* adjudication of water rights in the Yakima basin. To date, key decisions in the *Acquavella* adjudication have endorsed the framework of the 1945 Consent Decree, described the scope of Tribal instream flow rights, and identified that Tribal instream flow rights may be used to provide flushing flows for outmigrating salmon (see, e.g. Order Re: Flushing Flows, dated April 13, 1995).

HISTORY OF PROJECT OPERATIONS

Reclamation has operated storage reservoirs to store and deliver water since the completion of Bumping Reservoir in 1910. Project operations have transitioned over time from a historic focus on irrigation to today's multiple purpose management approach. In this subsection, we provide a summary of identified operational phases. Specific details about project operations, including operational considerations and constraints are provided as part of the Proposed Action in Chapter 3.

PRE 1979

Prior to 1979, Reclamation's operations focused on irrigation storage, delivery, and flood control, with little formal attention paid to fisheries impacts. From the completion of Bumping Dam in 1910, the scale of operations incrementally increased as Reclamation completed construction of additional storage reservoirs and diversions. With the completion of Rimrock Dam in 1925, the Project reached current operational capabilities for the Naches River basin, and with completion of Cle Elum Dam in 1932, the Project reached current

operational capabilities in the upper Yakima River. While Roza Dam was constructed with a fish ladder in 1941, it was operated such that the upper Yakima was inaccessible to nearly all fall-run steelhead for 18 years.

1979 – 2002: YRBWEP AND SOAC OPERATIONS

Between 1979 and 2002, Reclamation integrated several key fisheries operation components into the Yakima Project. The creation of an advisory committee and subsequent creation of the flip-flop operation, construction of fish screens at major diversions under the YRBWEP, and the establishment of minimum streamflows at Prosser Dam were each a significant departure from pre-1980 operations.

In 1980, the Federal Court for the Western District of Washington ordered Reclamation to consider fisheries in project operations. Specifically, Reclamation was to consult with fisheries biologists to provide sufficient water for successful incubation of spring Chinook redds. As a result, Reclamation convened the SOAC, an advisory board consisting of fishery biologists from the USFWS, the Yakama Nation, the WDFW, and irrigation entities represented by the Yakima Basin Joint Board (YBJB).

The flip-flop concept was SOAC's first recommendation. Flip-flop, along with its counterpart mini flip-flop, reshapes irrigation deliveries to safeguard spring Chinook redds below Cle Elum and Keechelus Dams. Since 1981, Reclamation has released water from the upper Yakima reservoirs earlier in the irrigation season and shifted to Rimrock Reservoir later in the irrigation season. This lowers the flows in the upper Yakima basin when spring Chinook salmon spawn, preventing establishment of Chinook redds in areas which would dewater after the conclusion of irrigation deliveries. Similarly, mini flip-flop times the releases between Keechelus and Kachess so that flows out of Keechelus are reduced when spring Chinook spawning occurs in the Keechelus reach of the upper Yakima River.

In 1979, Congress passed the YRBWEP Act (PL 96-162). In response to this legislation, Reclamation and Ecology initiated the YRBWEP study to identify water needs, available resources, and potential plan elements in 1981. Among the early implementation activities in this plan were the construction of fish screening facilities at irrigation diversions in the Yakima basin. A more thorough description of these screen facilities appears in Section 2.3.5 below

In 1994, Congress passed Title XII of the Act of October 31, 1994 (103 PL 434). This formally added fish and wildlife to the authorized purposes of the Yakima Project, allowing Reclamation to store and release water for instream purposes. This legislation also set the Title XII target flows on the Yakima River at Parker and Prosser, which provided minimum flows in the lower river during the irrigation season. Additionally, Congress authorized Reclamation to purchase or lease water and land from willing sellers, implement water

conservation, and enhance Yakima River tributaries for fish and wildlife and irrigation purposes. A full YRBWEP legislative and program history is provided in Sections 4.1 and 4.7.1 in the IOP.

The Title XII legislation recognized that the minimum instream flow targets set for Parker and Prosser were based on available water supply, rather than biological requirements, and directed the SOAC to evaluate what is necessary to have biologically-based target flows for the Yakima basin. In 1999, the SOAC issued a report with this evaluation. A key conclusion of the 1999 report was that Title XII target flows "do not provide for normative ecosystem function and cannot be expected to fully achieve the objectives of enhancing and recovering anadromous fish populations" (SOAC 1999, pp. 1-4). Additionally, the SOAC asserted the Title XII focus on two reaches of the lower Yakima River was too restrictive spatially and conceptually, since the entire Yakima River basin provides important habitat (SOAC 1999, pp. 3-1). The importance of another key flow component, heightened flows to mimic a natural freshet to aid smolt outmigration had already been documented by the *Acquavella court's* Memorandum Opinion in 1994. The SOAC report highlighted five hydrologic parameters: magnitude, frequency, duration, timing, and rate of change, which should be evaluated for ecological relevance (SOAC 1999, pp. 3-1).

2002 – Present: The Interim Comprehensive Operating Plan

The Title XII legislation also directed Reclamation to develop an Interim Operating Plan (IOP) to assist the Yakima Project superintendent in operating the Yakima Project. The IOP was intended to document the operating capability and constraints of the system, information of water supply and needs, system operations and flow objectives, and SOAC activities. Reclamation completed this plan in 2002 and has used it to guide the evolution and optimization of project operations.

In addition to the Title XII minimum flow targets, the IOP specified how project operations would consider the needs for winter flows for spawning, rearing and incubation, passage flows, ramping rates, and outmigration flows. Since the IOP was developed, project operations have evolved to better consider these instream flow needs. For example, a risk analysis framework established in 2002 enabled Reclamation to better predict the impacts of increased winter releases out of the reservoirs and in many years provide additional winter flows. In 2005 and 2006, new guidelines were developed to improve spring outmigration conditions. The first was the pulse flow guidelines developed by SOAC, identifying the conditions under which water is released from storage to stimulate downstream smolt migration. The Yakima Field Office subsequently developed a protocol for identifying naturally developing freshets and determining how long the freshet will be able to pass for smolt outmigration purposes before canal diversions increase for irrigation and power production purposes.

Another key development since the IOP was written in 2002 is the water savings from the implementation of YRBWEP conservation projects and direct lease or purchase of water is available for instream use. A portion of the water that has been secured through water conservation for instream use is shapeable, meaning that this water can be stored and then released to provide a specific flow benefit to fisheries.

2.3.2 STORAGE DIVISION FACILITIES

Reclamation operates the six storage dams and reservoirs that comprise the Storage Division. Overall, the Storage Division can store approximately 1.05 million acre feet of water (Table 2-4). Snowpack provides additional storable supplies and is often thought of as an additional reservoir. The construction of storage facilities has important and independent impacts on habitat access in the upper Yakima and Naches basins. Further, the facilities themselves have inherent operational limitations relevant to their continued O&M. This subsection provides background on these facilities, including any non-discretionary constraints on their operation due to the facility limitations, irrigation entitlements, fisheries flows, and flood control.

Table 2-4. Storage dams and reservoirs.

Dam ***Reservoir***	**Date of first storage**	**Capacity**	**Flood Control**	**Fish Passage**
Keechelus Dam *Lake Keechelus*	1917	157,800 af	Yes	No
Kachess Dam *Kachess Lake*	1912	239,000 af	Yes	No
Cle Elum Dam *Cle Elum Lake*	1933	436,900 af	Yes	Interim
Bumping Dam Bumping Lake	1910	33,970 af	Yes	No
Tieton Dam *Rimrock Lake*	1925	198,000 af	Yes	No
Clear Creek Dam *Clear Lake*	1914	5,300 af		Yes

The water storage facilities are Keechelus, Kachess, Cle Elum, Rimrock, and Bumping Lakes. Clear Lake is also a federal storage dam, but at 5,300 acre-feet of storage, has a negligible effect on irrigation flow supplementation and its use for this purpose would only be considered in an extreme water short year. These five major storage dams only store 30 percent of the average annual total natural runoff. Basin snowpack therefore constitutes an essential natural storage feature and is considered the sixth reservoir.

The five major storage facilities/reservoirs store runoff during the winter and spring/summer seasons for later release to supply irrigation demands during the low flow periods of runoff in the summer/fall seasons. Because the federal storage facilities can store only about one-third of the average annual total natural runoff, the Yakima Project is dependent on the timing of spring and summer snowmelt and rainfall. The early spring/summer natural flow is utilized to supply most river basin demands through June in an average year.

2.3.3 WATER DELIVERY DIVISIONS

The Yakima Project contains six water delivery divisions: Kittitas, Tieton, Roza, Sunnyside, Kennewick, and Waptao[3]. These divisions outline the physical and institutional structures needed to deliver water to different areas in the Yakima basin. Each division is a mixture of federal diversion and carriage facilities, and privately owned distribution facilities. In all water delivery divisions, Reclamation has transferred O&M of federal facilities to an irrigation or reclamation district with water distribution responsibilities in that division. This subsection describes each of these divisions, the entity responsible for their operation, and the federal facilities associated with them.

KITTITAS DIVISION

Construction of the Kittitas Division was initiated in 1925 and completed by 1933. The entire water supply diverted by the Kittitas Reclamation District (KRD) at Easton Diversion Dam is proratable. The Kittitas Division is a complex system of over 330 miles of distribution facilities including canals, siphons, laterals, pumping plants, tunnels, and wasteways. Water is diverted at Easton Dam on the mainstem of the upper Yakima River (RM 202.5, elevation 2170 feet) into the Main Canal, which can carry up to 1,320 cubic feet per second (cfs). The Main Canal carries water for 26.2 miles on the south side of the Yakima River until it bifurcates, becoming the North Branch and the South Branch Canals.

Reclamation transferred O&M responsibilities in the Kittitas Division to the KRD. KRD operates federal facilities to feed water into district-owned canals and laterals; and privately-owned conveyances to deliver project water. Most water deliveries are metered at point-of-

[3] As explained in Chapter 1, the Wapato division is operated and maintained by the BIA and not part of the Proposed Action in this consultation. We discuss it here because it is relevant to understanding baseline conditions in the Yakima Basin.

diversion into a private ditch.[4] In the Kittitas Valley, some water users have water rights to both tributary and project water. As a result of factors such as operational spill (the release of excess water in the canal) and dual (tributary and project) water rights, there is some intermingling of project and tributary water in Big Creek, Little Creek, Taneum, Manastash, Reecer/Currier, Wilson, Naneum, Cook, Caribou, Parke, Johnson, and Wippel/Badger Wasteway. Major operational spills are made at the Wippel Pumping Plant, at the eastern end of the District which returns to Badger Wasteway and eventually the Yakima River.

When excess canal capacity is available (i.e., water demands are low due to crop cycles or weather conditions), KRD transports water in excess of its own irrigation requirements to meet the needs of other entities. For example, KRD transports up to 50 cfs per day for the Cascade Irrigation District. In a cooperative project with Reclamation, KRD transports up to 20 cfs to improve instream flows for fish in Taneum Creek as part of the YRBWEP. Also, KRD transports up to 400 cfs for Reclamation to facilitate the flip-flop operation in the upper Yakima River. This water is delivered from the Main Canal back to the Yakima River at Wasteway 1146.

TIETON DIVISION

Tieton Diversion Dam is located on the Tieton River (RM 14.2, elevation 2282 feet), downstream from Rimrock Reservoir and diverts water into the Tieton Canal. This diversion dam was completed in 1908 and water was first delivered through the main canal in 1910. Tieton Main Canal extends 12 miles from the Tieton Diversion Dam to French Canyon re-regulating reservoir.

In 1986, the Yakima-Tieton Irrigation District (YTID) completed a Rehabilitation and Betterment Project converting nearly all of the original open canal system into a pressurized pipeline delivery system. Part of this project, French Canyon Reservoir is situated on the North Fork of Cowiche Creek and has a 550 acre-feet capacity. It was constructed without fish passage and restricts the migration of anadromous salmonids into the North Fork of Cowiche Creek. The re-regulating reservoir is necessary to allow for fluctuations in water use and to manage water efficiently and creates hydraulic head to pressurize the water delivery system. The Tieton Canal which runs from the Tieton River Diversion Dam to the French Canyon Dam is the only remaining open canal in the Tieton Division distribution system.

Responsibilities for O&M for the Tieton Division have been transferred to the YTID. From French Canyon Reservoir, YTID distributes water through more than 200 miles of buried pipeline to 2,000 turnouts. Because of the closed, pressurized irrigation system, YTID can

[4] The term point of diversion here is used synonymously with "turnout" to refer to the point at which the control of water shifts from an irrigation district to a water user.

deliver water on demand. Six pumping stations maintain pressure in the pipeline system. In addition, YTID also operates Cowiche and Orchard Avenue Hydropower plants under FERC License No. 7337 and 7338 and State DOE Permit No. 256. These are YTID owned powerplants that have a combined capacity to produce 3 megawatts of electricity, and they serve as pressure-reducing stations for the pipeline distribution system.

ROZA

The construction of the Roza facilities began in 1935. In 1941, irrigation water was initially applied to the district and by 1951 most of the system was complete. Irrigation water is diverted at Roza Dam (RM 127.9, elevation 1226 feet) and conveyed via the Roza Canal. For the first 10.9 miles, Roza Canal carries up to 2,200 cfs. At canal-mile 10.9, water is delivered to the Roza Powerplant (operated by Reclamation) for hydroelectric production. Beyond this point, the canal is reduced to carry 1,300 cfs and is totally dedicated to irrigation service.

Responsibilities for O&M for the Roza Division have been transferred to the Roza Irrigation District (RID). In addition to the Roza Canal, RID operates approximately 18 pumping plants and 380 miles of canal laterals. Approximately 2,300 turnouts exist for the delivery of water to lands within the district. RID maintains six wasteways which carry return flows, operational spills, and may act as emergency spillways. In 1958, the RID and the Sunnyside Valley Irrigation District (SVID) entered into separate contracts with Reclamation to construct a system of drain channels.

In 1984, RID implemented a modernization program to improve water delivery service, increase water supply reliability, and meet the needs of rapidly changing cropping patterns. These objectives are being met by the installation of approximately 10 miles per year of enclosed conduit systems, and by the construction of automatic canal control structures and re-regulating reservoirs. To date, approximately 27,000 acres or one-third of the district is served by enclosed conduits.

RID lands are located at higher elevations than lands within the Sunnyside Division. Thus, much of the return flow is captured in the Sunnyside Canal and other irrigation facilities and reused. Return flows are also intermingled with Sunnyside Division return flows. In 1996, the Roza-Sunnyside Board of Joint Control (RSBOJC) was formed with management responsibility over land within both the Roza and Sunnyside Divisions.

SUNNYSIDE

The origin of the Sunnyside Division dates back to 1878, when the Konewock Ditch was constructed near the present day Sunnyside Dam. Initial construction of the Sunnyside Canal began in 1890 in the same location as the Konewock Ditch; the canal was sold to the U.S. Reclamation Service in 1905 and expanded to its present capacity. Sunnyside Canal extends

over 60 miles eastward from Sunnyside Diversion Dam (RM 103.8, elevation 900 feet). The canal has an initial capacity of 1,316 cfs. The canal delivers water to numerous entities, distribution laterals, and individual irrigation deliveries. Operational spills from the Sunnyside Canal discharge to three major wasteways and in turn to the Yakima River: Zillah Wasteway (RM 89.1), Sulphur Wasteway (RM 61.0), and Spring Wasteway (RM 41.8).

The Sunnyside Division is comprised of a number of entities which hold water rights with various priority dates extending back to 1878. Overall, these entities may divert up to 498,576 acre-feet per year, for irrigation, related domestic uses, and hydropower generation for pumping plants. A portion of water rights holders within the Division are subject to prorationing during water short years. The SVID constitutes over 80 percent of the total acreage. The joint use facilities are operated by the SVID.

KENNEWICK

Responsibilities for O&M for the Kennewick Division have been transferred to the Kennewick Irrigation District (KID). KID's water is diverted at Prosser Dam (RM 47.1, elevation 633 feet) into the Chandler Power Canal which has a capacity of 1,500 cfs and is conveyed 11 miles to the Chandler Power and Pumping Plant to meet the irrigation demands of KID; and operate the two hydraulic turbines which pump water through a pipeline that passes beneath the Yakima River to the Main Kennewick Canal. KID's diversions are generally met by return flows rather than storage releases.

KID has a contract with the U.S. dated July 22, 1953 to divert up to 109,275 acre-feet of water from the Yakima River annually. The annual diversion claimed for power for pumping is 136,594 acre-feet; the combined total diversion is 245,869 acre-feet.

The Main Canal has a capacity of 330 cfs and extends for about 24 miles to the Amon Siphon and Wasteway. The Amon Wasteway leads to the confluence of the Yakima and Columbia Rivers. The Badger East (17 miles long) and Badger West (3 miles long) laterals leave the Main Canal at mile 14.5. At the Amon Siphon, the Main Canal splits into the Amon Pump Laterals, the Highlift Canal (3.3 miles long), and the Division IV Canal (18 miles long). The Division IV Canal ends at the Hover Wasteway, which leads to the Columbia River.

WAPATO DIVISION

The Wapato Division is operated and maintained by the BIA. BIA is responsible for the main canals, laterals, drains, and pumping. Laterals of 10 cfs or less usually are maintained by the water users.

2.3.4 POWER FACILITIES

Reclamation developed four hydroelectric powerplants and nine hydraulic pump plants as part of the Yakima Project (Table 2-5). Reclamation operates the Chandler and Roza plants. Yakama Power PUD operates the Drop 2 and Drop 3 plants as part of Wapato Project. The nine federally constructed, direct-connected hydraulic turbine-pump units are operated either by Reclamation or the appropriate irrigation entity. These facilities are described in detail in Section 2.4.3.2 of the IOP. The hydraulic pump plants use a hydraulic turbine to pump water without the use of an electric motor. Of the nine hydraulic pump plants, eight reuse the power tailwater for in-district irrigation purposes (except for a portion of Wippel plant tailwater), and one, the Chandler Pump Plant, releases power tailwater into the Yakima River. For all pump plants, except the Chandler Pump Plant, the power water needed to activate the irrigation pumps is incidental to other irrigation requirements and no separate water right is involved (except part of KRD Wippel Plant); however, the right to use the water for power is expressed or implied along with the diversion right for irrigation.

Table 2-5. Powerplants and pump plants.

Facility	Year Constructed	Operating Entity	Total Power Water Requirement
Chandler Powerplant	1956	Reclamation	-
Chandler Pump Plant	1956	Reclamation	431 cfs
Roza Powerplant	1959	Reclamation	-
Wippel Pump Plant	1932	KRD	275 cfs
Amon Pump Plant	1957	KID	148 cfs
Outlook Pump Plant	1916	Outlook ID	215 cfs
Snipes Mountain Pump Plant	1915	Snipes Mtn ID	130 cfs
Grandview Pump Plant	1917	Grandview ID	35 cfs
Prosser Pump Plant	1919	Prosser ID	25 cfs
Spring Creek Plant	1919	Prosser ID	25 cfs

For many years, the City of Ellensburg operated a hydroelectric generating plant on the Yakima River. Power generating water rights for the operation of the facility were secured by the City in 1902. The use of this generating facility was discontinued in 1957. The City of Ellensburg transferred up to 70 cfs of its power right to the KRD and then converted to municipal and industrial use.

2.3.5 FISH PROTECTION INFRASTRUCTURE

The 1980 Pacific Northwest Electric Power Planning and Conservation Act (Public Law 96-501) created the Northwest Power Planning Council (now the Northwest Power and Conservation Council [NPCC]). The Council was charged with the responsibility to prepare a Regional Conservation and Electric Power Plan and to develop a program to protect, mitigate, and enhance fish and wildlife within the Columbia River Basin and its tributaries.

In 1982, the Council adopted its Fish and Wildlife Program. This program identified measures within the Yakima basin intended to help mitigate hydroelectric impacts in the basin and provide off-site mitigation to compensate for fish losses caused by hydroelectric project development and operations throughout the Columbia River Basin. The Bonneville Power Administration (BPA) was designated as a major source of funding for such off-site mitigation measures and initiated discussions with the appropriate federal project operators and the Council to fund and implement the program.

The installation of fish passage and protective facilities were the first measures to be implemented in the Yakima River basin (Table 2-6). Section 109 of The Hoover Powerplant Act of 1984 authorized the Secretary of the Interior to design, construct, operate, and maintain fish passage facilities within the Yakima River basin. Under Phase I of the program, improvements to existing fish passage facilities and installation of new fish ladders and fish screens at 16 of the largest existing diversion dams and canals began in 1984 and were completed in 1990.

The Phase II fish passage program was an extension of the Phase I program (Table 2-7 and Table 2-8). In 1988, the Yakama Nation submitted an application to amend Sections 803(b) and 1403(4.5) of the NPCC's Columbia River Basin Fish and Wildlife Program to begin preliminary design on the Phase II fish screen program. The Council authorized BPA to provide funding for Phase II screens through the Fish and Wildlife Program. BPA then asked Reclamation to provide engineering and design expertise to the Phase II projects.

Table 2-6. Phase I fish facilities operated and maintained by Reclamation.

Facility	Year in Service	Associated Dam Diverts Contract Water	River Body
Fish Ladders			
Sunnyside Right Bank Fish Ladder	1985	Yes	Yakima River
Naches-Cowiche / Nelson Dam Fish Ladder	1985	Yes	Naches River
Prosser Dam Right Bank Fish Ladder	1986	Yes	Yakima River

Facility	Year in Service	Associated Dam Diverts Contract Water	River Body
Sunnyside Dam Fish Ladders (LB and Center)	1986	Yes	Yakima River
Horn Rapids Dam Fish Ladders	1986	Yes	Yakima River
Wapato Dam East and West Branch Fish Ladders	1987	Yes[1]	Yakima River
Marion Drain Fish Ladders	1988	Yes[1]	Yakima River
Roza Dam Fish Ladder modifications	1988	Yes	Yakima River
Ellensburg Town Dam	1989	Yes	Yakima River
Prosser Center Fish Ladder	1989	Yes	Yakima River
Prosser Left Bank Fish Ladder modifications	1989	Yes	Yakima River
Easton Dam Fish Ladder modifications	1990	Yes	Yakima River
Fish Screens		**Screens Project Water**	
Sunnyside Canal Screen	1985	Yes	Yakima River
Wapato Canal Fish Screen	1986	Yes[1]	Yakima River
Toppenish-Satus Unit Canal Fish Screens	1986	Yes[1]	Toppenish River
Richland Canal Fish Screens	1986	Yes	Yakima River
Columbia Canal Fish Screens	1986	Yes	Yakima River
Chandler Canal Fish Screens	1987	Yes	Yakima River
Toppenish Creek Diversion Fish Screens	1987	No	Toppenish Creek
Roza Canal Fish Screen	1988	Yes	Yakima River
Westside Canal Fish Screen	1988	Yes	Yakima River
Easton / KRD Canal Fish Screens	1989	Yes	Yakima River
Ellensburg Town Canal	1989	Yes	Yakima River
Taneum Canal Company	1989	Yes	Taneum Creek
Knudson Fish Screens	1990	No	Taneum Creek
City of Yakima	1992	Yes	Naches River

Facility	Year in Service	Associated Dam Diverts Contract Water	River Body
Other			
Roza Wasteway Adult Fish Barrier	1987	Yes	Yakima River
Chandler Juvenile Evaluation Facility	1987	NA	Yakima River
Prosser Dam Adult Trapping Facility	1989	NA	Yakima River
Bruton Roughen Stream Channel (replaced phase 1 ladder)	2009	Yes	Taneum Creek
Taneum Canal Company Fishway (replaced phase 1 ladder)	2011	Yes	Taneum Creek

[1] Water diverted for use by the Wapato Irrigation Project is not included as part of the Proposed Action (see Section 1.2). Some of the WIP facilities are using or diverting return flows from the federal project.

Table 2-7. Phase II fish screen facilities operated and maintained by WDFW and Reclamation.

Site	Year In Service	Screens Project Water	River Body
Bull	1997	No	Yakima River side channel
Bull/Wilson	2001	No	Wilson Creek
Clark	1997	No	Naches River
Congdon	1994	No	Naches River
Ellensburg Mill	1997	No	Yakima River
Fogarty	2006	Yes	Yakima River
Fruitvale	1996	No	Naches River
Gleed	1993	No	Naches River
Kelley-Lowry	1994	No	Naches River
Lindsey	1997	No	Naches River
Naches/Selah	1996	Yes	Naches River
Naches-Cowiche	1990	Yes	Naches River
New Cascade	1993	Yes	Yakima River

Site	Year In Service	Screens Project Water	River Body
Old Union	1998	No	Naches River
Packwood	2004	No	Yakima River
Powell/LaFortune	2001	No	Naches River
Selah Moxee	2002	Yes	Yakima River
Snipes-Allen	1993	No	Yakima River
Taylor	1994	No	Yakima River
Union Gap	1997	Yes	Yakima River
Younger	1998	No	Yakima River

Table 2-8. Phase II fish screen facilities operated and maintained by Reclamation.

Site	Year In Service	Screens Project Water	River Body
Bachelor/Hatton	1994	No	Ahtanum Creek
Johncox	1999	No	Ahtanum Creek
Toppenish Pump	1995	Yes[1]	Toppenish Creek
WIP Lower	1993	No	Ahtanum Creek
WIP Upper	1996	No	Ahtanum Creek
Yakima-Tieton	1997	Yes	Tieton River

Key fish facility upgrades over the past decade have included:

- The Yakima-Tieton Diversion Dam fish ladder rebuild in 2007.
- Improvements to the Wapatox fish ladder in 2009.
- Modifications to the Roza roller gate in 2010 to provide surface spill passage over the dam for outmigrating fish.
- Modifications to the Chandler Canal Fish Bypass Outfall in 2011 to reduce potential predation opportunities.

Additionally, to help prevent false attraction into the Sulphur Wasteway, a barrier was installed in 2008. In an effort to improve fish passage into Taneum Creek, Bruton Diversion Dam was removed in 2009 and the fish passage structure at the Taneum Canal Company diversion was retrofitted in 2011.

2.4 ONGOING FEDERAL, STATE, AND PRIVATE ACTIVITIES

2.4.1 ACTIVITIES IMPLEMENTED UNDER YRBWEP AUTHORITIES THAT ARE NOW PART OF THE BASELINE

YRBWEP LAND AND WATER ACQUISITION PROGRAM

YRBWEP Phase II authorized Reclamation to acquire land for securing water rights and habitat improvement. Pursuant to this authority, Reclamation established a Land and Water Acquisition Program. Since 2001, Reclamation has purchased nine properties and their water rights totaling 1,820 acres and 3,873 acre-feet (Table 2-9). These acquisitions are intended to mitigate for the loss of habitat associated with irrigation induced wetlands due to water conservation under YRBWEP's Basin Conservation Program. The 1999 EIS for the YRBWEP program recommended that the YRBWEP program focus on preserving high value wetland and riparian areas and replace lost areas of lower value habitat resulting from the basin water conservation program with acreage in higher value areas (Reclamation 1999, p153). The YRBWEP purchase of properties in key mainstem alluvial reaches and tributaries is aligned with this strategy.

Acquisitions along two Yakima River mainstem reaches in particular target key alluvial areas identified in an ecological and geomorphic investigation of the Yakima River basin with high conservation and restoration potential (Stanford et al. 2002, p. 145). These acquisitions include approximately 600 acres of floodplain habitat in the Union Gap reach and 285 acres in the Kittitas reach.

Stanford et al. (2002, p. 145) emphasized the restoration potential in the Union Gap reach in particular and YRBWEP's purchase of key parcels in this area have advanced a broad-scale, multi-agency effort known as the Gap to Gap Floodplain Restoration and Enhancement Plan (Gap to Gap). Project partners such as the U.S. Army Corps of Engineers, Yakima County, and Washington State Department of Transportation have already implemented floodplain reconnection improvements. These improvements include an expansion of the SR 24 bridge span in 2006, and interior levee removal and levee setback through Reclamation owned properties in 2011 (Anchor QEA 2014, p. 11).

Table 2-9. Summary of YRBWEP land and water acquisitions.

Property Name	County	Date Purchased	Acres	Water Right
Roy	Yakima	November, 2001	434	169 acre-feet/yr 363 acre-feet/yr[1]
McCormack	Yakima	April, 2001	146	60 acre-feet/yr
Gerdes	Yakima	December, 2006	25	120 acre-feet/yr[2]
Greenway	Yakima	April, 2002	68	-
KOA	Yakima	September, 2008	20	20 acre-feet/yr
Wenas (Buchanan)	Yakima	June, 2001	290	888 acre-feet/yr
Mackey	Yakima	June, 2003	139	-
Schaake	Kittitas	August, 2003	285	625 acre-feet/yr
Istvan	Kittitas	September, 1999	39	108 acre-feet/yr
Heart K Ranch	Kittitas	December, 2000	374	1,520 acre-feet/yr
			1,820 acres	**3,873 acre-feet/yr**

[1] Purchased by the Department of Ecology
[2] Water right sold to a private party and Point of Diversion moved downstream to Red Mountain

Habitat improvements already made on YRBWEP properties include native plant revegetation at the Roy, McCormack, and Wenas properties, interior fence removal, and clean-up of existing infrastructure where required.

Reclamation, in partnership with Ecology, purchased the Wapatox Powerplant in 2002 and subsequently transferred the PacifiCorps natural flow Wapatox Power Water Right into an instream water right. The total water right purchased from PacifiCorps amounted to 260,000 acre-feet annually. As part of this purchase, Reclamation supplies irrigation water to existing irrigators served by the Wapatox Diversion (Naches RM 17.1) and conveyance canal. The Wapatox Diversion was not included in the original federal irrigation project. Reclamation has not generated hydroelectric power at the Wapatox Powerplant since the 2002 purchase. The water that was previously diverted for power production is instead left instream, benefiting a 7.4 mile reach in the Naches River.

YRBWEP CONSERVATION PROGRAM

The water conservation program of YRBWEP was established to improve the reliability of water supplies for irrigation and for fish and wildlife protection and enhancement. The act described two goals for conserved water to increase the target flows for the Yakima River below Parker and Prosser, and to "facilitate meeting recommendations of the System

Operations Advisory Committee for flushing flows or other instream uses," [P.L. 103-434, Sec. 1205(a)(4)(A)(i)]. Water savings resulting from the water conservation program are split: two-thirds of the conserved water is for instream flow, while one-third is retained for irrigation. Conserved water is subject to proration at the same level as the original water right. This split of water was not explicitly described in Title XII, but was derived from the context of the legislation and the split in funding.

Since 2004, Reclamation has funded water conservation projects through the YRBWEP program on the Sunnyside Valley Irrigation District (NOAA Fisheries Tracking Nos. 2004/00828, 2009/03983, 2012/01799), the Benton Irrigation District (NOAA Fisheries Tracking No. 2008/03127), and the Roza Irrigation District (NOAA Fisheries Tracking No. NWR-2013-10043). The total quantity of water available for instream needs through these efforts is 53,508 acre-feet. This figure represents the total quantity that will be available at full build-out of the water conservation upgrades and includes a proratable component. As of March 2014, the total quantity of YRBWEP conservation water available is 35,953 acre-feet. This annual total is subject to variation since a portion of this water is proratable.

TRIBUTARY IMPROVEMENT PROJECTS

YRBWEP Phase II authorization also enables Reclamation to implement water enhancement programs in Yakima basin tributaries for fish and wildlife and irrigation needs. Under this authorization, Reclamation has partnered with other entities to significantly improve passage and access into Taneum and Manastash Creeks.

Two water diversions on Taneum Creek, Bruton and Taneum Canal Company Dams were partial barriers to fish migration. Both of these facilities had existing fish ladders that were operated and maintained by Reclamation but required structural improvements to ensure passage throughout the year. The Kittitas Conservation Trust (KCT) obtained a grant to design and construct these improvements. At Bruton Dam, a roughened channel was preferred as this design would provide passage for a variety of life stages and fish species to pass upstream and downstream while still protecting key infrastructure at the site. In order for the roughened channel approach to be implemented, Reclamation facilitated a Bruton-KRD water exchange project to provide water users who were supplied with irrigation water at the Bruton Diversion with KRD water which Reclamation had obtained through the purchase of the Heart K Ranch property on Taneum Creek in 2000. A small quantity of stock water continues to be diverted year round from the Bruton site via an infiltration gallery. In 2009, Bruton Dam was decommissioned and the roughened channel installed by KCT.

The second partial fish passage barrier at Taneum Canal Company was addressed in 2011 when KCT constructed a fish passage channel and modified the diversion dam and headworks. Reclamation provided partial funding for this effort. Additionally, Reclamation joined the Washington Water Trust, Ecology, BPA, the National Fish and Wildlife Foundation and the Yakama Nation to purchase water rights from Taneum Creek and transfer them into the Washington State Trust Water Program. This stock water right purchase increased winter instream flows by 2.8 cfs, a 100 percent increase over 21 miles of stream.

In 2013, Reclamation partnered with Ecology, KRD, Manastash Creek water users, and the Kittitas County Conservation District to convert 3.2 miles of an unlined KRD lateral to a pressured pipeline. This project resulted in instream and out-of-stream benefits with an average of 4 to 5 cfs of conserved water delivered to lower Manastash Creek. As part of this project, Reclamation constructed an additional pipeline and other features to enable the consolidation of several existing water diversions and the remaining diversion dam and fish passage barrier to be removed (NOAA Fisheries Tracking No 2013/9763).

2.4.2 RECLAMATION CONTRACT EXECUTION ACTIONS THAT ARE NOW PART OF THE BASELINE

In 2009, Reclamation entered into a 40-year Water Storage and Exchange Contract with Ecology (09XX101700). Reclamation and Ecology entered into this agreement to provide a mechanism for junior water right holders subject to curtailment and those wishing to establish new groundwater wells in parts of the Yakima basin subject to an exempt well moratorium to secure senior water rights.

The water storage and exchange contract specifies that Reclamation will store and release up to 1,000 acre-feet, annually, of assigned and exchanged water rights for Ecology to provide to third parties. This contract enables Reclamation to store and release senior water which Ecology had purchased and fallowed in the Yakima basin for transfer into the State Trust Water Right Program. The State Trust Water Right Program is a mechanism Ecology uses to legally hold water rights for future uses, while maintaining the original priority date of the right and preventing relinquishment. In 2008, Reclamation informally consulted with the Services on the annual storage and release of up to 1,000 acre-feet of State Trust water for projects where the diversion or well could be mitigated from a source upstream of the point-of-diversion and where the total diversion of the stream reach did not exceed 1 percent of the critical low flow (NOAA Fisheries Tracking No. 2008/01692; USFWS Ref. No. 13260-2008-I-0065). Two supplemental consultations were required for individual exchange projects which did not meet these requirements (NOAA Fisheries Tracking Nos. 2011/02215, NWR-2013-9771; USFWS Ref. Nos. 13260-2011-I-0076, 01EWFW00-2013-I-0378).

In 2014, Reclamation entered into a 40-year three party contract with the YTID and Cowiche Creek Water Users' Association (CCWUA). This contract authorized YTID to utilize available excess capacity in the Tieton Division facilities to deliver non-project water to non-project lands. This contract action enabled CCWUA to change their source of water supply from their historic diversion on Cowiche Creek to the existing YTID diversion on the Tieton River so that up to 7.9 cfs of formerly diverted water remained in Cowiche Creek. As a result of this change in diversion, negative impacts to fish in Cowiche Creek due to diversion dam fish barriers, seasonal dewatering, and unscreened diversions were addressed. As a result of these activities, access has been restored to over 20 miles of habitat. Since BPA was a major funding source of this effort, potential impacts to steelhead were addressed through the Habitat Improvement Program III programmatic biological opinion (NOAA Fisheries Tracking No. 2013/9724). Informal consultation was conducted with USFWS (USFWS Ref. Nos. USFWS Reference 13260-2007-1-0136).

2.4.3 STATE AND NON-PROFIT WATER CONSERVATION

In 2003, Washington State initiated Washington Water Acquisition Program. This program enables water to be acquired from voluntary participants to increase streamflows in the upper Yakima, Naches, lower Yakima basins, and 13 other basins outside of the Action Area. These basins were selected by Washington State because low flows were a known limiting factor for salmon populations. State agencies involved include the Departments of Ecology, Fish and Wildlife, and Washington Conservation Commission. Under this program, state and federal funds acquire or lease water rights for instream use. Water can also be donated on a permanent or temporary basis. All water obtained through the program is returned to the creeks, streams, and rivers where it was originally withdrawn. Program sponsors have developed criteria and guidance to help ensure water-right acquisitions receive fair market value and are targeted in areas that will most benefit fish.

Private conservation groups such as the Washington Water Trust and the Washington Water Project of Trout Unlimited have been actively purchasing or leasing water rights to improve instream flow in the Yakima River basin. These groups depend on a variety of public and private funding to acquire property, reduce development intensity, or prevent development altogether. Currently, 898 acre-feet of water rights have been purchased for permanent instream flow protections, and 1,123 acre-feet of water rights have been leased. Another 1,282 acre-feet of water rights have been purchased for water bank purposes to offset new groundwater development.

2.4.4 INTEGRATED PLAN EARLY IMPLEMENTATION ACTIVITIES BY PARTNER AGENCIES

Reclamation requires new Congressional Authorization to implement any Integrated Plan elements which are not included in existing authorization. However, given the scope of the Integrated Plan in providing direction for improved water management, various other entities are able to implement plan components. The Washington State Legislature has passed a Capital Budget (ESSB 5035) and the Yakima Policy "Water, Jobs, and Fish" Bill (2SSB 5367) which enables, authorizes, and funds Washington State Agencies to implement early actions associated with this plan. Early implementation efforts advanced by the state include the purchase of 50,000 acres of private forest land in the Teanaway watershed, the establishment of a Water Supply Facility Permit and Funding Milestone for 214,000 acre-feet of additional water supply, and provides funding for the state's portion of implementation cost for the 2013-2015 biennium. Water storage and water supply infrastructure improvements of the federal Yakima Project will undergo separate ESA consultation. Finally, the Washington State Capital Budget provided implementation funding for projects addressing the habitat/watershed protection and enhanced water conservation Integrated Plan elements.

2.4.5 FISH RECOVERY EFFORTS

RECOVERY PLANNING

Section 4(f) of the ESA requires that NOAA Fisheries and USFWS prepare recovery plans for each listed species, unless such a plan would not promote conservation of the species. In preparing the recovery plan for MCR steelhead, NOAA Fisheries initiated a collaborative process to involve local communities, state, Tribal, federal entities, and other stakeholders (NOAA Fisheries 2009, p. ES iv). The Yakima Basin Fish and Wildlife Recovery board worked with NOAA Fisheries and other entities to write the 2009 Steelhead Recovery Plan. This locally written plan was formally incorporated into the Middle Columbia Steelhead ESA Recovery Plan.

In 2002, the USFWS released a Draft Bull Trout Recovery Plan. Finalization of this plan was deferred while a 5-year status review was underway. This status review was completed in 2008 and the USFWS provided a public review Draft Bull Trout Recovery Plan on September 3, 2014.

SALMON RECOVERY FUNDING BOARD

After the listing of Columbia River and Puget Sound stocks under the ESA, the Governor and State Legislature passed the Salmon Recovery Act of 1998. This created the statewide Salmon Recovery Funding Board (SRFB) and tasked it with funding habitat improvement projects with state appropriations and Washington's portion of the Federal Pacific Coastal Salmon Recovery Fund administered by NOAA Fisheries. Washington's Recreation and Conservation Office administers the SRFB and its funding programs. The Salmon Recovery Act also called for creating Lead Entities, local organizations that work at a watershed scale to prioritize and propose projects for SRFB funding and operate with technical and financial support from WDFW. The Yakima Basin Fish & Wildlife Recovery Board is under contract with WDFW to act as the Lead Entity for the Yakima basin.

Each year, Yakima Basin Fish & Wildlife Recovery Board solicits SRFB proposals from potential project sponsors in the basin, convenes technical and citizen's committees to review and prioritize the proposals, and submits a list of recommended projects to the SRFB. Between 1999 and 2013, the SRFB has provided a total of $12.5 million for 82 fish habitat projects in the Yakima basin (YBFWRB 2013). These include acquisitions of key fish habitat, projects to improve fish passage at road crossings and irrigation diversions, and projects that improve riparian and floodplain function. Priorities are guided by the Yakima Watershed Salmon Recovery Strategy, and since 2006, the Yakima Subbasin Salmon Recovery Plan.

COMMUNITY SALMON FUND

The Community Salmon Fund (CSF) was a partnership between the National Fish & Wildlife Foundation and the SRFB. This funding source targeted smaller projects that emphasized community involvement in fish habitat restoration projects. Between 2005 and 2010, the CSF provided a total of $536,269 for 15 projects within the Yakima basin (YBFWRB 2013).

2.4.6 BONNEVILLE POWER ADMINISTRATION AND THE NORTHWEST POWER & CONSERVATION COUNCIL

As described in Section 2.3.5, the BPA funds projects in the Yakima basin to offset the impact of Columbia River dams on fish and wildlife. In addition to funding providing for fish screening efforts under YRBWEP Phase 1 and II, BPA provides support to the Yakima Tributary Access and Habitat Program (YTAHP), Yakima/Klickitat Fisheries Program, and Yakima basin habitat enhancement work by a variety of project sponsors (YBFWRB 2013).

YAKIMA/KLICKITAT FISHERIES PROJECT

The Yakima/Klickitat Fisheries Project (YKFP) is a joint project of the Yakama Nation and WDFW, and is sponsored in large part by BPA with oversight and guidance from the NPCC. The YKFP is committed to salmon reintroduction through supplementation and habitat protection and restoration. It is designed to use artificial propagation in an attempt to maintain or increase natural production while maintaining long-term fitness of the target population and keeping ecological and genetic impacts to non-target species within specified limits. The YKFP is also designed to provide harvest opportunities. The purposes of the YKFP are to enhance stocks of anadromous fish in the Yakima and Klickitat River basins while maintaining genetic resources; reintroduce stocks formerly present in the basins; and apply knowledge gained about supplementation throughout the Columbia River Basin.

Species currently being enhanced by the YKFP and the Yakama Nation Fisheries Program include spring, summer, and fall Chinook salmon, coho salmon, sockeye salmon, and steelhead trout (via kelt reconditioning) (Sampson et al. 2013). Since 1983, the fall Chinook run has consisted of hatchery-origin fish from the Prosser Hatchery. In 2009, the Yakama Nation began releasing Wells Hatchery summer-run Chinook in order to increase the temporal and spatial distribution of summer/fall run Chinook. Upper Yakima spring Chinook supplementation has been occurring since 1997. Substantial numbers of hatchery-reared coho have been released since the 1980s, but with the inception of the YKFP in 1996, the coho program has focused on reestablishing a naturally spawning population and releases were moved to more suitable habitats. Since 2005, the Yakama Nation has been conducting an interim fish reintroduction program at Cle Elum Reservoir. As part of this re-introduction effort, adult sockeye have been transported upstream of the dam annually since 2009, coho parr and smolts since 2005, and spring Chinook adult and jacks in 2012 and 2013 (Reclamation and Ecology 2014). Anadromous fish can currently migrate out of the reservoir utilizing interim outmigration fish passage facilities.

YAKIMA TRIBUTARY ACCESS AND HABITAT PROGRAM

The YTAHP is a multiparty effort to restore fish passage to Yakima River tributaries that historically supported salmon and to improve habitat in areas where fish access is restored. Projects funded through YTAHP are primarily fish screening and fish passage improvements, but also include riparian plantings, fencing, and irrigation systems improvements that improve fish habitat conditions. BPA has funded the program since 2001, with additional funding for individual projects coming from BPA and other sources, including the SRFB, Ecology's Water Infrastructure Program, the Community Salmon Fund, and other local, state, and federal programs. Funded participants include Kittitas and North Yakima County Conservation Districts, WDFW, Yakama Nation, and South Central Washington Resource Conservation and Development. Other partners include the Kittitas Conservation Trust, Mid-Columbia Regional Fisheries Enhancement Group, Benton Conservation District, Yakima Basin Joint Board, and Ecology.

YAKIMA RIVER SIDE CHANNELS PROJECT

The Yakima River Side Channels Project was initiated in 1997 and has been approved for BPA funding through 2017. This program has been supported through the Fish and Wildlife Program administered by BPA and has received expanded funding through the Accords Agreement between BPA and the Yakama Nation. Objectives include habitat protection and restoration in the most productive reaches of the Yakima River basin. The geographic focus includes Easton, Ellensburg, Selah, and Union Gap reaches on the Yakima River and the Gleed reach in the lower Naches River, with some recent activities in productive tributaries, including Taneum, Reecer, and Swauk Creeks. The mainstem areas were identified through the Reaches Project (Stanford et al. 2002). Active habitat restoration actions include reconnecting structurally diverse alcoves and side channels, introducing large woody debris (LWD), fencing, and revegetating riparian areas. Over 1800 acres have been permanently protected. Much of this work has been done through collaboration and cost share with other entities, including Washington Water Trust, Mid Columbia Fish Enhancement Group, Washington Department of Fish and Wildlife, Kittitas Conservation Trust, and Forterra.

2.4.7 POPULATION GROWTH AND ASSOCIATED DEVELOPMENT

The population in the basin is projected to increase 1 to 1.5 percent annually through 2060 (YRBWEP 2013). The populations of the Yakima Project area are shown in Table 2-10.

Table 2-10. Estimated 2014 population of the counties in the Yakima Project Area (Census 2014).

County	Population	Percent Change 2010-2014
Benton	186,486	6.5%
Kittitas	42,522	3.9%
Klickitat	20,861	2.7%
Yakima	247,687	1.8%

LAND USE REGULATIONS

FEDERAL

The Federal Government controls and manages a substantial portion of the land in the Project Area, including forests and rangelands. Federal activities on these lands are not subject to state and local laws and regulations.

The five storage reservoirs are within National Forest lands and the U.S. Forest Service manages recreation at these sites. The National Forest Management Act requires every national forest or grassland managed by the U.S. Forest Service to develop and maintain a Land Management Plan (also known as a Forest Plan).

STATE AND LOCAL

The Washington State Legislature passed the Shoreline Management Act (SMA) in 1971 and Growth Management Act (GMA) in 1990. The GMA requires local governments to plan for and manage population growth by identifying and protecting critical areas and natural resources lands, designating urban growth areas, and preparing and implementing comprehensive plans. The SMA aims to prevent uncoordinated and piecemeal development of the state's shorelines. The SMA requires jurisdictions with shorelines of the state to prepare shoreline master programs. These programs must be approved by Ecology and are intended to protect shoreline ecology, public access, and water-dependent uses and to require mitigation of impacts where appropriate.

Forest practices on all non-federal and non-Tribal lands in Washington are regulated by means of the Forest Practices Act (Chapter 76.09 RCW). The Washington Forest Practices Board (Board) governs the industry to protect the state's public resources while maintaining a viable timber industry. The rules adopted by the Board are implemented and enforced by the Washington Department of Natural Resources. These rules require the maintenance and restoration of aquatic and riparian habitat. Through the Forest Practices Habitat Conservation Plan, the State of Washington seeks to provide long-term conservation of covered species, support an economically viable timber industry, and create regulatory stability for landowners.

FLOOD HAZARD MANAGEMENT

As part of its Comprehensive Flood Hazard Management Plans, the Yakima County Flood Control Zone District (Yakima Flood District) is advancing floodplain restoration projects that reduce flood risk and provide habitat restoration. These projects are identified in three Comprehensive Flood Hazard Management Plans (CFHMPs). The upper Yakima CFHMP encompasses the floodplain of the Yakima River from the mouth of Yakima Canyon to Union Gap and the Naches River from its mouth to Twin Bridges. Actions currently being implemented under the CFHMP include floodplain restoration projects at several locations in the lower Naches River and in the Gap to Gap reach of the Yakima River through partnerships (Section 2.4.1). Reclamation acquisitions in this reach under its YRBWEP authority have been crucial for advancing floodplain connectivity work in this area. Full implementation of the Gap to Gap would restore channel floodplain connectivity and reduce flood hazards along approximately 5 miles of the Yakima River.

The Naches River CFHMP was completed in 2005, while the Ahtanum – Wide Hollow CFHMP was completed in 2011. The Yakima Flood District plans to develop a CFHMP for the lower Yakima River in cooperation with the Yakama Nation.

In 2012, Kittitas County Board of County Commissioners formed the Kittitas County Flood Control Zone District (KCFCZD) and county voters subsequently approved funding. The KCFCZD boundaries include Kittitas County and all incorporated areas. This district has been charged with updating the 1996 Comprehensive Flood Hazard Management Plan and using this plan to determine which projects should be implemented.

TRANSPORTATION

The Washington State Department of Transportation (WSDOT) has various programs focused on meeting its stewardship goals of avoiding and minimizing environmental and habitat disturbance associated with its road projects. Ongoing projects include wetlands mitigation, maintenance of habitat connectivity, and fish passage restoration. In Yakima and Kittitas Counties, WSDOT has funded over $2 million for fish passage barrier projects. The WSDOT 10-year fish passage project funding plan (2007 to 2019) includes funding for a project at Silver Creek, along Interstate 90 at mile post 70.9. Through its habitat connectivity and wetlands mitigation programs, WSDOT contributes funding to the Cascade Land Conservancy, the Kittitas Conservation Trust, YKFP, and other entities for land acquisition and conservation easements aimed at maintaining wildlife movement corridors and improving floodplain habitat function. WSDOT also funds restoration projects through its Chronic Environmental Deficiencies Program which identifies areas of state highways that are subject to chronic repair needs associated with impacts from stream channel erosion and flooding.

2.4.8 WATER QUALITY – TMDL DEVELOPMENT AND IMPLEMENTATION

In accordance with Section 303(d) of the Clean Water Act, every two years the state must identify its polluted water bodies and the type of pollution contaminating them and submit this list to Environmental Protection Agency (EPA). In 2010, the state updated the list of impaired streams and rivers in the Yakima subbasin. Impaired water bodies within the Action Area are identified in Section 4.3.1. Ecology has initiated or completed Total Maximum Daily Load (TMDL) plans for the Granger Drain (sediment), the Teanaway River (temperature), the lower Yakima River (sediment and DDT), the upper Yakima River (sediment and organochlorines), Wilson Creek (sediment), and Naches (temperature). In June 2014, Ecology released a Draft Upper Yakima River Tributary TMDL Water Quality Improvement Report and Implementation Plan. With cooperation from irrigation districts, agricultural organizations, other state and federal agencies, and local governments,

implementation of these TMDL plans has resulted in dramatic decreases in pollutant loading in both upper and lower Yakima River. Ecology also funds water quality projects through its 319 and Centennial Water Quality grants program.

2.4.9 AGRICULTURAL ACTIVITIES

The Yakima basin is a major contributor to Washington's agricultural economy, accounting for an estimated $3.2 billion of the state's crops and food processing industries (YRBWEP 2013). Major crops by acreage are orchard fruit, hay/silage, and wine grapes (Table 2-11). Other common basin crops include cereal grains, hops, vegetables, and mint. As suggested by the district breakdown of major crops, agricultural production varies on a geographic scale and is influenced by climate, soil conditions, and water availability.

Table 2-11. Major crops (in acres) by district from 2002-2008 based on WSDA data (HDR and Anchor 2011a).

Crop Group	KRD	ROZA	SVID	YTID	KID	Total
Orchard	527	26,034	8,120	15,248	1,998	**51,927**
Hay/Silage	24,661	3,739	8,618	900	1,502	**39,420**
Cereal Grain	2,413	3,749	11,864	16	1,168	**19,210**
Vineyard	9	18,865	11,397	7	1,973	**32,251**
Hops	0	2,789	5,452	0	0	**8,241**
Non-Crop	9,320	224	587	220	686	**11,037**
Vegetable	976	906	1,612	0	840	**4,334**
Mint	0	108	887	0	0	**995**
Other	639	3,622	2,733	592	502	**8,088**
Total	**38,545**	**60,036**	**51,270**	**16,983**	**8,669**	**175,503**

The largest use of water in the basin is agriculture, primarily supplied by the Yakima Project operated by Reclamation (HDR and Anchor 2011a). Smaller quantities of agricultural water are supplied from non-federal water diversions and wells (HDR and Anchor 2011a, p. 31). Total diversions have declined over the past 60 years, most likely caused by conservation practices (e.g., lining or piping canals, installing automated gates on irrigation canals, and installing high efficiency sprinkler systems), cropping and land-use factors, and changes in operations of the Yakima Project to improve instream flow. Irrigation technique is currently variable across irrigation districts (Table 2-12).

Table 2-12. Yakima Project irrigation techniques by District – WSDA data (in acres) (HDR and Anchor 2011a).

Irrigation Type	KRD	Roza	SVID	YTID	KID
Rill	25,817 (67.0%)	4,280 (7.1%)	16,960 (33.1%)	205 (1.2%)	179 (2.1%)
Sprinkler	885 (2.3%)	34,104 (56.8%)	15,929 (31.1%)	15,587 (91.8%)	2,740 (31.6%)
Drip	183 (0.5%)	13,697 (22.8%)	5,328 (10.4%)	354 (2.1%)	2,098 (24.2%)
Wheel Line	3,172 (8.2%)	2,889 (4.8%)	6,533 (12.7%)	456 (2.7%)	319 (3.7%)
Center Pivot	4,034 (10.5%)	3,597 (6.0%)	5,482 (10.7%)	0 (0.0%)	2,828 (32.6%)
Other	4,453 (11.6%)	1,469 (2.4%)	1,038 (2.0%)	382 (2.2%)	506 (5.8%)

Along with economic losses, droughts limit the crops that can be grown and cause conflicts over water use for municipal growth and development in the basin.

The potential effects of climate change on water needs with respect to evapotranspiration needs of plants under current and future conditions was projected to increase in the Yakima Project irrigation districts approximately 9 percent or approximately 95,000 acre-feet per year (HDR and Anchor 2011b). That estimate assumes current cropping patterns will continue in the future and does not consider farmers who may plant different crops in response to climate change. The estimate also assumes a full water supply is available for all currently irrigated crops; in drought years less water would be available and the increase in consumptive use would be less.

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Chapter 3 Proposed Action

The Proposed Action is the continued O&M of Reclamation project facilities in the Yakima River basin, collectively referred to as the Yakima Project.

This section describes the Proposed Action in detail, and identifies any operational changes, facility maintenance, and other actions necessary to facilitate project objectives and fulfill Reclamations obligations under Section 7 of the ESA. To begin, this section provides background on the scope, purpose, and nondiscretionary requirements applicable to the Proposed Action. Section 3.1 describes water management activities. Section 3.2 describes the O&M of specific facilities. Section 3.3 describes YRBWEP property management and Section 3.4 the conservation actions to reduce adverse effects to steelhead and bull trout. Interrelated and Interdependent Activities are reviewed in Section 3.5. Section 3.6 provides a review of activities not addressed though this consultation.

The purpose of the Proposed Action is to continue to operate the Yakima Project for irrigation, flood control, fish and wildlife, power production, recreation, and municipal and industrial purposes in a manner consistent with existing legal and institutional constraints such as water rights, contracts and other non-discretionary agreements or obligations; and maintain Yakima Project facilities in efficient working order.

The scope of the Proposed Action is limited to the O&M of the Yakima Project, excluding the Wapato Division. Project O&M involves those discretionary and non-discretionary actions taken by Reclamation or by contractors on Reclamation's behalf to achieve a project's authorized purposes within the scope established by federal reclamation law and state water law, contracts, and other non-discretionary requirements or obligations. Generally, these requirements operate in a comprehensive scheme to provide public benefits while assuring repayment of the capital costs of a reclamation project.

The general design, location, duration, and timing of activities that comprise the Proposed Action appear in two types of documents and are incorporated by reference. First, the IOP describes how Reclamation manages water supplies to fulfill the authorized purposes of the Yakima Project (Reclamation 2002). Reclamation operations have evolved within the scope of the IOP. Second, facility specific SOPs describe requirements for the operation of a specific facility.

Reclamation's role in O&M differs from facility to facility. At reserved works, Reclamation is physically responsible for the O&M of the facility. Reclamation may also transfer O&M responsibility to another entity, typically an irrigation district through a contract. These facilities are typically referred to as transferred works. In the Yakima Project, reserved works include the Storage Division; the Roza and Chandler Division works associated with power generation, and associated fish facilities (see Table 2-2). At these locations, Reclamation directly manages storage and delivery, and diversion activities for power generation. Responsibility for O&M for the remaining federal diversion, conveyance, and power facilities have been transferred to one of six irrigation districts. A number of fish protection facilities throughout the basin were constructed under YRBWEP authorization. As described in further detail in Section 2.3.5 of this document, at these fish ladders and screens, Reclamation is either directly involved in the O&M of the facilities, or shares O&M responsibilities. Similarly, at present, Reclamation operates and maintains the Wapatox Diversion and associated canal due to its purchase of the Wapatox water right under YRBWEP.

3.1 Water Management

3.1.1 Operational Overview

Reclamation operates the Yakima Project to meet specific purposes: irrigation water supply, instream flows for fish, and flood control. Hydroelectric power is produced incidentally to other project purposes. Reservoir storage releases are not made to meet hydroelectric power demand and, at times, power subordination is implemented in order to meet instream flow requirements. Recreational needs are considered, but are incidental to other project purposes.

Reclamation supplies total system demands through a combination of stored water releases, unregulated tributary flows (natural flow), bypassed reservoir inflow, and return flows from Yakima Project irrigation divisions and non-Yakima Project irrigation entities. The total average annual demand in non-drought years for all basin water users upstream of the Parker gage is about 2.4 million acre-feet, with about 1.7 million acre-feet supplied to the federal diversions (Period of Record 1990-2009, HDR and Anchor 2011a, p.6). This water amount does not include instream flows that are supplied out of storage; such is the Title XII flows. Total active storage in the Yakima Project reservoirs is slightly over 1 million acre-feet. The remainder of the system demand is supplied through unregulated tributary flow, bypassed reservoir inflows, and return flows. Irrigation return flows are an important component of water management in the Yakima River basin. During summer and fall, return flows can contribute significantly to the flow of the Yakima River in certain reaches, as well as to flow in a number of tributaries (Rinella et al. 1992). Thus, roughly only one-third of the basin irrigation demand is met through reservoir storage controlled by Reclamation; this partly explains why operation of the river is complex and difficult and why demands cannot always

be met in years of below average runoff. Since demands cannot always be met in years of below average runoff, a system of prorationing is used. Prorationing describes the process of equally reducing the amount of water delivered to junior ("proratable") water right holders in water deficient years.

The water storage facilities used to supplement unregulated flow from the Yakima River are Keechelus, Kachess, Cle Elum, Rimrock, and Bumping Lakes. Clear Lake is also a federal storage dam, but at 5,300 acre-feet of storage, has a negligible effect on irrigation flow supplementation and its use for this purpose would only be considered in an extreme water short year. These five major storage dams only store 30 percent of the average annual total natural runoff. Basin snowpack therefore constitutes an essential natural storage feature and is considered the sixth reservoir.

The timing and quantity of reservoir releases are shaped in large part by irrigation needs, fishery flows, flood control releases, and management of conserved and acquired water for instream flow purposes. These key considerations and constraints and their influence on reservoir operations is described in Section 3.1.2. A more comprehensive reservoir by reservoir description of filling and release considerations and resulting patterns is provided in the IOP (Reclamation 2002, p 5-53 to 5-59).

Decision-making and Communication

The Yakima Field Office Manager is responsible for Reclamation's operational control and management of the TWSA for the Yakima River basin. Each year, in light of the annual prevailing conditions and all current legal considerations, the Yakima Field Office Manager informs concerned parties about operational considerations and anticipated outcomes. The Yakima Field Office Manager maintains contact with the different groups to ensure continuity as the year's operation evolves. Opportunities for communication and feedback include SOAC's meetings for fishery-related issues, River Operations monthly meetings for all interested parties, and the Field Office Managers' attendance at monthly Joint Board meetings for the irrigation district managers.

Total Water Supply Available and Forecasting

Reclamation will continue to use TWSA to determine the amount of water available for irrigation use and certain fisheries related flows. TWSA is defined in the 1945 Consent Decree as "That amount of water available in any year from natural flow of the Yakima River, and its tributaries, from storage in the various Government reservoirs on the Yakima watershed and from other sources, to supply the contract obligations of the U. S. to deliver water and to supply claimed rights to the use of water on the Yakima River and its tributaries, heretofore recognized by the United States."

Reclamation interprets the TWSA definition provided in the 1945 Consent Decree to mean the TWSA for the Yakima River basin above Parker Gage (PARW, located below Union Gap and the Sunnyside Diversion Dam), for the period April through September, expressed in a mathematical formula, reading as follows:

	April 1 through July 31 forecast of runoff
+	August 1 through September 30 projected runoff
+	April 1 reservoir storage contents
+	Usable return flow upstream of the Parker gage
=	TWSA

TWSA provides an estimated total water volume available for use in determining the Title XII instream flow targets (see "Title XII Flows" in Section 3.1.2).

Return flow resulting from irrigation diversions above Sunnyside Dam are an integral part of the TWSA estimate. The return flow depends on the quantity and location of diversion and loss, which is also controlled by amount, time, and availability of runoff. The return flow will vary from year to year, but the usable portion is a fairly uniform base flow that is generated by fairly stable upstream diversion rates. The return flow volume projected to be usable is 400,000 acre-feet in high runoff years, 375,000 acre-feet in average years, and 350,000 acre-feet in low runoff years.

Annual unregulated flow of the Yakima River basin near Parker ranges from 1.5 million acre-feet (MAF) to 5.6 MAF, with an average of 3.4 MAF. Total storage in the basin is a little over 1 MAF. As the average basin water use totals approximately 2.4 MAF, demand cannot always be met in years of below average runoff. Project operations make use of a monthly forecasting process to provide an advanced indication of water availability. Each year, Reclamation develops monthly runoff forecasts beginning in January and typically ending in July. Early forecasts (January and February) are primarily used in flood-control and winter flow operations. By March, forecasts become more suitable for TWSA estimation. The forecasts are made for anticipated precipitation levels of 50 percent, 100 percent, and 150 percent of normal. On a daily basis, the project must take into account varying weather conditions, water demand, travel time of the flow from the reservoirs to the point of use, inflow from unregulated tributaries, return flow, and other factors to maintain appropriate flow levels at several control points (generally gaging station locations) in the basin.

The Adjudication court has verified Reclamation's operational control of the TWSA in meeting its contract/water right and treaty trust water right obligations. Interim jurisdiction of water rights rests with the court at least until completion of the Adjudication. Many of the

project water rights are held in the name of the U.S. on behalf of the water user entity, and treaty trust rights are also held by the U.S. Interest is determined by law, settlement, agreement, and court order. Additionally, the Court has confirmed rights for specific federal uses.

For determining the TWSA, Reclamation recognizes and limits diversion entitlements to adjudicated water rights. Many of those rights had their basis in Limiting Agreements, water delivery contracts between the U.S. and water user entities, and amounts set forth in the 1945 Consent Decree. During non-prorated water years, unused TWSA irrigation entitlements are not carried over to the next month's TWSA entitlements for that entity. The water supply not used from these entitlements is rolled into the next TWSA supply forecast for re-allocation to supply the demands of the river basin during the remaining months of the water supply period.

Reclamation uses runoff forecasts for TWSA analysis, to determine flood control space, and to set fish specific target flows. Runoff forecasts are made for the five major reservoirs. A number of different models are utilized for forecasting. Modeling approaches both incorporate contingency forecasts by considering a range of potential precipitation inputs and take prevailing weather outlooks into account.

3.1.2 Key Considerations and Constraints

In the most general terms, project operations are geared at storing water outside the irrigation season (roughly mid-October to mid-March), for use in the irrigation season. However, operations during the preceding year can have possible ramifications for water supply in a given year. Therefore, Reclamation has identified a 15-month operational year. Within this scheme, Reclamation has divided system operations into four general time segments which generally correspond with seasons of the year (Figure 3-1). Reclamation then lists key considerations and constraints associated with each operational time period. A full accounting and description of these considerations and constraints organized by hydrologic season is found in Section 5.1 of the IOP (Reclamation 2002). In this BA, we describe key considerations and constraints which affect Reclamation's discretion and have shaped project operations under the Proposed Action.

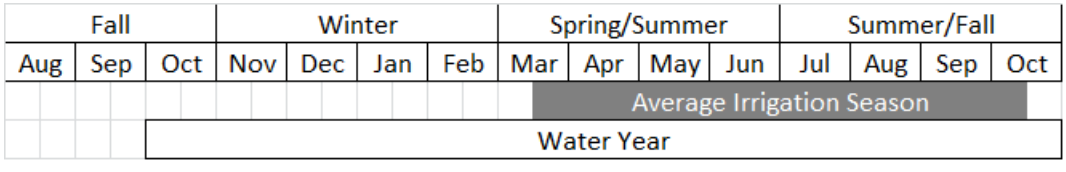

Figure 3-1. Operating periods and season in the Yakima River basin 15-month operation year.

Facility Limitations

Facility limitations are the physical limits at which Reclamation can safely operate a facility. At storage facilities, facility considerations constrain operations through limits on the volume of storage, and minimum and maximum release capacities at different reservoir elevations. The outlet works on all the storage dams are a bottom-draw configuration. Consequently, facility limitations constrain Reclamation's ability to control water quantity and quality through the operation of a facility. Facility limitations can also play an important role in determining minimum flows available from a storage dam during inspection and maintenance activities. Table 3-1 provides a brief summary of the overall range of storage capacities and discharge capabilities. Importantly, the actual discharge capacity at any time depends on other factors such as pool elevation. More detailed facility descriptions and limitations appear in Section 5.3 of the IOP and are incorporated by reference.

Table 3-1. Storage capacities and discharge capabilities.

Dam	Capacity (acre-feet)	Outlet Works Maximum Discharge (cfs)	Minimum Potential Discharge (cfs)	Spillway Capacity at specified elevation
Keechelus	157,800	3,000	15	8,000 cfs at 2520.9 ft.
Kachess	239,000	3,690	35	4,000 cfs at 2262.0 ft.
Cle Elum	436,900	4,600	45 (at full pool)	~40,000 cfs at 2240.0 ft.
Bumping	33,970	1,140	20-50	3,400 cfs at 3429.0 ft.
Tieton	198,000	2,760	15	45,700 at 2928.0 ft.

Stored Water Location Relative to Diversion

While no one reservoir is designated to supply the needs of one particular area, irrigation district, or division, the general location of each reservoir in relation to a particular diversion point affects the potential source of stored water. Stored water supplied to KRD can only be served by water releases out of Keechelus and Kachess. Likewise, stored water supplied to YTID is provided by releases from Rimrock Reservoir. In general, Kachess and Keechelus are an important source of water for demands from Easton Dam to Sunnyside Dam. Cle Elum is the largest storage facility in the system; therefore, a main resource for meeting the large irrigation demands in the lower basin. Bumping Reservoir is primarily used to supplement water supply for demands in the upper Naches River during summer months. Downstream of PARW, irrigation demands are met through usable return flows.

Flood Control

The Yakima Field Office uses the Yribar Flood Control Rule Curve, dated February 25, 1974, as the main guide curve in influencing the flood control and refill strategy for the Yakima Project along with internal guidance (Schramm 1995). Key considerations in the Flood Control Rule are reservoir elevation, inflow rates, and the time of year. When water needs to be vacated for flood control purposes, Reclamation communicates with SOAC and water users to determine if this water can be used to benefit outmigration flows, hydropower, or irrigation purposes.

Reclamation exercises discretion to carefully fill above the flood control curve for short durations on a case-by-case basis depending on an evaluation of the flood risk. It will be based on the current snowpack, the time of year, the weather outlook (forecasts and trends), as well as other considerations.

During the winter months, November through February, the flood guide seeks to maintain 300 thousand acre-feet (KAF) of unfilled storage space to provide protection against a winter flood event before the spring forecasts become available. The 300 KAF of system storage space is distributed as follows: Keechelus (39 KAF) 13 percent, Kachess (36 KAF) 12 percent, Cle Elum (126 KAF) 42 percent, Bumping (39 KAF, not obtainable, normally 20 KAF) 13 percent, and Rimrock (60 KAF) 20 percent. From March 1st though June 30th, the flood guide requires variable system storage space of 0 to 850,000 acre-feet to be available, depending on forecasted runoff. The spring/summer storage space distribution is based on the same percentages as described above.

Carryover

During the summer/fall period of operations, it is desirable to maximize storage carryover by the end of irrigation season (October 21). The Yakima storage system is designed only to store the current year's spring/summer runoff and deliver it to meet irrigation demands in July through October. If there is only minimal storage (52 KAF) left on October 21, then the winter and spring/summer periods of operation require a tighter control over the reservoir releases, resulting in lower flows. As illustrated in the example provided in Section 5.4 of the IOP, maximized storage carryover helps to ease those operations and meet demands during a dry year. Entities do not have carryover storage rights as all carryover from one year to the next is considered to be a part of the TWSA for the subsequent year.

Management of YRBWEP Water

YRBWEP legislation has made water available through three mechanisms: 1) target instream flows at Sunnyside and Prosser Dams (Title XII flows), 2) conserved water, and 3) water purchased and leased for instream use. Once water has been acquired through YRBWEP authorities, its management becomes part of Yakima Project operations.

Title XII Flows

YRBWEP's Title XII legislation established minimum flow instream targets downstream from Sunnyside (gaging station PARW) and Prosser (gaging station YRPW) Dams. These flow targets range from 300 cfs to 600 cfs, depending on the estimate of TWSA (Table 3-2). Per YRBWEP legislation, these target flows are not instantaneous flows to be uniformly maintained at all times, but are subject to reasonable fluctuations due to project operations. However, for any period exceeding 24 hours, flows at PARW cannot decrease to less than 65 percent of the target flow; and the flows at YRPW cannot decrease by more than 50 cfs from the target flow.

As displayed in Table 3-2, the Title XII legislation established minimum instream targets from April through September. In its operations, Reclamation provides the Title XII flows through the end of the irrigation season, which generally ends on October 20. In water short years, the October TWSA may be calculated.

Table 3-2. Title XII streamflow targets based on TWSA.

TWSA (million acre-feet)				**Parker and Prosser flows (cfs)**
Apr - Sept	**May - Sept**	**June - Sept**	**July - Sept**	
3.2	2.9	2.4	1.9	600
2.9	2.65	2.2	1.2	500
2.65	2.4	2.0	1.5	400
Less than above TWSA				300

Conserved Water

When Reclamation funds a water conservation project through YRBWEP, Reclamation enters into a diversion-reduction agreement with the irrigation district in order to account for the water savings attributed to the project. Conserved water is then split so that two-thirds of the conserved water is dedicated to instream flow, while the remaining one-third is retained by the district for irrigation. This split is derived from YRBWEP's Title XII legislation. Since conserved water reserved for irrigation purposes cannot be applied to new lands per the YRBWEP legislation, this water typically is not used during years with full water entitlement. This unused water contributes to carryover storage in the reservoir at the end of the irrigation season. During prorationing years, conserved water for irrigation use can be called upon and used by the appropriate entity.

Conserved water dedicated to instream flow is characterized by shapeable and non-shapable components. Water savings resulting from the YRBWEP water conservation results in water available for instream flow that was formerly stored and released for irrigation purposes. A portion of this conserved water can potentially be shaped to maximize instream and fishery benefits. However, Reclamation cannot control the entire annual volume of conserved water, as it is the result of reducing irrigation diversions. At the beginning of the irrigation season while the reservoirs are either filling or spilling, Yakima basin irrigators divert mostly natural flows from unregulated snowmelt and runoff for their water supplies. Reducing diversions during this portion of the season increases the flows in the rivers below the diversions, but natural flows cannot be controlled by, shaped by, or stored in the reservoirs. Once natural flows diminish and water must be released from the reservoirs to meet downstream demands, the project goes on storage control operations. After storage control begins, the Yakima Field Office has the ability to store or release the YRBWEP conserved water. The Yakima Field Office Manager, with input from SOAC, can decide to release water to augment target flows at Parker and Prosser during the irrigation season, to supplement outmigration or winter flows, or another beneficial instream use identified by SOAC. As the date of storage control varies annually, the volume of unregulated conserved water will also vary, and is unknown until the TWSA and storage control date are determined.

The volume of conserved water potentially available for shaping and use in advance of the storage control date is a forecasted quantity based on a conservative estimate of the proration rate and storage control date. Conserved water that is stored during the storage control period can be shaped and used after the end of the storage control period (i.e. during the winter until March 31 or until the reservoirs spill). This volume is a known, rather than a forecasted quantity. As discussed in greater detail in Section 2.4.1, the current quantity of YRBWEP conservation water for instream purposes is 36,392 acre-feet. This quantity will increase as conservation projects currently underway are completed. The annual total is subject to variation since a portion of this water is proratable.

Leased and Purchased Water

As described in Chapter 2 of this BA, water has been acquired under the federal YRBWEP program to enhance instream flow. These water rights are described by the monthly quantities mirroring the historic consumptive use of the parent irrigation water right. Reclamation will work with Ecology to establish flexibility to shape the post-storage control portion of the water for water rights that can be shaped by the storage reservoirs.

Reclamation observes the instream flow right created by Reclamation and Ecology's Wapatox power water purchase by maintaining an instream flow target of 450 cfs at the Naches River near Naches (NACW) from November 1 through March 31. The instream flow target is also observed from April 1 through October 31, but is diminished by up to 150,835 from April 1 to September 30, and 125,835 cfs in October to satisfy the Wapatox Ditch Company and lower Wapatox water rights. Just as with the underlying water right,

observing the instream flow target created by the Wapatox power water purchase is dependent on the availability of natural flow. Therefore, NACW flows may drop below the instream flow target at times. Consistent with historic operations before the water right purchase, Reclamation may need to store water in Rimrock Reservoir which would otherwise be bypassed. Reclamation would only take this action if necessary to provide bull trout passage into the South Fork Tieton in drought years. Under this scenario, Wapatox water would be saved in Rimrock Reservoir and NACW would drop below the instream target flow. The water stored in Rimrock could be used after August 10 and before March 31 of the following year for instream flow purposes, if desired. If it is necessary to store a component of the Wapatox water right to provide bull trout passage, a minimum instream flow target of 125 cfs at NACW, informal subordination target when the Wapatox powerplant was operational, will be maintained.

Coordination State and Non-profit Water Conservation and Acquisition

When other entities acquire water under the Washington Water Acquisition Program, the water rights are recorded mirroring the historic consumptive use of the parent irrigation water right. Ecology and Reclamation maintain regular communication regarding these amounts, and Reclamation accounts for these amounts by adding the consumptive use water savings to the Title XII flows observed at Parker and Prosser.

3.1.3 Operations to Meet Water Entitlements

Reclamation operates the Yakima Project to meet a variety of requirements. Chief among these are the various water rights adjudicated in the Yakima County Superior Court case *Department of Ecology v. Acquavella*. These rights establish the obligations of the U.S. to deliver water that comes from natural flow, storage, and other sources. Water rights for the Yakima Project include storage rights to Reclamation, and diversion and delivery rights to Reclamation on behalf of the districts. Reclamation must also ensure that the contractual obligations of the U.S. as reflected in the adjudicated water rights are met in its Yakima Project operations.

Operations during Water Short Years

When the TWSA is not adequate to meet all irrigation entitlements, prorationing is necessary. Historically (except WY 1993), the prorationing period has not started until the date of storage control. The amount of proration is determined monthly, biweekly, or as needed, by project operations and this information is provided to water using entities at manager meetings. The nonproratable users can divert their full irrigation entitlements. This amount is deducted from the water supply available for irrigation entitlements, with the remainder available for the proratable irrigation entitlements.

Natural runoff proportion attempts to maximize the use of natural runoff (the unregulated runoff below storage reservoirs) and return flow, and at the same time minimize storage releases to meet demands. The major water users above Parker voluntarily agree to share natural runoff and return flow supply proportionally based upon their entitlements. If reservoir releases are called for prior to storage control and formal prorationing, they will be deducted from the requesting entity's water bucket when prorationing formally begins.

Based upon experience gained in previous water-short years, operations use the following framework when faced with below average years. The basic concepts of this policy are: 1) share flood water and return flow during the main runoff period; 2) discourage storage releases during the tail end of the main runoff period when runoff is unable to meet full demand); 3) allow waters users to shape, via requests in advance, their estimated water supply use pattern ("bucket") during the period of heavy reservoir release (after the main runoff period); and 4) maintain control during end of season (October) operations. Additional details about the constraints for short water year operations are found in Chapter 5 of the IOP.

If requested by irrigation entities during a water-short year, project operations will develop an October water supply available (OWSA) to meet October water demands and, like in TWSA, the entitlements could be subject to prorationing. The OWSA includes natural runoff, return flow, and storage. To meet non-proratable average use for October, project storage must be operated to provide a minimum of 76,000 acre-feet storage as of the end of September. Title XII flow requirements and estimated carryover storage for the end of the irrigation season are then subtracted from the OWSA. The remainder is the OWSA for requested irrigation entitlements.

3.1.4 Operations to Meet Fisheries Needs

Ramping Rates

Reclamation has established ramping rates to address fisheries needs. Reclamation uses a general ramping guideline of 2 inches per hour (stage in river) when operationally possible. During periods of flood control operations, it is sometimes not possible to meet this ramping rate and provide maximal flood control benefits. Additionally, ramping rates when the river is rising (ramping up) is generally not of high concern for fisheries impacts. Therefore, during flood control, ramping up will be limited only by operational and safety concerns until bank full stage, when the 2 inches per hour limit will apply if public safety is not jeopardized. In the Yakima River at Easton reach, a ramping down rate of 1 inch per hour is employed during the spawning, incubation, and rearing periods for anadromous salmon. If operations require a large release of water, Reclamation attempts to hold the increased peak for 24 hours before starting to ramp back down.

In addition to fisheries needs, other considerations inform ramping rates. The day-to-day operation of the reservoir system and hydropower facilities can cause flow fluctuations. While the project is limited in its ability to maintain stable flows in the system because of operational demands, operations seek to minimize occurrences of fluctuation and stranding. Ramping rates have always been constrained by operational and safety concerns. Large rates of change generally are inefficient, causing flows greater than required for a short period of time and making interpretation (reading) of the river system difficult for operators. Several smaller changes are usually more efficient. Moreover, large rates of change, especially increases, may also endanger recreationists in the river.

Spawning Flows

Operational changes targeted at setting and then maintaining spawning flows are aimed at spring Chinook salmon. The combination of the spatial distribution of spawning and spawn timing makes this species particularly vulnerable to potential redd stranding. Spring Chinook spawn in the late summer when flows are still elevated to make irrigation deliveries. The incubation period; however, extends throughout the winter when reservoir releases were historically minimized as part of refill operations. Spawning in the Keechelus reach of the Yakima River and the Cle Elum River are of particular concern, as flows in these reaches are controlled almost exclusively by dam operations.

Reclamation and SOAC developed flip-flop and mini flip-flop operational schemes geared to be protective of spring Chinook redds in the upper Yakima basin. Section 4.5.2 of the IOP details the 1980 court order and subsequent work to establish the flip-flop scheme. The objective of flip-flop and mini flip-flop is to provide reduced late September and October flows during the spring Chinook spawning period so that redds are established in areas of the stream channel where incubation flows can continue to be provided while at the same time storing winter reservoir inflows. The flip-flop operation achieves this aim by sequencing reservoir releases for irrigation between the upper Yakima and Naches arms of the basin. Irrigation demand early in the irrigation season is primarily met by drafting upper Yakima basin reservoirs (Cle Elum, Keechelus, and Kachess), so that flows from these reservoirs can be reduced in September, when demand is then primarily met through Rimrock and Bumping Reservoirs.

While Reclamation has utilized the flip-flop operation to successfully meet its irrigation delivery responsibilities while concurrently protecting spring Chinook redds, the operation requires heavy drafting out of each arm of the Yakima basin at a specified time of the year, instead of making more consistent releases among the entire reservoir system throughout the year. Concerns have been raised about the potential negative ecological effects from both the high magnitude of flows and the relatively rapid rate of flow change in September when irrigation deliveries switch from releases out of the Yakima arm to those out of the Naches arm. In response to these concerns, Reclamation attempts to modify the yearly flip-flop operation by extending the amount of time it takes to perform the flip-flop flow transition.

When feasible, Reclamation will begin to ramp down flows out of Cle Elum Dam for flip-flop a few weeks earlier in the season (late August) rather than early September. The ability of Reclamation to draw-out and moderate the flip-flop operation depends of specific water supply conditions in any given year.

The mini flip-flop operational sequences reservoir releases between Kachess and Keechelus Reservoirs so that spring Chinook spawning in Keechelus, Easton, and Cle Elum reaches can be protected. Under the mini flip-flop operation, heavier releases are made from Keechelus during June, July, and August to meet the upper basin demands, and releases from Kachess Lake are restrained. In September and October, heavier releases are made from Kachess to meet upper basin demands, and the releases from Keechelus Lake are reduced to provide suitable spawning flows in the Yakima River reach from Keechelus Lake to the head end of Lake Easton. Historically, Reclamation could not reliably implement the mini flip-flop operation; therefore, would close the Easton fish ladder to exclude fish from the Keechelus reach since spawning flows could not be maintained throughout the incubation period. However, due to improvements to the Kachess Dam outlet structure and improvements in water management planning, Reclamation can commit to providing fish passage at Easton Dam in all years.

Winter Incubation and Rearing Flows

In response to concerns that Reclamation's winter operations resulted in the release of water for flood control operations which could have instead been released more steadily throughout the winter incubation and rearing period, Reclamation implemented a risk analysis framework in 2002. The objective of this risk analysis framework was to increase winter releases while simultaneously minimizing risk to water entitlements. This winter flow setting process was developed in consultation with SOAC and has been used successfully and subsequently refined. Reclamation uses a risk analysis procedure relating potential water supply (the known November 1st reservoir system carry-over storage and known and expected fall and winter precipitation) to meeting all irrigation demands, i.e. no shortage, a full supply. Other conditions are also taken into consideration when setting and adjusting winter flows, such as impact to redds and short-term weather outlook. This analytical method has enabled Reclamation to maintain higher and more stable winter flows in reaches downstream of storage reservoirs while protecting the water supply for irrigation.

Reclamation sets minimum flow targets at Keechelus, Easton, Cle Elum, and Bumping Dams in early September and maintains these flows through the reservoir filling period, until flow rates increase due to increased releases to provide outmigration flows and make irrigation deliveries. Kachess, Rimrock, and Tieton River at Tieton Canal headworks minimum flow targets are set after October 20th (Table 3-3). Target flows are set based on estimated November 1 system reservoir storage and anticipated precipitation related to the El Nino Southern Oscillation (ENSO) condition. The ENSO and system storage indicate a low (dry), medium (average), or high (wet) condition and determine a corresponding flow. Since early

season forecasts are inherently the least accurate and one management objective for fisheries purposes is to avoid flow reductions which could threaten incubating eggs, flows are only set to low and medium conditions initially. All flows are evaluated and possibly adjusted after December 1 and January 1, to a low, medium, or high flow. This adjustment is based on the ENSO condition, the November 1 system storage, and fall/winter precipitation. Potential effects to incubating eggs are considered before flow adjustments are made.

In dry years, inflow into the storage reservoirs may fall below specified minimum flow targets. If reservoir inflow is less than outflows and reservoir storage is low, Reclamation may need to cut releases below the minimum instream flow target in order to prevent depleting its stored water. Under these circumstances, adjustments to flows would consider potential impacts to incubating eggs and Reclamation would attempt to transition slowly to the lower flow.

Table 3-3. Minimum winter instream flow targets (cfs).

	Minimum Flow (cfs) by Water Year Type		
Location	**Dry**	**Average**	**Wet**
KEE	Inflow - 80	100	120
KAC	Inflow - 30	30	30
EASW	190	250	300
CLE	Inflow - 180	220	250
BUM	Inflow - 130	Inflow - 130	Inflow - 130
RIM	Inflow - 50	75	90
TICW	75	100	120

Outmigration Flows

Historically, snowmelt dominated runoff in the April through June time period functioned both to stimulate smolt outmigration and create conditions which improved survival for outmigrating fish. Flow conditions related to enhanced survival include decreased travel time as water velocities increase and higher turbidity to help guard against predation. Reclamation proposes to take steps to minimize the effect of project operations on outmigrating smolts. Proposed actions are focused on addressing impacts to ESA-listed steelhead smolts, but will also benefit other outmigrating salmonids when their outmigration timing coincides. As part of the Proposed Action, Reclamation will take steps to minimize project effects on outmigration flows through 1) storage reservoir operations and 2) Reclamation-controlled diversion operations.

Storage Reservoir Operations

In order to minimize effects from storage reservoir operations during the primary steelhead outmigration window of April 1st through May 31st, Reclamation will commit to providing a specific volume of water that will be released out of Rimrock and Cle Elum Dams. A volume of outmigration flow water will also be specified at the Yakima River at Easton gage and will be met through a combination of natural flow and Keechelus and Kachess releases. This quantity of water will be used to elevate flow conditions above minimum winter instream flow targets. TWSA will be used to set these minimum volumes. The best outmigration flows will be provided in the years with the best water supply conditions. More moderate flows will be provided when there is more moderate water supply and the lowest outmigration flow targets will be used in drought years. In this way, outmigration flow targets are reflective of natural year-to-year variability and are aligned with available water supply.

Due to the nature of spring runoff conditions and the importance of timing reservoir releases with runoff patterns experienced throughout the Yakima basin, outmigration flows will not be prescribed on precise days. Rather, a minimum monthly quantity of water will be identified based on April and May TWSA estimates and this volume of water will be released during that month based on prevailing conditions and input from SOAC (Table 3-4). As a general rule, Reclamation will attempt to mirror the timing and potentially the magnitude change of unregulated flow when releasing water from reservoirs. Water released from storage to enhance outmigration will be protected from diversions and should pass from the dam where it originates all the way downstream to the confluence with the Columbia River.

Table 3-4. Minimum volume of water (acre-feet) that will be available in April and May, each year, to provide outmigration flows as measured at Tieton Dam (RIM), Cle Elum Dam (CLE), and Yakima River at Easton gage (EASW).

	Monthly Min. acre-feet for Outmigration Flows		
April TWSA (MAF)	**< 2.36**	**2.36 - 3.13**	**> 3.13**
May TWSA (MAF)	**< 2.20**	**2.20 - 261**	**> 2.61**
RIM	4,500	8,400	14,800
CLE	4,200	9,900	18,800
EASW	3,700	4,800	9,900

One tool Reclamation can use to provide these minimum outmigration flows is to forecast projected run-off in excess of storage and delivery capacities, and release this expected volume even if it has not yet arrived at a storage reservoir. This water can be referred to as shapeable spill. If Reclamation forecasts that the amount of shapeable spill is even greater than the minimum volumes listed in Table 3-4, then Reclamation may exercise its discretion to provide this shapeable spill in April and May in order to minimize the effect of project operations on outmigrating smolts.

Reclamation Diversion Operations

In order to help minimize the effect of Reclamation diversion operations during the outmigration period, Reclamation will continue to implement its freshet guidelines and power subordination at Roza and Chandler Powerplants.

During the period of March 15 to June 15, Reclamation operates its diversions at Roza and Prosser Dams for power water according to a protocol intended to identify naturally developing freshets and let them pass without capitalizing on these natural flow events by increasing canal diversions. Reclamation applies the freshet guidance to the diversions that it has direct operational control over and requests that the irrigation districts not increase their irrigation diversions when a freshet has been identified. A freshet is allowed to pass until the peak of the freshet has passed, or up to 48 hours, whichever is shorter. If the rising limb of the freshet does not reach a peak within 48 hours, it will be assumed that the flow increase does not meet the definition of a freshet or the rising limb has already benefitted downstream migrating fish as intended and normal diversions will resume. The 48-hour clock is gage specific, that is, the clock starts only once the freshet begins at a particular gage. A freshet in either arm of the basin will be assumed to travel to PARW and beyond. If a freshet occurs and is followed by a second freshet within 48 hours, it is not required that the second freshet be left to pass undiverted for power generation or irrigation. If a freshet begins over 48 hours after the last freshet peaked, the freshet should remain undiverted in an effort to minimize outmigration delay.

In addition to foregoing potential power production in response to freshet events, Reclamation subordinates power during the outmigration period at both Roza and Chandler Powerplants. A description of these operations is found in 3.1.5 of this BA.

Fish Passage

Passage at Sunnyside and Prosser Dams

At least 300 cfs is required at both Sunnyside and Prosser Diversion Dams to keep at least one fish ladder open and operational at each of these facilities. Since the Title XII legislation sets instream flow of at least 300 cfs at both of these locations, this instream flow requirement helps provide upstream fish passage even during low-flow conditions. While

Reclamation takes every reasonably practicable measure to keep instream flows above the Title XII instream flows, operational constraints prevent Reclamation from ensuring that flows never fall below 300 cfs. Flow fluctuations allowed under the YRBWEP legislation for Title XII flows specifically reflect the operational constraints composed by travel time from the storage reservoirs to the Parker and Prosser control points, and changing nature of diversions, return flows, and natural inflows in the intervening river reaches. From July through August, flow travel time for normal operational releases between the reservoirs and the control point at Parker ranges from a minimum of 10 hours from Tieton Dam to over 40 hours from Keechelus Dam. After storage control, the system will normally develop a diurnal 80 to 100 cfs cycling effect from evaporation and irrigation practice, and a weekly increase (+/- 200 cfs) in return flows due to weekend irrigation practice, which greatly affects the flow available at PARW. Managing the river system for 6,800 to 7,200 cfs of irrigation diversions allows for these uncertainties in maintaining the minimum flow of 300 to 600 cfs by permitting to dip to 65 percent of the target for a period not to exceed 24 hours.

To remove some of the uncertainty in the system and to better meet target flows, Reclamation requests that irrigation districts and other diverters of 1 cfs or greater verbally inform the Yakima Project operator 48 hours in advance of any planned diversion or change in diversion (by Judicial Order in State of Washington vs. *Acquavella*). Unplanned changes in diversions are to be reported as soon as possible after the change has been made. Regular contact is maintained with the five major irrigation districts (holders of 82 percent of TWSA entitlements) diverting above Parker.

Bull Trout Passage into the South Fork Tieton River

The south fork of the Tieton River is a bull trout spawning tributary which flows into Rimrock Reservoir. A seasonally submerged falls near the stream mouth creates a migration barrier when the reservoir elevation falls below approximately 2899 feet (127,000 acre-feet). In order to meet the management objective of providing bull trout with passage to their spawning habitat, Reclamation takes reasonably practicable measures to keep the Rimrock Reservoir pool above at least 127,000 acre-feet through August 10th. Implementation of the flip-flop operation and shaping the release of Wapatox power water (see Leased and Purchased Water in Section 3.1.2) enables Reclamation to operate Rimrock Reservoir to provide bull trout passage into the south fork of the Tieton River.

Bull Trout Passage at Clear Creek Dam

Clear Creek Dam separates Clear Lake from Rimrock Lake. When Clear Creek Dam was rebuilt in 1992, two fish ladders were added to the bedrock spillway of Clear Creek Dam. These ladders are located in the upper and lower section of the spillway. The lower ladder is actually a series of four denil ladders interspaced with resting pools located on the right bank of the spillway. The upper ladder is a pool-and-weir design constructed on the left side of the spillway channel. The denil ladder is considered too steep for successful passage, though

there is preliminary evidence that under some conditions, at least some adult bull trout can ascend the bedrock spillway in this section (Thomas et al. 2014, p. 16). In 2007, Reclamation changed Clear Creek Dam operations so that the dam outlet works were used to regulate discharge instead of the spillway, so that the Clear Lake elevation and this spillway discharge were kept more stable. These conditions are believed to be more conducive for bull trout passage up the spillway channel than if there is more varied discharge. Reclamation currently targets a reservoir elevation of 3011.3 to 3011.4 to optimize passage conditions on the spillway. A PIT-tag study that is underway and scheduled to be completed in 2016 aims to identify operational configurations that will benefit bull trout passage. Reclamation will continue to be responsive to new information and adjust Clear Creek Dam operations when practicable to aid in bull trout passage at this location.

Cle Elum Sockeye

Reclamation also manages Cle Elum Reservoir refill and downstream winter releases in order to meet sockeye outmigration needs. Since 2005, interim downstream passage has been provided via a stop-logged overflow section and plunge pool installed in the second radial gate bay from the left side of the spillway, and a temporary plywood and lumber framed flume built on the existing spillway. The overflow section can pass flows whenever the reservoir pool is at least two feet above the spillway crest (elevation 2223 feet). The critical sockeye smolt outmigration period is March 15 through May 15. Thus, Reclamation attempts to refill Cle Elum so that fish passage is provided as early in the spring time as possible, considering Reclamation's irrigation, flood control, and fishery obligations.

Minimum Pool Elevations

For Keechelus, Kachess, Cle Elum, and Bumping Reservoirs, the historic lake bed currently creates a minimum pool. Due to the outlet works configuration, operations cannot cause reservoir volumes to fall below these amounts (Table 3-5). Clear Lake does not have a historic lakebed and in only rare occasions would water be released from Clear Lake for irrigation needs. In the case that water is drafted out of Clear Lake, only up to 2,200 acre-feet are released, leaving a volume of 3,100 acre-feet.

Table 3-5. Total reservoir storage and minimum pool volumes.

Reservoir	Reservoir Capacity (acre-feet)	Historic Lake Volume[1] (acre-feet)
Bumping Lake	33,970	27,361
Cle Elum Lake	436,900	569,484
Kachess lake	239,000	Lower Pool – 586,104 Upper Pool – 59,172
Keechelus Lake	157,800	121,250
Rimrock Lake	198,000	N/A (see text for description of end of season pool elevation maintained through operations)

[1] Based on most recent calculations based on available bathymetry.

While nearly all the water could be evacuated from Rimrock Lake, Reclamation takes every reasonably practicable measure to keep the end of season reservoir volume above 30,000 acre-feet in most years, and above 10,000 acre-feet in all years.

3.1.5 Power Production

Hydroelectric power is produced incidentally at Roza and Chandler Powerplants, thus, reservoir releases are not made to meet hydroelectric power demand. Power subordination occurs at both of these facilities when power generation is reduced or shutdown, allowing the power water diversion flows to remain in the river system to protect the fishery resources or to enhance fish passage.

Water for the Chandler Powerplant is diverted into the Chandler Power Canal, with a diversion capacity of 1,500 cfs at Prosser Dam. Reclamation has the authority to subordinate power production at Chandler as identified in the 1999 YRBWEP legislation, which specifies that diversions for hydropower generation at the Chandler Powerplant will be subordinated to meet flow targets determined by the Yakima Project Superintendent in consultation with the SOAC. Under the Proposed Action, power production at Chandler will continue to be subordinated to various flows throughout the year. In April through June, power is subordinated to 1,000 cfs over Prosser Dam. During the remainder of the irrigation season, the subordination target is 450 cfs or the YRBWEP Title XII target flow, whichever is higher.

Water for the Roza Powerplant is diverted at Roza Dam. The powerplant can use up to 1,123 cfs of power water and the total diversion at Roza is limited to 2,200 cfs for irrigation, domestic supply, and power generation. Preference is given to irrigation. While there is no legislation specifying subordination amount at Roza, Reclamation works to balance competing needs of irrigation, fish, and power and seeks input and communicates decisions with BPA, SOAC, irrigation districts, and others.

Reclamation has a contractual obligation to the Roza Irrigation District to supply its pumping power needs. A Power Shaping Agreement between Reclamation and BPA was implemented in 1988 to allow for lost power generation due to the flip-flop operation. This agreement shapes the Roza generation on an annual basis so that Reclamation does not need to buy power from BPA. Through this shaping agreement, Reclamation delivers all of Roza's output to BPA and BPA returns an amount of firm power equal to Roza station service and Reclamation's obligation to serve the District's electrical load up to 40,000 megawatt hours per year (MWhrs/yr).

In order to minimize take of ESA-listed outmigrating smolts, Reclamation proposes to subordinate power production when flows are less than 1,300 cfs below Roza Dam for the period of April 1st to May 31st. For the remainder of the year, the flow subordination target will continue to be 500 cfs. Reclamation also proposes to reserve the option to further examine smolt mortality at Roza Dam and apply the results from that investigation to adaptively manage future Roza power subordination flows. New information may reveal that Reclamation can achieve dam-specific survival rates at flows between 850 and 1,299 cfs that are comparable to survival rates under a flow subordination target of 1,300 cfs. Under this adaptive management process, Reclamation would submit a plan to NOAA Fisheries identifying the steps Reclamation would take to ensure no increased outmigration smolt mortality under the revised subordination plan. Upon concurrence that this new operation did not result in increased take, Reclamation would adjust operations as specified in the proposal.

Additionally, Reclamation manages weirs installed in 2010 on the top of Roza Dam's west gate in order to provide surface passage at the dam. Weir configuration, the number of weirs placed in the up or down position, is determined by the amount of water available to pass over Roza Dam, the configuration of the entire dam most likely to provide a stable forebay elevation, and flow forecasts. Due to facility constraints, forebay elevation may drop during weir adjustments, affecting both water diversions and flows downstream of Roza Dam. Therefore, Reclamation expects that after re-configuring the weirs, flows may fall below 1300 cfs below Roza Dam for a short period (several hours).

3.2 Project Infrastructure Operations and Maintenance

The Proposed Action includes periodic maintenance activities required to maintain project infrastructure for water storage, water diversion and delivery, water monitoring, and fish passage (protective screens and fish ladders) purposes. This section describes these activities by first, identifying general Best Management Practices (BMPs) that will be used on a regular basis to protect natural resources are described in Section 3.2.1 for all applicable project types. Those BMPs related to in-water work, including project timing, and worksite isolation and fish salvage are detailed first. Next, BMPs aimed towards minimizing impacts in the terrestrial locations are presented. Sections 3.2.2 through 3.2.4 provide more detailed information about the types of maintenance activities required for Reclamation's primary facility types: storage and delivery facilities, irrigation diversion facilities, and fish screening and passage facilities. Finally, routine land management activities conducted on Reclamation lands are described in Section 3.2.5. Information about maintenance activity frequency, typical footprint area, and advanced notification requirement to the Services is presented in Table 3-6. Sections 3.2.2 through 3.2.5 provide additional project detail.

Table 3-6. Summary of maintenance activity by category, describing typical associated activities, project footprint, and number of sites covered by year. This table also identifies the activities proposed for Project notification.

Activity ID	Name	Typical Activities	Typical Project Footprint	Sites Treated Per Year	Advanced Project Notification
1	**General Activities**				
1a	Site Access	Small scale brush and tree clearing and road regrading to provide access to existing infrastructure.	1,000 sq. ft. 420 miles canal 1,697 laterals	5	No, unless other project elements require notification.
1b	Worksite Isolation	Placement of cofferdam/sandbags within the wetted area and associated water pumping, or flows will be diverted around the area of construction using appropriate features (e.g., a bypass culvert or pipe, or a lined, non-erodible diversion ditch).	500 sq. ft.	2	Yes

Activity ID	Name	Typical Activities	Typical Project Footprint	Sites Treated Per Year	Advanced Project Notification
1c	Fish Salvage	Remove fish from isolated sites or sites dewatered due to irrigation shut-off operations	4 Phase 1 sites, Live Boxes, Phase 2 Sites by WDFW		Yes - construction activities No - screen site salvage
2	**Herbicide Application**				
2a	Terrestrial	Herbicide applications	< 3,500 acres total		No
2b	Aquatic	Herbicide application	420 miles canal 1,697 laterals		No
3	**Storage Infrastructure Inspection and Maintenance**				
3a	Inspections		N/A		No
3b	Dam and spillway debris and vegetation clearing	Collect wood by boom truck, small boat, or backhoe and relocate downstream or burn	40 cubic yards	4	No
3c	Repairs to existing rock armoring				
3c (i)	Repairs upstream of dams	Place riprap by backhoe or dump truck upstream of the dam, when reservoir is drawn down due to routine operations.	Not to exceed current footprint, <250 yards	3	If in-water rock placement required or required due to Northern Spotted Owl considerations
3c (ii)	Rock Placement - downstream of dam	Place riprap by backhoe	Not to exceed current footprint	3	If in-water rock placement required
3d	Concrete Repair	Spot treatment of joints, crack, spalling and concrete panel replacement			
3d (i)	Spillway		1,500 square feet	5	No
3d (ii)	Outlet conduit		16 square feet	5	No
4	**Gaging Station**				
4a	Inlet flushing		N/A	90	No
4b	Repair or replace gage station components				

Activity ID	Name	Typical Activities	Typical Project Footprint	Sites Treated Per Year	Advanced Project Notification
4b (i)	Gaging Station Repair - minimal to no in-water work	Concrete or rip-rap repair to gage station foundations. Replace staff gages. Remove sediment from clogged intakes.	< 1 - 45 square feet	5	If in water work required
4b (ii)	Gaging Station Repair – in-water work / worksite isolation	Repair or replace staging gage components. Excavation and work site isolation may be required.	200 square feet	0.33	Yes
4c	Staff Gage Replacement		2 square feet	5	Yes - if mounting pole needs to be replaced
5	**Irrigation Division**				
5a	Dam inspection				
5b	Diversion dam - debris relocation	Changes in dam configuration (Roza) or debris relocation via excavator	40 cubic yards	1.5	Yes - If heavy machinery required.
5c	Canal Repair	Concrete or riprap repair or replacement, shotcrete applications, reshaping earthen canals, filter fabric overlay installation	50 miles		No
5d	Drain maintenance - tile replacement	Excavation and tile replacement	4 miles		No
6	**Fish Passage Program**				
6a	Inspections				
6a (i)	Annual		N/A		No
6a (ii)	Regional Facility		N/A		No
6 b	Operations				
6b (i)	Fish Ladders		N/A		No
6b (ii)	Fish Screens		N/A		No
6c	Gravel and Debris Removal				

Activity ID	Name	Typical Activities	Typical Project Footprint	Sites Treated Per Year	Advanced Project Notification
6 c (i)	Gravel and debris Removal - in front of screens	Removal or relocation by excavator	10 - 40 cubic yards	39	No
6c (ii)	Gravel and debris removal - bypass outfalls and fish ladder entrances	Removal or relocation by excavator	< 500 cubic yards	2	Yes
6d	Routine Repairs and Structural Maintenance				
6d (i)	Fish Ladders	Activities to address or prevent deficiencies in the ladder structure, including entrances and exits, gates, dissipation features, and attraction flow valves.	Existing Structure		Yes
6d (ii)	Fish Screens	Repair porosity boards, replace damaged screen seals, open drain valces, repair trash rack, trash rake, fencing.	Existing Structure	39	No - repairs that occur outside irrigation season. Yes – repairs during irrigation season that necessitate in-water work or a change in operations

3.2.1 Best Management Practices

Project Notification and Variance Requests

For the specific activities described in this document, Reclamation will notify the Services in advance about maintenance activities that either:

1. Utilize heavy machinery in waters where ESA-listed fish species may be present.

2. Occur at Keechelus, Kachess, Bumping, or Rimrock Dams during the northern spotted owl early nesting period and generate noise above background levels.

Reclamation will submit a project notification form (Appendix B) to the Services no later than 30 days before beginning work. The Services will respond to verify that the activity meets the requirements of this consultation. If project-specific considerations prevent the use of a BMP specified in this document, Reclamation will request a variance from the Services. Variance requests may be submitted and approved by email correspondence and will include:

1. Name and brief description of project, location of project, and 6th field hydrologic unit code (HUC) number.
2. Definition of the requested variance.
3. Environmental conditions of the project site.
4. Biological justification as to why a variance is necessary and a brief rationale why the variance will not cause additional adverse effects beyond the scope of the Proposed Action.
5. Attachments providing necessary approvals by state agencies.

Best Management Practices for All Maintenance Activities

Timing

If conditions allow, Reclamation will perform in-water work during low flow or dry conditions and during dry weather. WDFW guidelines for timing of in-water work windows will be followed unless a variance is requested and approved by the Services[5].

Machinery

When heavy machinery is required, Reclamation or its contractors will:

- Make sure heavy machinery is in good working order and inspected for leaks to prevent lubricants and any other deleterious materials from entering the water.
- Fuel and maintain all equipment more than 150 feet from the nearest wetland, ditches, or flowing or standing water, unless site specific review completed by the project biologist indicates that no impacts to the resource areas will result due to topography or other factors.

[5] WDFW 2010. Times when spawning or incubating salmonids are least likely to be within Washington State freshwaters. Available at: http://wdfw.wa.gov/licensing/hpa/freshwater_incubation_avoidance_times_28may2010.pdf

- Make sure that all machinery to be used in or near flowing water will have undercarriages and drive mechanisms cleared of dirt and oil deposits and will be free of any external petroleum products, hydraulic fluid, or coolants. Wash water will not be discharged to any water body.

- Use vegetable oil or other biodegradable, acceptable hydraulic fluid substitute for all equipment entering waters that may be occupied by listed fish species and/or if the waters are critical habitat.

- Conduct the work so that heavy machinery enters the water to the minimum extent possible.

Construction Techniques

Reclamation or its contractors will use the following general construction BMPs:

- In fish bearing waters, concrete work will be conducted after worksite isolation and dewatering is conducted in order to prevent leaching into the waterbody. The concrete will be allowed to fully set (approximately 48 hours) before contact with surface water.

- For projects involving concrete, concrete truck chute cleanout areas will be established to properly contain wet concrete and wash water and prevent it from entering wetlands and other water bodies.

- Preparatory painting pressure washing of structures will be done using appropriate filter fabric to control and contain paint particles generated by the activity. Wash water will be fully contained when it would otherwise discharge to waters with listed fish species.

- Installation of riprap and other materials will occur from the banks or outside the wetted perimeter as much as possible.

- All materials, such as riprap or gravel, placed within the water will be free of rock fines, silt, soil, or other extraneous material.

- If there is a potential for eroded sediment to enter the stream, sediment barriers will be installed and maintained for the duration of the maintenance activity. Temporary erosion control measures may include fiber wattles, silt fences, jute matting, wood fiber mulch and soil binder, or geotextiles and geosynthetic fabric.

Post Construction Conditions

- Projects will not inhibit passage of any listed fish species life stage following completion.
- All project related waste will be removed.
- All disturbed areas will be rehabilitated in a manner that results in similar or improved conditions relative to pre-project conditions. This will be achieved through redistribution of stockpiled materials, allowing intact root systems to resprout, and/or planting with local native seed mixes or plants.
- If extensive ground disturbance is required and native root system is no longer intact, riparian vegetation will be re-established through plantings. Weed control, mulching, and watering will be used as necessary to ensure re-establishment of riparian vegetation.

Terrestrial Construction

The following BMPs will be used with routine O&M activities at reserved works that require terrestrial construction in locations with the potential to impact ESA-listed species. These sites include facilities associated with the storage dams and HydroMet sites. Construction is defined as vegetation or ground disturbance or use of heavy machinery which will generate noise above baseline levels.

- Construction impacts will be confined to the minimum area necessary to complete the project.
- Clearing limit boundaries associated with site access and construction limits will be clearly flagged to prevent ground disturbance and vegetation removal outside the limits.
- Temporarily disturbed areas will be restored to pre-work conditions to the extent possible, including protecting existing root systems and allowing re-sprouting of herbaceous and woody plants.
- If an ESA-listed threatened or endangered species is present or could occur within the project Action Area, timing restrictions identified in the Wildlife Sensitive Periods Calendar (Appendix C) will be used.

3.2.2 General Activities (Activity Type 1)

Activity 1a - Site Access

The Proposed Action includes maintenance of existing infrastructure (e.g., diversion dams, headgates, fish passage facilities, HydroMet sites, storage dams). These facilities are accessible existing access roads and paths. Site access refers to maintaining or re-establishing (in situations where the access path is infrequently used and shrub vegetation regrows) existing access paths to access these facilities. It does not include in-water access. Actions included in this activity are vegetation clearing, re-grading existing roads, and placing gravel on existing roads. Vegetation clearing to maintain these areas is expected to primarily target smaller diameter trees (less than 14 inches diameter at breast height), shrubs, and herbaceous vegetation. The removal of single hazard trees may be conducted to ensure safe site access. Vegetation control through herbicide application is covered under Activity 2a.

Reclamation and irrigation district crews also maintain canal access through vegetation control on canal access roads. Large sections of canal banks and access roads are mechanically mowed at least once annually to limit the expansion of large aggregations of brushy vegetation growth and to maintain appropriate vehicle access to facilities along the canal alignment.

Minimization Measures

- All applicable BMPs from Section 3.2.1.
- In the event that vegetation clearing is necessary to re-establish site access, Reclamation will insure that boundaries of clearing limits are clearly flagged to prevent ground disturbance outside the limits.
- Removal of riparian vegetation will be minimized to the greatest extent possible.
- When clearing riparian vegetation, preference will be given to cutting rather than grubbing the vegetation. Cutting the vegetation instead of grubbing protects the existing root systems and allows re-sprouting of herbaceous and woody plants.
- If riparian vegetation must be entirely removed through grubbing, Reclamation will require that disturbed areas are treated with erosion control features (such as silt fencing or hay bales) until disturbed areas are stabilized or revegetated.
- Temporarily disturbed areas will be restored to pre-work conditions to the extent possible. If extensive ground disturbance is required within the riparian zone, native vegetation will be planted.

Activity 1b - Worksite Isolation

Work below the ordinary high-water mark will be conducted in isolation from flowing waters whenever any lifestage of an ESA-listed fish is likely to be present based on known temporal and spatial distributions. Unless in-water work without worksite isolation is explicitly described in this BA (see Activity 6c), exemptions for worksite isolation will be granted through the variance process. Fish salvage protocols (see Activity 1c) will be utilized when worksite isolation is employed.

Worksite isolation will be accomplished either through the placement of cofferdam/sandbags within the wetted area and associated water pumping, or flows will be diverted around the area of construction using appropriate features (e.g., a bypass culvert or pipe, or a lined, non-erodible diversion ditch).

Minimization Measures

- All applicable BMPs from Section 3.2.1.
- If pumps are used to temporarily bypass water or to dewater residual pools or cofferdams, pump intakes will be screened in accordance with current NOAA Fisheries fish screen criteria (NOAA Fisheries 2011a or most recent at the time of activity).
- Water pumped out of the isolated Project Area will be discharged to a temporary storage and treatment site or to upland areas and filtered through vegetation prior to reentering the stream channel. Discharge of water back to streams will not occur via overland flow and will not cause erosion.
- If Reclamation diverts flows away from the construction area, we will provide safe reentry of fish into the stream channel, preferably into pool habitat with cover.

Activity 1c - Fish Salvage

As stated above, fish salvage is conducted when in-water maintenance or routine repairs requires worksite isolation. Additionally, fish recovery activities are routinely conducted at several of the major canal diversions on the Yakima and Naches Rivers during annual operations to shut down and maintain these facilities. Fish recovery is targeted at facilities where site drainage conditions may cause fish stranding. Facilities with annual fish recovery operations include the Roza, Sunnyside, and Chandler Canals on the Yakima River and the Wapatox Canal on the Naches River. These salvage operations occur from mid-October through the end of November. Fish recovery is also required annually at the Roza fish ladder when the Roza forebay is lowered for annual canal maintenance and the low pool fish ladder is used instead of the high pool fish ladder. Switching fish ladders requires that the high pool ladder be drained. As the high pool ladder is draining, some juvenile fish exit through the 1-

to 2-inch-diameter drain ports. Fish recovery efforts are necessary for larger fish. Any fish recovered from the ladder are relocated to either the Yakima River or to the lowermost pool of the fish ladder for it to resume its migration when water again flows through the ladder.

Reclamation has installed live-boxes on two Roza Canal drains. Live-boxes were installed in these locations because Chinook and steelhead/rainbow trout were observed in these sections of the Roza Canal, and this canal features area of low-lying, concrete sections which can effectively be drained enabling fish located behind the screens to be captured. Fish arrive at the live boxes when the Roza Canal is dewatered for annual powerplant maintenance. After fish arrive at the live-box, Reclamation removes fish out of these live-boxes and transports them to the Yakima River. Fish are removed from the live-boxes with a dip net and placed in an oxygenated tank located on the back of a truck for transport. The live boxes are checked about three times during the first week after the canal is drained. Subsequent checks occur on a weekly basis until the canal is re-watered (generally, after a 3-week period). An additional drain on the Roza Canal in Tunnel 1 transports fish directly to the Yakima River.

Minimization Measures

Where fish listed under the ESA will or may be present, Reclamation will require that fish exclusion, capture, handling, and electroshocking follow standards identified by USFWS (2012) and NOAA Fisheries (2000) or current at time of activity. Briefly, a biologist will be onsite to insure that fish capture and removal operations adhere to the following minimum performance measures or expectations. Volitional movement of fish out of the site through gradual dewatering and upstream block net placement will be the preferred first step in fish removal when feasible. Electrofishing will not be used unless and until other, less injurious methods have been used. Specifically, seining techniques will be employed first. Electrofishing will not be used until all adult fish have first been removed using less injurious methods. Electrofishing will not be conducted when turbidity reduces visibility to less than 0.5 meter, when water conductivity exceeds 350 μS/cm, or when water temperature is above 18°C (64°F) or below 4°C (39°F). If bull trout may be present, fish salvage will not occur when temperature is above 15°C (59°F).

The fish biologist on site will confirm success of fish capture and removal before completely dewatering or commencing with other work within the isolated work area; the operations shall conduct a minimum of two complete passes without capture of target (ESA-listed fish) using electrofishing equipment. ESA-listed fish will not be held in containers for more than 10 minutes, unless those containers are dark-colored, lidded, and fitted with a portable aerator. Fish will be released to appropriate habitat which was identified before the capture and removal process.

Once salvage operations are completed, a salvage report will document procedures used, the number and size class of salmonids (excluding whitefish) salvaged, any fish injury or mortality (including numbers of fish affected), and a description of the causes for mortality.

3.2.3 Herbicide Applications (Activity Type 2)

Activity 2a - Terrestrial Herbicide Application

As part of the Proposed Action, Reclamation proposes to routinely apply terrestrial herbicides to control weeds at federal facilities, (e.g.: Phase 1 screen sites, access roads, HydroMet sites). Herbicide application at Phase 2 screen sites is funded by BPA, meets the requirements for the Habitat Improvement Programmatic (HIP) III, and is covered under that programmatic consultation. Herbicides may also be utilized at YRBWEP properties for weed management and to facilitate native plant establishment. Proposed herbicides and the typical application rates are presented in (Table 3-7). Reclamation estimates that 1,500 acres may be treated annually for general weed management of project facilities (screen sites, canal and lateral alignments, dams, and HydroMet stations). Additionally, YRBWEP manages approximately 2,000 acres.

Table 3-7. Proposed herbicides and application rates.

Common Name	Trade Name	Typical Application Rates (ai/ac)	Maximum Label Application Rate (ai/ac)	General Geographic Application Areas
2,4-D (amine)	Many	0.5 - 1.5 lbs	4.0 lbs	Upland & Riparian
Aminopyralid	Milestone®	0.11 - 0.22 lbs	0.375 lb	Upland & Riparian
Chlorsulfuron	Telar®	0.25 - 1.33 oz	3.0 oz	Upland
Clethodim	Select®	0.125 - 0.5 lbs	0.5 lb	Upland
Clopyralid	Transline®	0.1 - 0.375 lbs	0.5 lb	Upland & Riparian
Dicamba	Banvel® only	0.25 - 7.0 lbs	8.0 lbs	Upland & Riparian
Glyphostate 1	Many	0.5 - 2.0 lbs	3.75 lbs	Upland & Riparian
Glyphostate 2	Many	0.5 - 2.0 lbs	3.75 lbs	Upland
Imazapic	Plateau®	0.063 - 0.189 lbs	0.189 lb	Upland & Riparian
Imazapyr	Arsenal®	0.5 -1.5 lbs	1.5 lbs	Upland & Riparian
	Habitat®			Upland & Riparian
Metsulfuron methyl	Escort®	0.33 - 2.0 oz	4.0 oz	Upland
Picloram	Tordon®	0.125 - 0.5 lbs	1.0 lb	Upland
Sethoxydim	Poast®	0.1875 - 0.375 lbs	0.375 lb	Upland
Sulfometuron-methyl	Oust®	0.023 - 0.38 oz	2.25 oz	Upland
Triclopyr (TEA)	Garlon 3A®	1.0 -2.5 lbs	9.0 lbs	Upland & Riparian

Minimization Measures

Herbicide label. Herbicide applicators will comply with all label instructions.

Herbicide applicator qualifications. Herbicides may only be applied by an appropriately licensed applicator using an herbicide specifically targeted for a particular plant species that will cause the least impact. The applicator will be responsible for preparing and carrying out the herbicide transportation and safety plan, as follows.

Herbicide transportation and safety plan. The applicator will prepare and carry out an herbicide safety/spill response plan to reduce the likelihood of spills or misapplication, to take remedial actions in the event of spills, and to fully report the event.

2,4-D. As a result of the National Consultation[6], this herbicide shall comply with all relevant RPAs from the 2011 Biological Opinion (NOAA Fisheries 2011b):

1. Do not apply when wind speeds are below 2 mph or exceed 10 mph, except when winds in excess of 10 mph will carry drift away from salmonids-bearing waters.

2. Do not apply when a precipitation event, likely to produce direct runoff to salmonids bearing waters from the treated area, is forecasted by NOAA National Weather Service or other similar forecasting service with 48 hours following application.

3. Control of invasive plants within the riparian habitat shall be by individual plant treatments for weedy species, and spot treatment of less than 1/10 acre for herbaceous species.

Herbicide adjuvants. When recommended by the label, an approved aquatic surfactant or drift retardant can be used to improve herbicidal activity or application characteristics (Table 3-8). Adjuvants that contain alky amine etholoxylates, i.e., polyethoxylated tallow amine, alkylphenol ethoxylates (including alkyl phenol ethoxylate phosphate esters), or herbicides that contain these compounds are not proposed.

[6] On June 30, 2011, NOAA Fisheries issued a final biological opinion addressing the effects of this herbicide on ESA-listed Pacific salmonids. The opinion has concluded that EPA's proposed registration of certain uses of 2,4-D, including aquatic uses of 2,4-D BEE are likely to jeopardize the continued existence of the 28 endangered and threatened Pacific salmonids. http://www.nmfs.noaa.gov/pr/consultation/pesticides.htm

Table 3-8. Adjuvants proposed by Reclamation.

Adjuvant Type	Trade Name	Labeled Mixing Rates per Gallon of Application Mix	General Geographic Application Areas
Colorants	Dynamark™ U.V. (red)	0.1 fl oz	Riparian
	Aquamark™ Blue	0.1 fl oz	Riparian
	Dynamark™ U.V. (blue)	0.5 fl oz	Upland
	Highlight® (blue)	0.5 fl oz	Upland
Surfactants	Activator 90®	0.16 - 0.64 fl oz	Upland
	Agri-Dex®	0.16 - 0.48 fl oz	Riparian
	Entry II®	0.16 - 0.64 fl oz	Upland
	Hasten®	0.16 - 0.48 fl oz	Riparian
	LI 700®	0.16 - 0.48 fl oz	Riparian
	R-11®	0.16 -1.28 fl oz	Riparian
	Super Spread MSO®	0.16 - 0.32 fl oz	Riparian
	Syl-Tac®	0.16 - 0.48 fl oz	Upland
Drift Retardants	41-A®	0.03 - 0.06 fl oz	Riparian
	Valid®	0.16 fl oz	Upland

Herbicide carriers. Herbicide carriers (solvents) are limited to water or specifically labeled vegetable oil.

Herbicide mixing. Mix herbicides and adjuvants, carriers, and/or dyes more than 150 feet from any perennial or intermittent water body to minimize the risk of an accidental discharge.

Spill Cleanup Kit. Provide a spill cleanup kit whenever herbicides are used, transported, or stored. At a minimum, cleanup kits will include material safety data sheets, the herbicide label, emergency phone numbers, and absorbent material such as cat litter to contain spills.

Herbicide application rates. Apply herbicides at the lowest effective label rates.

Herbicide application methods. Apply liquid or granular forms of herbicides as follows:

- Broadcast spraying – hand held nozzles attached to back pack tanks or vehicles, or by using vehicle mounted booms.

- Spot spraying – hand held nozzles attached to back pack tanks or vehicles, hand-pumped spray, or squirt bottles to spray herbicide directly onto small patches or individual plants.

- Hand/selective – wicking and wiping, basal bark, fill ("hack and squirt"), stem injection, cut-stump.

- Triclopyr – will not be applied by broadcast spraying.

Washing spray tanks. Wash spray tanks 300 feet or more away from any surface water.

Minimization of herbicide drift and leaching. Minimize herbicide drift and leaching as follows:

- Do not spray when wind speeds are outside speeds specified in Table 3-9.

- Be aware of wind directions and potential for herbicides to affect aquatic habitat area downwind.

- Keep boom or spray as low as possible to reduce wind effects.

- Increase spray droplet size whenever possible by decreasing spray pressure, using high flow rate nozzles, using water diluents instead of oil, and adding thickening agents.

- Do not apply herbicides during temperature inversions, or when air temperature exceeds 80 ^{o}F.

Rain. Do not apply herbicides when the soil is saturated or when a precipitation event likely to produce direct runoff to salmon bearing waters from the treated area is forecasted by the NOAA National Weather Service or other similar forecasting service within 48 hours following application. Soil-activated herbicides may follow label instructions. Do not conduct hack-squirt/injection applications during periods of heavy rainfall

Herbicide buffer distances. Observe the following no-application buffer-widths, measured in feet, as map distance perpendicular to the bankfull elevation for streams, the upland boundary for wetlands, or the upper bank for roadside ditches. Widths are based on herbicide formula, stream type, and application method, during herbicide applications (Table 3-9 and Table 3-10). Before herbicide application begins, flag or mark the upland boundary of each applicable herbicide buffer to ensure that all buffers are in place and functional during treatment.

Table 3-9. Herbicide buffer widths to minimize impacts on non-target resources.

Herbicide	Broadcast Application		Backpack Sprayer/Bottle Spot Spray Foliar/Basal		Hand Application Wicking/Wiping Injection
	Min buffer from high water mark (ft)	Max/ Min wind speed (mph)	Min buffer from high water mark (ft)	Max/ Min wind speed (mph)	Min buffer from high water mark (wind speed not a factor)
2,4-D (amine)	100	10/2	50	5/2	15 feet for aquatic labeled formulations.
Aminopyralid	100	10/2	15	5/2	Up to high water mark.
Chlorsulfuron	100	10/2	15	5/2	Up to high water mark.
Clethodim	NA	NA	50	5/2	Do not use within 50 feet of any surface water
Clopyralid	100	10/2	15	5/2	Up to high water mark.
Dicamba (Banvel only)	100	10/2	15	5/2	Up to high water mark.
Glyphostate 1	100	10/2	15	5/2	Up to water's edge for aquatic labeled formulations.
Glyphostate 2	100	10/2	100	5/2	100 feet
Imazapic	100	10/2	15	5/2	Up to water's edge for aquatic labeled formulations.
Imazapyr	100	10/2	15	5/2	Up to water's edge for aquatic labeled formulations; otherwise, up to the high water mark.
Metsulfuron methyl	100	10/2	15	5/2	Up to high water mark.
Picloram	100	8/2	100	5/2	Do not use within 100 feet of any surface water.
Sethoxydim	100	10/2	50	5/2	Do not use within 50 feet of any surface water
Sulfometuron-methyl	100	10/2	15	5/2	Up to high water mark.
Triclopyr (TEA)	100	10/2	50	5/2	Up to high water mark for cutstump application of aquatic labeled formulations; 15 feet for other applications.
Herbicide Mixtures	100	Most conservative of listed herbicides	Most conservative of listed herbicides		Most conservative of listed herbicides

Table 3-10. Adjuvant buffer widths to minimize impacts on non-target resources.

Adjuvant	Broadcast Application	Backpack Sprayer/Bottle Spot Spray Foliar/Basal	Hand Application Wicking/Wiping Injection
	Min buffer from high water mark (ft)	Min buffer from high water mark (ft)	Min buffer from high water mark (ft) (wind speed not a factor)
Dynamark™ U.V. (red)	100	15	Up to water's edge when using herbicides labeled for aquatic uses.
Dynamark™ (yellow)	100	15	Up to water's edge when using herbicides labeled for aquatic uses.
Dynamark™ U.V. (blue)	100	> 50	50 ft, or distance based on herbicide (Table 2-3), whichever, greater.
Highlight® (blue)	100	> 50	50 ft, or distance based on herbicide (Table 2-3), whichever, greater.
Activator 90®	100	15	Up to water's edge when using herbicides labeled for aquatic uses.
Agri-Dex®	100	15	Up to water's edge when using herbicides labeled for aquatic uses.
Entry II®	100	100	Do not use <100
Hasten®	100	15	Up to water's edge when using herbicides labeled for aquatic uses.
LI 700®	100	15	Up to water's edge when using herbicides labeled for aquatic uses.
R-11®	100	50	50 ft, or distance based on herbicide (Table 2-3), whichever, greater.
Super Spread MSO®	100	15	Up to water's edge when using herbicides labeled for aquatic uses.
Syl-Tac®	100	50	50 ft, or distance based on herbicide (Table 2-3), whichever, greater.
41-A®	100	15	Up to water's edge when using herbicides labeled for aquatic uses.
Valid®	100	50	50 ft, or distance based on herbicide (Table 2-3), whichever, greater.

Activity 2b - Aquatic Herbicide Application

Within irrigation conveyance facilities, Ecology regulates herbicide application for aquatic weed control under National Pollutant Discharge Elimination System (NPDES) General Permit WAG – 991000. This general permit was renewed and effective on June 15, 2012 and expires on June 15, 2017. Irrigation districts apply herbicides to federally-owned irrigation conveyance facilities in a manner consistent with this NPDES permit. Herbicides covered by the NPDES general permit include acrolein, two endothall-based herbicides, xylene, copper, sodium carbonate peroxyhydrate, fluridone, and imazapyr. For fluridone, imazapyr, and sodium carbonate peroxyhydrate, conditions in the permit require virtually no-discharge at the point of compliance. For the other herbicides covered by the general permit, Ecology has derived maximum instantaneous concentration limits (Table 3-11).

Table 3-11. NPDES general permit numeric limits for pesticides.

Parameter	Maximum instantaneous concentration
Copper, dissolved	25 ug/l
Acrolein	21 ug/l
Dipotassium Salt of Endothall (such as Cascade)	5.0 mg/l (acid equivalent)
Mono (N,N-Dimethyl Alkylamine) Salt of Endothall (such as Teton)	0.050 mg/l (equal to 50 ug/l) (acid equivalent) at any time and
	0.2 mg/l (equal to 200 ug/l) (acid equivalent), subject to timing windows.
Xylene	5.1 mg/l

3.2.4 Storage and Water Delivery Facility Maintenance (Activity Type 3)

Activity 3a - Facility Inspections

Routine dam inspections are conducted under Reclamation's Review of Operation and Maintenance Program. Annually, field office personnel conduct local inspections to evaluate structural integrity and assess the need for repairs. Electrical, hydraulic, and mechanical systems are inspected during these reviews. External inspections, either from Reclamation's Regional O&M Program or Technical Service Center, occur at least every 4 years. Less frequent inspections are required for the intake structures.

In order to use the gated spillways, the reservoir must be near full pool. At Bumping Dam, Reclamation inspects the outlet works and stilling basin when Bumping Lake is full and discharge down the spillway can be used to meet target flow requirements downstream in the Bumping River. These inspections typically take 2 to 3 hours and are conducted every 6 years, with the exception of Kachess. Due to weep holes in the Kachess outlet works, annual inspections are required at this facility.

In addition to the outlet inspections described above, regulating and emergency gates are tested on an annual basis at each storage dam. Most of the inspection and gate maintenance work is conducted when no water is present; however, some of the regulating gate tests must be performed when water is present. These outlet gate maintenance activities could result in short-term flow fluctuations but are required to maintain the gates within operational criteria.

Kachess, Cle Elum, and Tieton Dams are equipped with gated spillways that must be annually load-tested to ensure proper function at maximum reservoir levels and/or during a flooding situation. Spillway gate load-tests are required under the Safety of Dams Act, and provide assurance that gated spillways will perform as designed under maximum head pressures (load). Reclamation performs these tests when lake levels are near or above spillway crests, usually during spring runoff or when each reservoir is full (May to June).

Keechelus, Clear Creek, and Bumping Dams are equipped with uncontrolled, fixed spillways that do not require load-testing. During flood events, Clear Creek Dam itself is designed to operate as an uncontrolled spillway.

Minimization Measures

- All applicable BMPs from Section 3.2.1.
- When planning facility inspections, Reclamation sets and maintains established instream flows downstream of the dams during these inspections and manages reservoir releases to ensure no substantial flow fluctuations occur.
- Reclamation's Yakima Field Office maintenance staff coordinates with staff hydrologists and biologists to confirm appropriate elevations and flows to ensure proper test timing. Reclamation typically solicits input from SOAC regarding inspection timing, flow conditions, and project duration.
- Generally, outlet inspections occur when downstream target flows can be met by releases from fish bypass pipes or outlet conduit at Keechelus, Kachess, and Cle Elum Dams or alternate reservoir outlet structures such as using one or two penstocks at Tieton Dam or gated spillways at Kachess, Cle Elum, or Tieton Dams.

- During spillway tests, Reclamation coordinates reservoir outflow by decreasing outlet releases at commensurate levels as spillway releases increase to dampen flow fluctuations below each reservoir when water is being released down a given spillway. However, load-tests require only minor gate movements, and Reclamation foresees no appreciable flow fluctuations in downstream reaches.

Activity 3b - Debris and Vegetation Clearing

Reclamation personnel remove debris and large wood that accumulates on the upstream face of the dams as well as on intake towers and on the crest of the spillway channels at most Reclamation facilities. While the amount of debris loading varies between years and between sites, clearing activities are generally required at each site on an annual basis. As part of the Proposed Action, Reclamation personnel will relocate some of this woody debris downstream of the storage dams. Reclamation anticipates that routine downstream relocation of at least 20 cubic yards of woody debris will occur at Keechelus, Cle Elum, Bumping, and Tieton Dams. Kachess and Clear Creek Dams do not receive sufficient material for this commitment. Reclamation will relocate this wood to predetermined downstream locations suggested by basin biologists. These downstream relocation sites must have existing access and be located downstream of dam gaging stations in order to be suitable.

Wood may be moved from the dam face or riprapped areas by the dam by boom truck, small boat, or backhoe. Material that is not relocated downstream (see "Minimization Measures," below) will be collected and disposed of through burning, as conditions allow.

Dam maintenance operations typically begin in the spring when equipment can access the sites and continues until the reservoirs reach full pool levels. Approximately 2 to 3 weeks are spent annually at each dam to perform log removal and debris clearing activities.

Minimization Measures

- All applicable BMPs from Section 3.2.1

- When possible, spillway releases may be used to move woody debris downstream. Wood selected for relocation will be sufficiently large to provide instream complexity, but not so large that Reclamation crews are not capable of moving the material (in excess of 12 ft in length and 3 ft in diameter).

- Reclamation will work with WDFW and the Yakama Nation to identify suitable sites to place wood.

Activity 3c – Repairs Existing Rock Armoring

Repairs upstream of dam (Activity 3c i)

Rock armoring repairs are restricted to the existing armored footprint. Due to routine wave action, rock replacement is annually needed on the reservoir side of the dam. One to two hundred cubic yards will be placed at Keechelus annually. Twenty cubic yards will be placed at Tieton Dam annually. At the remaining storage dams, 20 cubic yards will be placed on an as needed basis, estimated to occur every other year.

Repairs downstream of dams (Activity 3c ii)

Repairs to existing rock armoring are a common maintenance need. Significant amounts of rock rip-rap bank armoring are present around the Tieton, Bumping, Cle Elum, Keechelus, and Kachess Dam outlet channels, spillway channels, and stilling basins. The rip-rap material at these facilities is designed to dissipate energy and protect channel banks downstream of the outlet works at these facilities. During peak discharge periods from the outlet works or spillway channels, large amounts of energy are released into the channels downstream which can erode the rock rip-rap armoring of the stilling basins.

Rock placement downstream of the dam, located along the outlet works channel and stilling basin is required every 2 to 5 years per dam. As with rock placed upstream of the dam, rock placement is restricted to the existing footprint. Rock is placed in these areas when undercutting or cavitation undermines the existing structure.

The Safety of Dam directives and standards requires that the dam face, outlet channel and spillway basin be kept free of vegetation and maintain the free flow of water. Therefore, rock placed in these areas will not incorporate woody debris or live vegetation. Rock armoring is typically placed along the stilling basin and/or outlet channel banks while low volumes of water are being discharged at each facility and when material placement can occur both above and below the ordinary high water mark when little or no water is present along the channel margin. Consequently, most rock placement can be conducted out of the water. A tracked excavator that can individually place large rocks with the thumb of the excavator is used rather than dumping large loads of rock to fill voids in the bank armoring. Spillway channel rip-rap replacement work occurs at those times of the year when there is no water on the spillways and work can be accomplished during dry conditions.

Minimization Measures

- All applicable BMPs from Section 3.2.1
- Placement of rock is limited to original footprint.
- Rock placed upstream of the storage dams will occur out of the water, when the reservoir is drawn-down for normal operations.
- Rock placed downstream of the dams is placed in the dry, if possible. If rock must be placed in wetted conditions, it will be placed with the thumb of an excavator and not dumped.
- Reclamation conducts repairs when flow criteria can be maintained. At Keechelus, Kachess, and Cle Elum Dams, Reclamation maintains target flows in downstream reaches by using fish bypass pipes or releases from the outlet conduit to the outlet channel. At Tieton Dam, the preferred method to provide minimum flows is to use one of two penstocks that provides instream flow to the Tieton River while the other is repaired or maintained. Alternatively, the spillway could be used if Rimrock is at full pool. At Bumping Dam, Reclamation provides instream flow to the Bumping River through pumps or other suitable, alternate means such as the spillway, while outlet chute repairs are conducted.

Activity 3d – Concrete Repairs

Concrete Repairs to Spillway (Activity 3d i)

Outlet work concrete repair work is frequently required to maintain the outlet structures ability to function as designed and to be operated safely. The outlet works and spillway channels for several Yakima Project storage dams consist of concrete abutments, concrete lined pipes, or outlet chutes to direct dam flow away from the dams and to dissipate energy. The age and consistent use of these structures results in high rates of deterioration due to weathering and physical abrasion.

Annual outlet work concrete work is performed to repair small sections of deteriorating concrete at all of Reclamation's storage dams. Concrete repairs at each storage dam's spillway may be required annually. Routine concrete repair work qualifying for this activity type will be less than 10 percent of the area of the face of the spillway. These repairs consist of spot treatment of seams, joints, cracks, and spalling. Within the outlet conduit, this patch-work usually only requires hand tools and is conducted when no to minimal water is present near the work area. Work site isolation is used to prevent concrete contamination and to allow the concrete to cure before exposing it to water.

Concrete Repairs to Outlet Conduit (Activity 3d ii)

Spot repairs are required annually to the outlet conduit. Routine concrete repair work qualifying for this activity type will be less than 100 square feet in size. More typically, spot repairs are typically less than 16 square feet in size, approximately five of these repairs done annually.

Minimization Measures

- All applicable BMPs from Section 3.2.1
- If the repair work requires dewatering the outlet tunnels or outlet channels, the outlet works will be closed and water rerouted around the outlet works and replaced with an acceptable alternative source of water such as from the spillway or fish bypass pipe if present at the dam. Downstream flows will be maintained during these repairs.

3.2.5 Gaging Station Maintenance (Activity Type 4)

Reclamation operates and maintains approximately 90 HydroMet gages that measure discharge in rivers, streams, irrigation canals, and wasteways/drains and stage height in reservoirs. HydroMet gage stations are an integral part of the operation of the Yakima Project because they provide Reclamation with real-time flow measurements used in Storage Division operations. The HydroMet system also includes weather stations, instrumentation that records reservoir elevations, and repeater equipment.

The HydroMet watercourse gaging system primarily consists of common stage-discharge equipment utilizing stilling wells, gas-bubble manometers, or pressure transducers. Stilling well and manometer systems require connectivity with the wetted perimeter of a waterway, accomplished through a shallow well dug adjacent to a water body, or by one or more inlet pipes extending into the active channel buried under substrates or lying on the surface of the streambed. Pressure transducer equipment is usually mounted to bedrock outcropping or other suitably stable location (e.g. poured concrete footings). Staff gages are also usually installed and maintained near gaging station locations, typically along one bank of the waterway or less often, in the middle of the stream being gaged. Reclamation has attempted to place long-term gaging stations in locations with stable stream morphology. Gage station facilities and equipment measure the elevation or stage of water in a flowing channel, and stage measurements are recorded by instrumentation located in gage houses situated atop the adjacent river bank. Most HydroMet stations are telemetered, and send out periodic stage measurements that are converted into streamflow and posted on the HydroMet website for the Yakima Project (http://www.pn.usbr.gov/yakima/index.html). Additionally, many HydroMet stations monitor water temperature through sensors installed within or along the same conduits or inlet static tubes that measure river stage.

Over time, river channel adjustments (i.e. aggradation, degradation, or channel migration) can affect the operation of HydroMet gages or endanger station integrity and long-term function. For example, inlet orifices can become clogged with sediment, channel changes can move streamflow away from gage intakes, inlet pipes can corrode and break, silt deposition in canal settings can compromise gage accuracy and function, and high flow events can dislodge protective rip-rap and/or erode station infrastructure.

Activity 4a – Inlet Flushing

In order to maintain these gage stations, Reclamation flushes gage station inlets with compressed air. Each site is typically flushed at least one time, usually during the spring when background turbidity levels are high. A subset of these sites needs to be flushed more frequently. Reclamation general flushed one to two sites a week with compressed air during the irrigation season (March 15 to October 15).

Activity 4b – Repair or Replace Gage Station Components

Minor Excavation (4b i)

Minor excavation is generally required at one gaging station per year to address plugged or inoperable intakes and orifices in small streams. This excavation entails digging a trench to a depth of 1 to 3 feet and length of 5 to 15 feet during low-flow periods, using hand tools. This activity may be done year round, but is most commonly required in the spring if flood flows cause significant sediment transportation.

Excavation with Heavy Equipment (4b ii)

Replacing or repairing the gaging station components shown in Figure 3-2 (intake pipes, cement concrete seal, stilling well, foundation) requires heavy equipment and in-water work. Typically, one gaging station must be repaired every 2 to 3 years. The footprint for worksite isolation for these repairs is typically 20 feet by 100 feet. The site must be isolated from the stream or river and excavated in order to conduct these repairs.

Minimization Measures

- All applicable BMPs from Section 3.2.1
- Reclamation will excavate gage station equipment, to the maximum extent practicable, with heavy machinery situated atop adjacent streambanks.

Activity 4c - Staff Gage Replacement

Generally, less than five outside staff gages need to be repaired or replaced annually. This activity requires the use of rock drills and/or hammers to attach equipment to bedrock, adjacent concrete structures, or existing mounting pole. At times (generally one site a year), the mounting pole for the staff gage needs to be replaced.

Minimization Measures

- All applicable BMPs from Section 3.2.1
- If a new mounting pole needs to be placed, it will be driven into the river bed using a vibratory tamper attached to the boom of a hydraulic excavator.

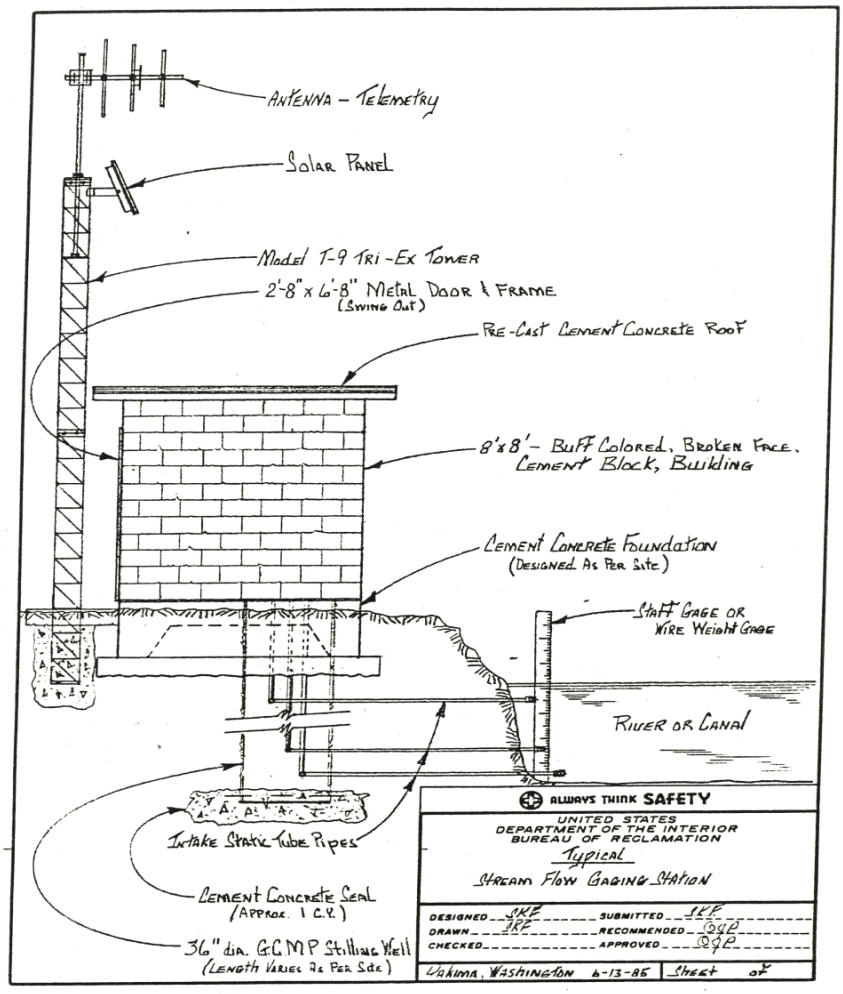

Figure 3-2. Drawing of a typical Reclamation streamflow gaging station. Drawing includes all components of the proposed gaging station at PARW including concrete footing, GCMP stilling well, three intake static tube pipes, slope gage, and gage house.

3.2.6 Irrigation Division Maintenance Activities (Activity 5)

Activity 5a - Diversion Dam Inspection

Reclamation conducts inspections on all diversion dams that are held in title by the U.S. Many of these diversion dams are transferred works and as such, are operated and maintained by the irrigation districts. Diversion dams that are transferred works include Easton, Yakima-Tieton, and Sunnyside Dams. Roza, Prosser, and Wapatox Diversion Dams are operated and maintained by Reclamation. Wapato Irrigation Project owns, operates, and maintains the Wapato Diversion Dam. Inspections consist of visual evaluation of the structures. Diversion dam inspections are proposed for all Yakima Project reserved and transferred works.

Minimization Measures

- All applicable BMPs from Section 3.2.1
- Inspection crews consult and coordinate with hydrology and environmental programs staff prior to implementing required activities in order to minimize adverse impacts to storage, flood control, irrigation diversion, fishery, and natural resources.
- When determining the most suitable time of year for the work, the instream flow requirements are considered along with maximum flows that can safely allow the inspection activities to occur. Inspections consist of visual evaluation of the structures.

Activity 5b - Debris Removal

Reclamation is responsible for debris management at reserved diversion dams (Roza, Prosser, and Wapatox). Woody debris can be operationally passed over or under Roza Dam and does not accumulate at Wapatox Dam. Large wood routinely accumulates at Prosser Dam and cannot be passed by altering the dam configuration, as it can at Roza Dam. Wood that accumulates at Prosser Dam can compromise fish passage conditions at the ladders, threaten the dam infrastructure, and affect water diversion. Therefore, annual maintenance to remove debris is proposed at Prosser. The normal work window for this activity is June 1 through August 31. To ensure fish passage through the ladders year-round, Reclamation may remove debris that accumulates within the ladder outside the June 1 through August 31 work window. Debris removal at Prosser Dam typically takes 1 to 2 days to complete. The work area cannot be safely and effectively isolated for this activity.

An excavator is used to remove the debris, and may need to enter the river channel to reach the locations where wood accumulates. In order for the excavator to safely enter the mainstem Yakima River for debris removal at the lower Yakima River sites, flows may need to be maintained in the 400 to 450 cfs flow range downstream of Prosser Dam.

Minimization Measures

- All applicable BMPs from Section 3.2.1
- When woody debris is removed from the dam, material is collected by an excavator from the forebay and/or dam crest and is placed downstream of the dam and within the ordinary high water line of the river.
- This material is kept as intact as possible, but if the piece is sufficiently large that it cannot be lifted with available equipment, it may be cut into smaller pieces.
- Non-natural debris is disposed of at an upland disposal site.

Activity 5c – Canal Repairs

Maintenance activities that routinely occur within the network of reserved and transferred federal water delivery canals include the annual repair or replacement of concrete wall sections, replacing rip-rap, installing filter fabric overlays, reshaping sections of earthen canals, applying shotcrete, grouting of cracks in canal walls, and removing sediment and debris that has accumulated in depositional areas of the canals. These activities are all performed after the canals have been dewatered after the irrigation season, so they will be conducted in the dry with little potential to impact aquatic areas. Work to inspect, repair, and remove debris from tunnels and siphons is typically conducted on an annual basis. As with other canal maintenance work, this activity is performed after water has been shut off for maintenance.

Small sections of canal bank are periodically removed and reconstructed as time, funding, and need allow. These repair activities occur during the non-irrigation season whenever possible so that work can be conducted in the dry and to limit disruptions to water delivery through the canal system. Heavy equipment is typically needed for the appropriate level of repairs to restore structural integrity of the canal bank. This equipment will typically access the canal break on adjacent canal access roads. Since canals are typically located away from the Yakima and Naches Rivers and their tributaries, canal repair activities should not have major aquatic impacts to downstream water bodies.

Minimization Measures

- All applicable BMPs from Section 3.2.1

Activity 5d – Drain Maintenance

Drains refer to the piping system that collects seepage along the entire main canal. Reclamation and irrigation district crews maintain the various canal toe drains and emergency canal evacuation drains on an as needed basis. These series of drains require vegetation and sometimes sediment removal for the drains to flow as designed. Routine maintenance activities include repairing a replacing drain tile annually. Reclamation anticipates that less than 4 miles of drain tile is repaired annually, across the entire main canal network. Additionally, mechanical removal of vegetation growth ("rotorooting") is required several times per year along the drain network. Finally, the drain canal may need to be dredged in places to remove accumulated sediment and aquatic vegetation mats that have overgrown the drain canals. Water seepage from toe drains is usually insufficient to result in a surface water connection to other downslope water bodies.

Minimization Measures

- All applicable BMPs from Section 3.2.1

3.2.7 Fish Screening and Passage Facility Operation and Maintenance (Activity 6)

The Proposed Action includes the routine operation, inspection, and maintenance of 55 fish screen and passage facilities in the Yakima basin where Reclamation has a role in O&M (see Section 2.3.5). For each facility, a SOP directs operations to provide for optimal function of the facility. In most instances, these SOPs were co-developed with NOAA Fisheries, WDFW, or both at the time the facility was designed. Each facility specific SOP is incorporated by reference and available for inspection at the Yakima Field Office.

A SOP identifies criteria for a particular facility that Reclamation and its contractors seek to achieve through the routine and active operation of the system. Being that these facilities function in dynamic hydrologic environments, operating consistent with criteria involves frequent, and often manual, adjustment and readjustment of facilities. Between adjustments, facilities may temporarily operate outside the criteria. This does not necessarily indicate a facility is not functioning; only that optimal performance is not being achieved. Similarly, over time, routine wear and tear and changes in river morphology can impair the ability of a facility to function as designed.

To assure that facilities are operated consistent with criteria and remain in effective working condition, Reclamation performs several levels of inspection and maintenance. Regular inspections occur during the operational period of a facility on at least a weekly basis to determine whether the facility is being operated according to SOP criteria. Annual inspections occur while facilities are off-line and serve to direct annual maintenance

activities. Regional inspections occur once every 6 years and serve to identify larger scale maintenance and operational needs. Inspections can also occur in response to reportable incidents.

At sites for which Reclamation has ownership or custody responsibilities, but does not conduct routine O&M, Reclamation will annually verify that work specified under our contracts is completed. Finally, during annual, monthly, and weekly inspections, Reclamation personnel or contractors check the facilities for problems impacting facility function. Any problems that cannot be resolved through operational adjustments are documented and scheduled to be addressed through a work order request.

Activity 6a – Fish Facility Inspections

Inspections (Activity 6a)

Annual Inspections

Reclamation annually inspects all fish passage facilities. Annual ladder inspections include operating all gates and weirs in both full open and closed positions. The trash and diffuser racks, staff gages, grating, and condition of the concrete structure are inspected. Reclamation notes the condition of these items and corrects minor deficiencies immediately. For larger deficiencies, Reclamation generates a work order and assigns a target completion date at that time.

If a large amount of bed material has accumulated in the ladder structure, it is usually behind the attraction racks in the lower ladder or jet flow bays. The attraction racks are finer spaced so the bed material is trapped behind them. The jet flow bays are located below the ladder floor and bed material drops into them as the water pushes it through the ladder. By pulling the diffuser racks and opening the jet flow, water flushes the bed load out of these two areas. These actions are coordinated with the Yakima Field Office biologists and hydrologists.

Fish screen inspections occur when the facility can go off-line for a period of time. At irrigation diversions, this occurs outside the irrigation season and at hydroelectric diversions, during a regularly scheduled shut-down period. Fish screen mesh and seals, gear boxes and drives chains, porosity boards, and site flow check gates are inspected. Seals and porosity boards are replaced as necessary. A system functional test is also conducted at these sites.

Regional Facility Inspections

Regional facility inspections occur every six years and include both Phase 1 and 2 sites. These inspections are documented in a report and result in recommendations with assigned due dates resulting in the need for project planning and budgeting for activities beyond routine O&M. In the future, all periodic regional evaluations will:

- Incorporate field-based hydraulic evaluations of site performance relative to design criteria during a range of flow conditions during the operational season.
- Include a fish biologist in the inspection and report review.
- Check for discrepancies between site conditions and engineering records, drawings, Designer's Operating Criteria, and SOPs.
- Check that current documentation of operational system configurations, including an identification of normal and abnormal conditions and emergency procedures, are up to date.
- Solicit input from operators about current operating practices and document any concerns.
- Review maintenance logs for records regarding deficiencies observed during site visits.
- Consider whether any new biological information is available which would suggest a change to the SOP or Designer's Operating Criteria is warranted.

Activity 6b – Fish Facility Operations

Fish Ladder Operations (Activity 6b i)

Fish ladders are operated year-round. During operational checks, personnel check that ladder and attraction flow settings meet operational criteria and assure there are no obstructions in the entrances and exits. If problems are encountered during weekly maintenance checks, the operators will address those problems that can be immediately corrected. Examples include clearing debris and accumulated material from the vertical slots or individual pool and weir fish ladder bays, adjusting fish ladder flashboards to maintain flow criteria whenever possible, or to adjust auxiliary attraction flows to aid fish in finding and using the fish ladder entrances. For problems that cannot be immediately corrected, operators alert the Fish Passage and Screening Supervisor and actions to correct the problem are developed.

Operational checks are made more frequently during periods of high flow and debris transport in the river as well as those times when fish are actively migrating; therefore, are more likely to be using the ladders. During periods of high flows, ladders are temporarily closed in order to protect the structure from bedload and debris. If high amounts of smaller debris are the concern, then the attractions may be closed during this period to prevent the total plugging of the finer attraction racks. This also allows the ladders to be operational sooner after the high debris load passes as cleaning takes less time. The SOP documents the river stage that triggers ladder closings and re-openings.

Given the range of flows in the Yakima basin, mainstem fish ladders need periodic adjustments to remain functional and to operate within established operating criteria. At low flows, water available to maintain fish passage at a particular location may be insufficient to maintain operating criteria at all ladders at a site with multiple fish ladders (e.g. Sunnyside, Wapato, and Prosser Diversion Dams). Conversely, during high flows, low flow fish ladder entrances need to be closed and high flow entrances opened to successfully attract and guide fish through the ladders. As a result, the type of ladder entrance (i.e. high flow or low flow entrance), use of auxiliary attraction flow needed (if any), and number of fish ladders in operation at each location must be constantly adjusted to have the proper ladder configuration to allow for maximum fish passage efficiency and to minimize fish migration delays.

To make operations and ladder adjustments as clear as possible, each diversion dam and fish ladder complex has been evaluated for fish passage efficiency over the range of flows that occur at each specific facility. SOPs have been created for each facility as guides to ensure that ladder adjustments are consistently applied over the range of flows observed over the period of operation. Ladder adjustments at each facility are outlined in the SOPs to provide the proper ladder configurations that will maximize passage at all flows. The SOPs are reviewed and modified if there are any alterations to the structure and/or changes in the river channel that affect them.

In general, fish ladders are operated to remain functional and within criteria at all times of the year. However, there are times when river flows are either inadequate or too high to keep the ladders within design flow or NOAA Fisheries passage criteria guidelines. Although, ladders will be maintained and adjusted throughout the year, fish ladders will be visited more frequently by maintenance crews during critical flow periods (e.g. during both high and low-flow periods, or when fish runs are actively migrating), and ladder adjustments will be made whenever flows change and conditions outlined in the SOPs require adjustments.

During periods of low flow, it is particularly difficult to keep fish ladders open and operating within criteria. For example, at Sunnyside Dam, all three ladders (i.e. right bank ladder, center ladder, and left bank ladder) can be operated within criteria when flows are held at 400 cfs or greater at Parker (PARW). However, when flows drop to 350 cfs at this location, the attraction flow gates for both the right and left ladders need to be closed due to insufficient water to maintain attraction flows through these ladders. Finally, as flows in the river drop further to 300 cfs, the right and left bank ladders are closed altogether and only the center ladder is operated within criteria (i.e. both the fish entrances are open and attraction flows on for both sides of the center ladder) (Appendix E).

Similarly, the three fish ladders at Prosser Dam are sequentially adjusted whenever flows over Prosser Dam fall from 500 to 300 cfs. At 500 cfs, all ladders at this facility (right bank ladder, center ladder, and left bank ladder) are open and operating within criteria (i.e. entrances open with full attraction flows through ladder). As river flows fall below 400 cfs,

attraction flows cease and the entrance to one half of the center ladder is closed due to insufficient water flow in the river. When river flow conditions fall to 350 cfs at Prosser Dam, the center ladder is completely shut down and only the right and left bank ladders are operated. Finally, on those rare occasions when flows reach 300 cfs at this location, the right bank ladder is closed and only the left bank ladder is operated within operating criteria at this facility.

Fish Screen Operations (Activity 6b ii)

During the irrigation season and at sites that Reclamation has operational responsibility, Reclamation visits each fish screen site at least weekly. For some sites and under some conditions, Reclamation personnel visit the site daily. During these inspections, Reclamation employees or contractors 1) determine that the screens meet submergence criteria and are operating properly, 2) insure fish bypass flows are within operating criteria and make adjustments as necessary, 3) remove debris, and 4) check for vandalism.

A key component of these regular inspections is to monitor the bypass systems for debris. Organic material and trash that accumulate on the upstream face of screens can increase water pressure and threaten the structural integrity of the screen. In order to prevent this problem, screens are equipped with self-cleaning mechanisms. The type of screening influences whether the majority of the debris caught on the screen is ultimately passed to the fish bypass or if a component is transferred downstream to the canal. In fixed plate systems, all debris ultimately is diverted to the bypass. In rolling drum screen designs, the majority of small vegetation rolls over the screen while larger woody debris ends up at the bypass.

Most of the debris that is carried to the bypass will flow through the bypass without a problem. Larger woody debris will sometimes get stuck in the down well after the bypass ramp and is removed by personnel checking the site prior to it accumulating other debris and impeding the water and fish movement and/or harming the fish using the bypass. At smaller diversions, the entire fish bypass may become clogged with sediment and/or debris, in which case it is necessary to clear the pipe using either a high pressure water jet system or compressed air to regain normal flow through the bypass pipe.

Maintenance crews also inspect the outfall pipes of bypass systems, where the fish exit and are returned to flowing waters downstream of the screening facility. Large woody debris or an accumulation of smaller pieces of organic debris, aquatic vegetation growth, as well as rock and sediment have been known to accumulate at fish bypass system outfalls to such a degree that they can interfere with bypass pipe hydraulics and impede the ability of fish to pass efficiently. These types of debris accumulations will be immediately removed using hand tools. Reclamation personnel also inspect the outfall location for bank erosion, rock instability around the outfall pipe, or for exposed outfall pipes that may be vulnerable to damage during future high flow events.

The frequency of visits depends on the nature of the site and the current operational conditions. At times of the year when debris load is low and the site does not require frequent cleaning and/or adjustments to maintain criteria, site visits occur at least 1 or 2 times per week. Due to certain operations at some sites, more frequent cleaning and/or adjustments are required to maintain criteria and are visited more often. Site visit frequency also increases during unusual weather events such as during flooding and when debris loading is high.

Activity 6c –Gravel and Debris Removal

Gravel and Debris Removal –Screens (Activity 6c i)

Routine sediment removal from the area located immediately in front of the screens is generally required at all sites. This activity occurs during annual shut-down operations, after the diversion headgate is closed, the screen forebay drained, and fish salvage conducted, as necessary. Approximately 10 cubic yards of fine sediment is annually removed from each of the smaller, Phase 2 facilities. Annual sediment removal activities at larger mainstem facilities are approximately 40 cubic yards per site.

Gravel and Debris Removal – Bypass Outfalls and Ladder Entrances (Activity 6c ii)

Channel aggradation often occurs upstream of diversion dams as bedload and fine sediments encounter slackwater conditions and fluvial transport diminishes or ceases. Periodic removal of deposited material is required in order to keep bypass outfalls and ladder entrances clear. Reclamation personnel and its contractors occasionally send compressed air through the bypass pipes, especially at the smaller facilities, during the irrigation season to keep the bypasses clear. Occasionally, in-water dredging is required to keep the outfall bypass and ladder entrances clear.

While patterns of sediment deposition can be unpredictable, routine dredging activity is required at Nelson Dam, Roza Dam, Sunnyside Dam, and at the Bachelor-Hatton diversions. Descriptions of activities at these locations are provided below.

Nelson Dam

Nelson Dam, a non-federal facility, is located within a depositional reach of the Naches River. In order to keep the associated fish passage facilities (two fish screens and one fish ladder) operational, Reclamation must routinely dredge gravel deposits that accumulate near these structures after depositional flow events occur. Gravel is removed every 1 to 3 years using a backhoe or tracked excavator to open up the fish ladder exit channel and clean the gravel out of the fish bypass outfall exit. The work area cannot be safely and effectively isolated for this activity. To perform this operation, heavy equipment needs to enter the

Naches River through existing access routes both upstream and downstream of the nearby dam. These access points are established rock rip-rapped portions of streambank that Reclamation has used in the past to walk tracked excavators into the stream channel. Once in the Naches River, the excavator works from within the river channel or from a dry gravel bar to cut a channel through the accumulated depositional material that is deep and wide enough to provide sufficient water flow to successfully pass adult fish from the fish ladder exit to the main channel of the Naches River during the lowest expected streamflow levels in the river. Similarly, the excavator will remove enough gravel from the fish screen bypass outfall pipe to allow juvenile fish to freely exit the bypass pipe and to successfully migrate to the main channel of the Naches River downstream of the dam. Approximately 40 to 80 cubic yards of material is cleared from around the fish ladder and fish bypass systems after each depositional flow event depending upon the amount of bedload material deposited at each location. The gravel removed from the fish ladder exit and from around the fish bypass pipe will not be removed from the river channel but will be spread downstream of the fish ladder and bypass outfall pipe locations. This activity is done from June 15th to October 31st, or from January 1st to January 15th time periods when streamflows are sufficiently low to allow machinery access into the river channel.

Reclamation anticipates that this routine dredging will be required at the Nelson Dam screen site outfalls until Reclamation can reconstruct the site so that water can be diverted and screened without the need for bypass. While Reclamation has advanced design work for this improvement, uncertainties associated necessary non-Reclamation infrastructure changes and required Reclamation and BPA funding, makes it difficult to anticipate the implementation timeline.

Roza Dam

Reclamation has historically needed to remove sediment from the front of the Yakama Nation's Roza Dam Adult Trapping and Monitoring Facility and the Roza Dam left bank low flow fish ladder approximately every 5 years. If the sediments are not removed, adult fish may get stranded in shallow areas or will be delayed in their return to the mainstem Yakima River upstream of the dam. Similarly, sediments also settle out upstream of the left bank low flow fish ladder and when excessive amounts accumulate in front of the ladder, water flow is restricted through the ladder which subsequently becomes out of criteria.

Reclamation removes approximately 300 to 500 cubic yards of sediment from the Roza Pool when passage conditions become poor for adults that are released from the Yakama Nation Adult Trapping and Monitoring Facility or when hydraulic conditions through the low flow fish ladder are out of criteria. Sediment removal is performed through the use of a 40-ton crane equipped with a bucket or clam shell dredge. The crane operates from an existing dam access road and hardened concrete pad adjacent to the Adult Trapping Facility. The crane used for this operation does not require entry into areas below the ordinary or high water marks of the Yakima River within the Roza Pool. The dredging to deepen the Adult

Trapping Facility bypass channel creates a channel through the accumulated sediment bar that is approximately 200 feet in total length and 8 feet wide by 5 feet deep. The dredging operation will remove enough sediment to keep the ladder operational. All dredged/excavated materials removed from the Roza Pool is loaded into dump trucks and disposed of in an existing spoil disposal site that is located on Reclamation property approximately 300 to 500 yards upslope from the Roza Pool.

Sediment removal operations take place after the Roza Pool has been drawn down to facilitate annual maintenance for the Roza Dam fish screen facilities. This annual drawdown period is from October 20th to late-November. When required, the dredging activities typically take place in the 1st or 2nd weeks of November to allow the sediments to fully drain prior to their removal. Because this project occurs while the Roza Pool is at its lowest elevation of the year (1207 feet), the dredging activity is completed in the dry as much as possible since the lowest elevation in the dredged trench is at 1213 feet. The clamshell dredge does not excavate in areas that are connected to the wetted margin of the Yakima River for activities related to the Adult Trapping Facility dredging. The clamshell dredge is also used to remove sediments along the Roza Pool margin (wetted, but not isolated through the placement of cofferdams) when dredging areas in front of the low flow fish ladder.

Sunnyside Dam

Gravel and sediment frequently deposit on the downstream side of the island and this sediment encroaches on the left bank side of the river near the Sunnyside Dam headgate. In some years, gravel encroachment has restricted flow into the SVID Main Canal, potentially limiting the amount of water that can be diverted. To correct this problem, SVID and Reclamation crews must remove accumulated sediment to open a flow path from the main river thalweg to the canal headgate approximately every 2 to 3 years. This operation occurs during a low-flow period in the summer when a flow restriction is apparent. The work is accomplished during a time when the equipment can be walked to the island and can be operated safely in the river channel. Gravel is also removed from the left bank fish ladder to help ensure that flows are sufficient for maintaining ladder flow and attraction water criteria. The work area cannot be safely and effectively isolated for this activity.

Bachelor-Hatton

Routine gravel removal is required every 1 to 3 years at the Bachelor-Hatton bypass outfall on Ahtanum Creek. This gravel removal occurs between August 15th and October 31st when the gage readings at the downstream Ahtanum gage are less than 45 cfs. Large sandbags are used to isolate the excavated area. A backhoe and/or excavator are used to remove the necessary gravels, which are either trucked offsite or placed outside the floodplain. The footprint for the isolated and excavated area is approximately 250 square feet. Approximately 40 cubic yards of bedload is removed per dredging event. Excavated gravel will either be trucked offsite or placed above the ordinary high water mark.

Minimization Measures

- All applicable BMPs from Section 3.2.1
- Machinery will, when possible, access fish ladders from positions atop adjacent riverbanks. When necessary, equipment will enter the Yakima and Naches Rivers or their tributaries to remove bed materials that prevent proper ladder operation.
- Excavated materials will be removed from ladder intakes and/or outfalls, and placed inside the active channel along downstream sites at or below bankfull channel elevation, if allowed, per the conditions of the Hydraulic Permit Application.

Activity 6d - Routine Repairs and Structural Maintenance

Fish Ladder Repairs and Maintenance (Activity 6d i)

Fish ladder repairs and maintenance refers to activities to address or prevent deficiencies in the ladder structure, including entrances and exits, gates, dissipation features, and attraction flow valves. For maintenance operations that occur on pool and weir configured fish ladders, it is not always necessary to completely dewater the ladder to perform maintenance activities. When these situations occur, residual pools typically remain between weirs when water flow ceases through the ladder and work can be conducted without completely dewatering the ladder. If a visual inspection indicates that fish are not present within residual pools and work will not result in large increases in turbidity, ladder maintenance is conducted with water present in the ladder. If maintenance work is required to be performed in the dry, water will be pumped out of pool and weir ladders with screened submersible pumps.

For problems requiring immediate maintenance to repair equipment, the affected fish ladder will be shut off and possibly dewatered to facilitate immediate repairs. Whenever possible, the ladder bays will remain wetted while repairs are performed. Repairs will be done as quickly as possible to limit the amount of time that the ladder is shut down to limit impacts to fish species that may potentially use the ladder during the repair period. Most center channel ladders have a left and right side, so in most cases only one half of the ladder will be dewatered to perform the repairs. If a ladder must be completely dewatered to effectively implement the repair, the ladder entrance and exit will be fully stop logged to prevent water flow through the ladder and water within the ladder will be drained by gravity flow or pumps to a level that will allow for repair activities to occur.

Reclamation defers maintenance on fish ladders that are not immediately impeding fish passage or during times when listed species are actively migrating, to a time when repairs or maintenance can be performed when fish are not likely to be present and using the ladder. Maintenance work at Yakima Project fish ladders will occur over as short a time period as possible to limit the disruption to fish species and amount of time that the ladders are not

operational. In addition, for those mainstem dams that have multiple fish ladders, Reclamation will only shut down one ladder at a time to decrease the impact on listed fish species that could be migrating through the facilities concurrent with maintenance activities.

Fish Screen Repairs and Maintenance (Activity 6d ii)

Most fish screen annual maintenance is performed during the non-irrigation season. Annual maintenance and inspection activities at larger, generally mainstem diversions, require about 2 weeks to complete. Annual maintenance and inspection activities at the smaller sites require about a week. Maintenance and inspection activities occur once the screen site is dewatered. At sites where dewatering results in potential fish stranding (where not all fish exit via the bypass pipe during dewatering), fish salvage is conducted (Section 3.2.1). Once the site is dewatered, screens, bays, and bypasses are inspected during the annual maintenance (Table 3-12). The inspections during this period are focused largely on structures and equipment that are submerged during the operating season. These include fish screens, bypass systems, supporting concrete and metal structures, trash racks, gates, valves, and porosity boards. On the fish screens, the points of inspection are seals, mesh, framework, coatings, bearings, grease lines fasteners, chains, sprockets, anodes, and cleaning system where applicable. These items are repaired or replaced as needed. Once the inspection and necessary maintenance is complete, the fish screens are checked to insure they operate as designed. Inspection of the bypass systems include looking for obstructions in the system or damage to ramps, pipes, gates, weirs, and outfalls that might impede or injure fish, and insuring the weirs and gates operate properly so criteria can be maintained. If any obstructions are found, they are removed and any damaged items or items not operating properly are repaired.

Inspection of the supporting structures such as the concrete around the fish screens, metal framework supporting the porosity boards, etc. is to insure their integrity to provide support for another operating season. Items of concern are repaired, if possible, and/or documented and reported for further review by an engineer. Trash rack inspection includes looking for damaged bars or pipes that might make cleaning them difficult, any severely corroded fasteners or metal parts that might fail, and any areas that could impede or harm fish passage through them. The porosity board inspections note the condition of the metal work, coating, fasteners, and the wood or metal boards, as applicable. Problem items are repaired or replaced and the porosity boards are set back into their slots. Deposition of silt occurs at the screen facilities as the water velocity in the canal is slowed to the 0.5 cfs velocity required through the screen. Accumulated silt (estimated as approximately 40 cubic yards annually at Phase 1 sites and 10 cubic yards annually at Phase 2 sites) is removed from the screen forebay and aftbays with backhoes, excavators, front-end loaders, and shovels. These sediments are transported to upland disposal sites that are located far enough away from the fish screen facility so that no silt laden material can re-enter the diversion facility or natural watercourse.

In addition to field-based maintenance at the screen sites, comprehensive screen refurbishment is conducted by the Yakima Field Office screen shop. Screens are refurbished to insure no catastrophic failures occur and to prevent deterioration of the screens to a point of needing total replacement. This rebuild also reduces field maintenance and extends seal and mesh life. The screens are brought into the Yakima Field Office screen shop; disassembled, blasted, frames are trued and modified as needed, painted, and reassembled. When all inspection, cleaning, maintenance, and repair activities are complete, Reclamation will record yearly repair activities for later review.

The Roza and Chandler Canals divert water year-round for power production. Generally, Reclamation performs maintenance at the Roza Canal fish screens in late October at the end of the irrigation season, taking approximately 3 to 4 weeks to complete. Maintenance activities are undertaken at the Chandler Canal fish screens in late November, and take approximately 3 to 4 weeks to complete. The Yakima Field Office Manager coordinates maintenance timing and flow subordination targets downstream from Roza and Prosser Dams with the input of SOAC, WDFW, and others. For example, Reclamation usually defers maintenance at the Chandler Canal fish screen site until fall Chinook salmon have completed their spawning and the WDFW informs Reclamation that it is acceptable to proceed with canal shut-down and power subordination at the Chandler Powerplant.

Table 3-12. List of fish screen annual repairs.

Close and secure head gates. This is usually performed by the irrigation district or powerplant. The head gates need to seal tightly to prevent water flow to screen site. Disable any auto-dialer/call-out alarm system for the winter.
Open fish bypass and pull incline ramps to allow fish to escape. Open all bypass drains, plugs, or gates to drain the remaining standing water.
Perform fish salvage if necessary.
Start dewatering pumps to finish dewatering site.
Rotate all screens and check bottom seals and side seals condition. Inspect screen fabric for dents, wear, holes, or gaps that would cause the screen to not be fish tight.
Disconnect gear box electric power cords and coil-up to prevent damage to cord, outlet, or outlet covers.
Perform safety inspection on gantry hoist, monorail hoist, and related equipment. Raise all screens and install storage pins or bars. Inspect gear heads, drive chains, chain tubs, drum bearings, and hubs for damage, wear, or leaks.
Wash-down screens and screen frames. Inspect anodes, screen frame bolts, and welds and repair/replace as needed. Clean all screen bays, bypass channels, and remove all debris.
Inspect and repair stop log/porosity board panels and frames and re-set stop logs.

Replace or adjust all damaged/worn screen seals or brushes.
Inspect fish bypass, weirs, ramps, pipes, and river out falls. Inspect pipe joints, clean, repair, and smooth any damaged joints or concrete areas.
Inspect and repair trash rack, trash rake, fencing, and gates.
Drain all wash-down pumps and piping. Open drain valves and remove any water that may cause winter freeze-up damage.
Clean generator/storage building and properly store tools, fasteners, and materials. Make daily log book entries of work progress and record date of annual work completion.

Screen Mesh Upgrades

Fish screens sites will be refurbished with replacement mesh meeting current NOAA Fisheries criteria when screen mesh replacement is required (Appendix D). The Roza screens will also be refurbished with replacement mesh meeting current NOAA Fisheries criteria. Due to cost and logistical issues associated with removing, transporting, and reinstalling the existing 17.5-foot diameter drum screens (27 drums total), Reclamation is pursuing a facility rebuild. The current approach being considered is the retrofit the 5 existing screen bays with flat plate fish screens. Reclamation will continue to work with NOAA Fisheries on review and approval of the design selected for implementation.

Minimization Measures

- All applicable BMPs from Section 3.2.1
- Conduct routine maintenance at fish screen structures when the water diversion is scheduled to be down (due to regular maintenance or regular irrigation shut-down operations)
- Prompt response to facility repairs when needed.

3.3 YRBWEP Property Management

Routine maintenance of properties purchased under YRBWP authorities are part of the Proposed Action. The scope of these routine actions includes weed management and basic vegetation management and establishment. More extensive restoration efforts at these sites fall outside the scope of O&M and constitute a distinct federal action and potential effects to listed species will be addressed through separate Section 7 ESA consultation.

Reclamation manages land purchased through the YRBWEP program (Table 3-9). Much of this land is being rehabilitated back to near native habitat vegetation. Through this process, Reclamation and its contractors use herbicides to suppress unwanted vegetation until native vegetation can be established. Herbicide use is covered under Section 3.2.2.

Reclamation uses chemical or mechanical weed control methods for 2 to 3 years to suppress weed populations before native plants are seeded. Generally, 20 percent reseeding is required the following year, and broadcast or spot spraying for weed control are conducted until grasses have become sufficiently established to out-compete weeds. Once native grasses have been established, Reclamation introduces native woody species to the plant community.

Other general land management activities include the installation of gates, locks and fencing, the removal of old interior fencing, and the placement of fencing around new vegetation to protect from beaver, elk, and other wildlife herbivory.

3.4 Conservation Measures

The term conservation measures is defined as actions to benefit or promote the recovery of listed species that are included by the federal agency as an integral part of the Proposed Action. These actions will be taken to minimize or compensate for project effects on the species under review. These may include actions taken prior to the initiation of consultation, or action which the federal agency or applicant have committed to complete in a BA or similar document. The conservation measures proposed assist Reclamation in best meeting the requirements under Section 7 of ESA by (1) "…utilizing our authorities in furtherance of the purpose of this Act by carrying out programs for the conservation of endangered species… and (2) avoiding actions that jeopardize the continued existence of listed species."

3.4.1 Operational Changes

Specific operational commitments intended to reduce take of ESA-listed fish species include:

- Implementation of ramping rates.
- The establishment of winter instream flows at EASW, CLE, BUM, RIM, and TICW.
- The establishment of minimum reservoir releases to provide flows downstream of Rimrock Dam, Cle Elum Dam, and in the Easton reach during April and May.
- Power subordination at Roza and Chandler Powerplants.
- Management of Rimrock Reservoir to hold at least 127,000 acre-feet in storage until August 10th.

- Attempting to provide flow conditions down the Clear Creek Dam spillway that are as conducive to bull trout passage as possible.

A full description of these operational commitments is located in Section 3.1.2.

In addition to these operational commitments, Reclamation proposes the following investigations, and where practicable, associated management actions to minimize take associated with specific facility operations.

3.4.2 Chandler Fish Bypass Steelhead Smolt Survival Study

Monitoring at the Chandler facility suggests that predation on outmigrating salmonids smolts by piscivorous fish is high within the Chandler Canal and that diversion operations can influence steelhead smolt exposure to predation. Reclamation proposes to conduct a 3-year steelhead smolt survival study at the Chandler Canal fish bypass facility. The objectives of this investigation are to 1) define the baseline steelhead smolt survival rate through the Chandler Canal, 2) identify and quantify primary causes of mortality, and 3) recommend management actions. This activity will conclude with a final report containing recommendations for specific activities to reduce smolt mortality at the bypass facility.

As part of this 3-year study, Reclamation will tag steelhead collected upstream of Prosser Dam with an active tag (radio transmitter nanotags or acoustic tags). Reclamation anticipates that steelhead caught by the Yakama Nation as part of their ongoing monitoring with the Toppenish Creek screw trapping effort will be used for this investigation. Twelve active tag receivers will be placed between the upper end of the Prosser forebay and the downstream end of the Chandler Powerplant wasteway. Fish detections at the receivers would enable researchers to determine steelhead smolt survival, travel time, and proportion of fish using different passage routes.

Reclamation would obtain a Section 10 permit for this study.

3.4.3 Interim Bull Trout Trap and Transport

Reclamation proposes to establish an interim trap and transport program aimed at relocating fish that entrained out of Keechelus, Kachess, and Clear Creek Dams back upstream of these facilities. This action is proposed because bull trout entrained downstream of the dams represent a potentially significant loss to these small and isolated populations. Additionally, it is believed that bull trout entrained from Kachess and Keechelus are not able to successfully access alternative, suitable spawning habitat. Reclamation proposes to first scope and then implement the interim trap and transport program. Scoping efforts will solicit input from the state, federal, Joint Board, and Yakama Nation fisheries staff, include

estimating the bull trout sample size in the study area (Keechelus and Kachess Dams downstream of Easton Dam) and evaluating trapping techniques, locations, trapping time periods, and level of effort. Three approaches to capturing bull trout will be considered: 1) hook and line capture of bull trout staged below Kachess, Keechelus, and Clear Creek Dams in preparation for upstream spawning migration, 2) trap netting of bull trout overwintering in Lake Easton and, 3) a picket weir trap targeting fish moving downstream to overwinter in Lake Easton. Catch per unit effort for the three techniques will be compared. In order to determine if the trap and transport program could mistakenly trap and move bull trout originating from downstream of the storage reservoirs, Reclamation proposed to conduct spawning and snorkel surveys in the Keechelus reach of the Yakima River and genetically assign for all bull trout captured or encountered.

Informed by scoping activities, Reclamation will implement a longer term trap and transport program. Trapping method(s), timing, duration, and location and frequency will be specified. An adaptive management approach will be used to direct the level of effort Reclamation will invest in the program. Reclamation will conduct a project effectiveness evaluation using life-cycle modeling to determine the population-level effect of the program. The interim trap and transport program will continue until either 1) permanent passage facilities are created at Kachess and Keechelus Dams or improved at Clear Creek Dam, or 2) the research component of the program indicates that trap and transport efforts are not able to locate and capture sufficient numbers of individuals to have a population-level effect on targeted bull trout populations.

3.4.4 Bull Trout Tributary Monitoring and Emergency Passage Program

Reclamation reservoir draw-down activities can create passage barriers for bull trout seeking to reach tributary spawning grounds and strand bull trout located within the reservoir draw-down zone. As part of the Bull Trout Tributary Monitoring and Emergency Passage Program, Reclamation will collect information regarding reservoir operations and tributary access to help inform future operations, conduct salvage operations to reduce mortality associated with stranding events, and ensure rapid emergency fish passage response when passage to spawning grounds are impeded. Under this work, Reclamation staff or its contractors will monitor and record tributary passage conditions at Kachess, Keechelus, and Rimrock Reservoirs from mid-July through mid-October and salvage stranded bull trout. Passage between the two Kachess basins will also be evaluated. Additionally, staff will collect stream course and habitat information in reaches that traverse the reservoir drawdown zone, inform the Yakima Field Office when fish passage into spawning habitat is impeded, and assist fishery managers with bull trout spawning surveys. After 3 years of baseline habitat mapping and data collection, Reclamation will issue a report identifying early indicators of dewatering or connectivity risk. If early indicators for dewatering are

identified, annual passage condition monitoring will be re-scoped to only be implemented in those years when these indicators suggest dewatering potential. Information about dewatering risk could also be used in the future to make changes to operations.

3.4.5 Monitoring and Reporting

Annually, Reclamation will submit a report to the Services in order to track key metrics associated with incidental take. The following information will be provided in the annual report.

Operations: An annual summary of reservoir metrics will be provided, including:

- Annual minimum pool levels for each of the storage dams.
- Winter minimum flows for the following sites: KEE, CLE, EASW, RIM, and TICW.
- Annual quantity of water provided for outmigration flows at CLE, EASW, and RIM.

Fish Screen and Passage Program Operations and Maintenance: Reclamation will summarize key findings from routine O&M inspections for the 55 facilities where Reclamation has a role in O&M (see Section 2.3.5), annual reviews, and reportable deficiencies raised by site operators. The annual report will also characterize the priority status of these deficiencies, and the schedule for repairs. Finally, the status of funding requests to BPA for routine O&M needs for the Phase II facilities will be included.

The first annual report will include a set of prioritization criteria that will be used to inform response time for problems identified through routine operational checks and scheduled inspections.

Fish Salvage Operations: Reclamation will summarize data collected during fish salvage operations including worksite isolation for in-water work, annual salvage conducted at the Roza, Sunnyside, Chandler, and Wapatox forebays, any fish salvaged out of project canals, and fish salvaged out of the Roza drain live-boxes.

Conservation Program Implementation: Reclamation will provide annual updates about the status of the Chandler and Roza smolt survival investigations and the bull trout trap and transport operations and emergency fish passage operations. This annual update will specify the number, location, and condition of bull trout encountered during these operations. Reporting for the emergency fish passage program will summarize the frequency with which spawning tributaries to Reclamation reservoirs were evaluated for passage, passage conditions noted, actions necessary to provide passage, date these steps were taken, and outcome. After the first 3 years of evaluating tributary passage conditions, Reclamation will provide an analysis relating the following parameters to dewatering risk: reservoir elevation,

tributary flow discharge, and channel morphology. After 3 years of preliminary investigation needed to develop a protocol for the interim trap and transport program, Reclamation will include this protocol in its annual report.

3.5 Interrelated and Interdependent Activities

The following activities are not part of the Proposed Action, but are considered interrelated and interdependent to the Proposed Action. The effects of these activities will be considered during this consultation.

3.5.1 Operation of Privately-Owned Facilities

Conveyance of Project Water through Private Infrastructure

Due to the co-mingling of project and non-project water, some private irrigators, particularly those on tributary streams traversing through the KRD, such as Little, Taneum, Manastash, Reecer/Currier, Wilson, Naneum, Cook, Caribou, Parke, Johnson, and Wippel/Badger Wasteway, end up diverting project water which arrives at these diversion points as operational spill or return flow.

Private Hydropower Facilities

The YTID operates the Cowiche and Orchard Avenue hydroelectric plants as pressure-reducing stations for the pressurized pipeline distribution system completed in 1986. The generators at the two plants have a combined capacity of 3,000 kW, operating only during the irrigation season, April through October. The operation of the plants is contingent upon the water demand within the district during the irrigation season.

The Leishman Powerplant serves as energy dissipators on an irrigation pipeline system, making use of two generating units with rated capacities of 25 kW and 7.5 kW to reduce line pressure, and supply electrical power for a farming and ranching operation. The powerplant utilizes an existing irrigation tailwater collection system to supply water for the generation units during irrigation season.

In 2006, Tieton Hydropower LLC installed a FERC-licensed twin 6.8 MW hydroelectric powerplant on the outlet works of Tieton Dam. This project underwent formal consultation with USFWS.

3.5.2 Recreation

Late-season white water rafting occurs on the Tieton River due to novel flow timing created by the flip-flop operation. While rafting would be expected to occur even in the absence of Reclamation operations, the timing of this recreation activity and the extent of recreation is influenced by Reclamation operations.

3.5.3 Yakama Nation Fish Passage Monitoring at Chandler and Roza

The Yakama Nation runs two long-term fish monitoring facilities on the Yakima River. These facilities include the Roza Dam Adult Trapping Facility on the upper Yakima River (RM 127.9) and the Chandler Juvenile Enumeration Facility located on the lower Yakima River at Prosser Dam and the Chandler Canal (RM 47.1). These facilities are operated by the Yakama Nation with funding and support from the BPA and Reclamation. Each facility is used to enumerate adult salmon and steelhead that pass over Prosser or Roza Dams during upstream migration periods as well as estimate juvenile or smolt abundance as these fish outmigrate from the Yakima basin. These facilities collect data on all species of salmonid fishes (and lamprey) that pass through the counting facilities. The Roza Facility is operated from December to May while the Chandler Juvenile Enumeration Facility is operated from January through July of each year.

3.5.4 Temporary Upper Yakima Dam Structures

Flip-flop operation reduces flows in the upper Yakima River during the latter portion of the irrigation season. Due to the lower water levels, irrigators at the West Side diversion must install check dams or wing dams in the Yakima River to create enough head to divert their water supply. Irrigators at Cascade and Town Dams may also install temporary structures under some circumstances (there has not been a temporary structure at Town Dam since the 1990s). Structures are installed from late August/early September through October.

3.6 Activities Not Addressed through this Consultation

The following activities are not part of the Proposed Action, nor are they interrelated or interdependent to that action. These activities, while not inclusive of all activities not addressed by the Proposed Action, are identified here to help clarify the scope of this consultation.

Future actions implemented under existing YRBWEP authorities. O&M activities are not inclusive of work planning, prioritization, or funding decisions for future activities carried out by the YRBWEP program. While Reclamation anticipates that additional water conservation, water or land purchases, and associated restoration activities will be implemented through the YRBWEP program and will benefit instream conditions, these future activities are outside the scope of this consultation.

Future implementation of Integrated Plan Activities. Reclamation has conducted planning efforts associated with the seven elements identified in the Integrated Plan. The inclusion of the Reservoir Fish Passage Element in the Integrated Plan, along with Reclamation's past efforts to lead a cooperative investigation on the feasibility of providing fish passage at the five large storage dams, demonstrates Reclamation's commitment to using it's authorities to carry out programs for the conservation of endangered species. The inclusion of the Habitat/Watershed Protection and Enhancement Element of the Integrated Plan, along with past tributary restoration and land acquisitions under YRWEP authorities, also demonstrate such a commitment. However, as described in Chapter 1, further work on these elements, in addition to the other five Integrated Plan elements (Structural and Operational Changes; Surface Water Storage; Market-Based Reallocation; Groundwater Storage; and Enhanced Water Conservation), are not reasonably certain to occur and in most instances, Reclamation lacks implementation authority. Thus, these activities fall outside the scope of this consultation.

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Chapter 4 Effect of the Proposed Action on Physical Conditions in the Action Area

This chapter provides general information on the influence of the Proposed Action on water quantity and timing, water quality, channel conditions and dynamics, and upland habitat. Generally, the sections in this chapter attempt to explain the influence the Proposed Action has over different environmental conditions, how changes in the Proposed Action have altered conditions over time, and the anticipated changes to these conditions to occur under the Proposed Action. More detailed information on the response of listed species and their critical habitats to these changes appears in Chapters 5 through 11.

4.1 Water Quantity and Timing

4.1.1 Overview

The hydrologic analysis in this section compares historic flows from the 1981 to 2009 water years to modeled operational scenarios over the same period.[7] Reclamation selected this period of record because it is of sufficient duration to capture longer term climatic events, such as the ENSO, which influence weather patterns and water supply and it occurred after the implementation of the flip-flop regime (Section 4.5.2 of the IOP). The historic dataset describes the flow conditions in aquatic and riparian habitats during this period, influencing the baseline conditions for aquatics-species. Potential effects due to climate change are discussed in the Cumulative Effects sections in Chapters 5 and 6.

Because Reclamation has refined operations in the later portions of the period of record, two sets of modeled data are presented in this analysis. The "Status Quo" scenario presents flows if operational rules applied since approximately 2006 had occurred over the period of record. Due to significant changes in operations that have evolved over this 29-year period, this dataset differs from actual historic data (see Section 2.3.1). The "Proposed Action" scenario implements the additional operational rules proposed in Chapter 3 to illustrate what additional changes in flows would result when compared to current operations.

[7] Modeled data presents what would have occurred had a different sets of operational rules been implemented over the same period of record. By controling for climatatic and water demand variability, this method allows Reclamation to evaluate potential results from the implementation of new operational scenarios in the future.

Both the Status Quo and Proposed Action dataset were developed using the RiverWare model. RiverWare is a general river basin modeling tool that simulates operations of complex river and reservoir systems such as the Yakima Project to understand the water supply and flow consequences of different operational scenarios. The model is controlled by a set of prioritized rules for a network of objects (Reclamation 2008a).

The accuracy of the model is dependent on the input dataset for each object, the methods used to route flows, the methods and assumptions that produce losses and return flows, and the assumed irrigation diversions. Additionally, the model may not capture more nuanced logic in that drives real-life project operations.[8] Thus, model output illustrates general hydrologic responses. To address limitations associated with these methods and assumptions, Reclamation staff evaluated the data output and utilized professional expertise and judgment to identify which outputs were representative of expected flow conditions, and which outputs were subject to error from modeling artifacts. These observations and conclusions are discussed in this chapter.

The instream hydrologic effects of the Proposed Action are illustrated in three sets of graphs provided for each of the 10 gaging stations. The hydrographs are based on daily minimum, median, and maximum values over the period of record to illustrate the range of values for a given throughout the year. Because these hydrographs are a composite of the period of record, they may not represent flow fluctuations that may occur within and between specific years during the period of record.

This section also provides graphs of minimum, median, and maximum water storage values at each of the five major storage reservoirs from the Historic, Status Quo, and Proposed Action datasets. These graphs are a composite of the entire period of record, and thus are not reflective of conditions in any specific year. A year-by-year breakdown of maximum and minimum storage amounts, and dates these quantities were reached, is provided in Appendix F.

4.1.2 Streamflow

This BA describes the hydrologic changes under the Proposed Action relative to historic conditions (Historic) and the anticipated hydrologic effects if current operations were carried into the future (Status Quo). However, a brief description of the fundamental ways in which irrigation and flood control projects alter hydrology is important for analyzing effects to aquatic species and provides a fuller context for these operational changes.

[8] Additional details regarding RiverWare modeling are documented in the Yakima River Basin Study Modeling of Reliability and Flows Technical Memorandum (HDR and Anchor 2011b). Some model parameters were changed in order to better represent Status Quo operations. The Proposed Action scenario is not documented in this technical memorandum.

Pacific Northwest river basins, such as the Yakima basin, that are regulated for irrigation and flood control purposes exhibit a common set of hydrologic patterns. Natural flows, usually produced from precipitation during the winter and subsequent snowmelt during the late winter and spring/summer operation periods, are captured for storage. Spring snow-melt induced unregulated high flows are also reduced to meet irrigation demand prior to going on storage control. Downstream from major storage facilities, winter outflows can be greatly reduced. Flow variability is also reduced when naturally high flood flows from rain, or rain-on-snow events are captured in available storage and bypassed later during a lower flow period. The magnitude and frequency of ecologically significant discharges (overbank and channel-forming flows) are reduced relative to unregulated conditions. The magnitude of change in winter and early spring flows is highest in those reaches where a large component of the basin runoff is regulated by a storage reservoir.

Patterns of summer and fall flows are largely influenced by downstream irrigation demands with flows typically reaching peaks during July and August above the major diversions. Below major diversions, streamflow can be below natural flow levels. Unnatural flow fluctuations may result from adjustments in reservoir releases intended to meet fluctuating irrigation demands downstream, and also, may result from the discharge of irrigation return flows to the river alone or in combination with other return flow discharges or reservoir releases (Poff et al. 1997). Section 6 of the Interim Yakima Basin Operating Plan contains a detailed discussion of the regulation of specific river reaches (Reclamation 2002).

Upper Yakima

Upper Yakima hydrology is represented by the stream gages downstream from the three storage reservoirs (Cle Elum - CLE, Kachess - KAC, and Keechelus - KEE) and the EASW gage located just downstream from Easton Dam (RM 202.5). The three gages located just downstream from the storage reservoirs thus illustrate the hydrologic effect of project operations without a significant unregulated flow component and without any effects from diversions. The EASW gage captures flow contributions from a few unregulated tributaries and flow reductions resulting from the KRD diversion. These upper Yakima gages do not capture significant contributions of flow from tributaries with no storage regulation, such as the Teanaway, Taneum, and Wilson/Naneum system, because they are all locations upstream from these inputs. These tributaries contribute unregulated flow in the winter, but are still subject to non-Project diversions during the irrigation season. In addition to the KRD diversion at Easton Dam, significant mainstem diversions in the upper Yakima include the Westside Canal, Town Canal, and Cascade Canal all located between about RM 160 to 166, and Roza Diversion Dam at RM 127.9 (Appendix G).

Naches

Naches basin hydrology is represented by stream gages located downstream from the two storage reservoirs—Bumping (BUM) and Rimrock (RIM) —in addition to the gage located just downstream from the Tieton Canal on the Tieton River (TICW), and the gage located on the Naches River near the town of Naches (NACW).

Bumping Reservoir is characterized by a relatively large average refill ratio of 5.9 times per year (Reclamation 2007). Runoff greatly exceeds the reservoir's storage capacity; therefore, a significant amount of water must be passed downstream rather than stored. For approximately 13 miles downstream from Bumping Dam, flows are highly influenced by dam operations. After this point, the American River, Little-Naches River, and Rattlesnake Creek all contribute unregulated flow. Flows in the upper Naches are relatively natural since Bumping Dam's effects are diminished by the significant portion of the upper Naches basin that is unregulated. The Naches-Selah Canal is the only major diversion on the Naches River upstream of the Tieton River confluence (Appendix G).

The Tieton River is largely regulated by Tieton Dam operations, though there are a series of smaller unregulated tributaries (Oak Creek at RM 2.3, Mill Creek at RM 18.2, Pine/House/Soup Creeks at RM 17.8-18.4, and Wildcat Creek at RM 20.6). Flow from these tributaries is most significant during spring runoff or rain-on-snow events (CWU 2005). The Tieton Canal diversion at RM 14.2 is the only major diversion on the Tieton River.

Downstream from the Naches–Tieton confluence, flows are shaped by both Rimrock and Bumping flow regulation, and the significant unregulated flow component from the upper Naches. The NACW gage reflects these hydrologic influences in addition to diversions made at the Wapatox Canal at RM 17.1. The RiverWare model did not model a 125 cfs minimum flow at the Wapatox Canal. Accordingly, winter minimum flows are expected to be lower than displayed in Figure 4-25 in some drought years (see Section 3.1.2 Leased and Purchased Water).

Lower Yakima

The Naches and Yakima Rivers meet at RM 116.3. Downstream from this location, flows reflect the net effect of regulation at all five storage reservoirs plus upstream diversions. Two gage sites represent flows in this area: Yakima River near Parker (PARW, RM 103.7) and Yakima River near Prosser (YRPW, RM 45). These are also the two control points for the Title XII instream flow requirements; therefore, Reclamation manages reservoir operations to meet flow requirements at these locations. Ahtanum Creek confluence (RM 106.9), Wapato (RM 106.7), and Sunnyside (RM 103.8) diversions are located upstream of the PARW gage site. Toppenish (RM 80.0) and Satus (RM 69.9) Creeks, along with the Chandler/Prosser Diversion at RM 47.1, are located upstream of the YRPW site. Return flows and operational spill also significantly affect flows in the lower Yakima (particularly

the Sulphur Creek wasteway [RM 61.0] and Marion drain [RM 82]). The RiverWare model is not well calibrated to these stream reaches, largely a result of poorly accounted for and complex return flows.

Winter Flows (November – February)

Generally, winter flows in the Yakima basin are lower and more stable than those that existed under unregulated conditions (Reclamation 2002). Incremental winter flow improvements have been made over time. Especially since 2002, Reclamation has sought to increase winter flows to improve aquatic winter rearing habitat and improve egg incubation conditions by refining operational rules for water storage and flood control. To evaluate how these refinements influence winter flow conditions, the daily minimum flow value through the period of record is compared between the historic dataset and Status Quo scenario (see Figures 4-1, 4-5, 4-8, 4-11, 4-15, 4-18, 4-22, 4-25).

Under historic dataset, operations resulted in minimal winter flow releases as low as 66 cfs at CLE, 15 cfs at KEE, and nearly 0 cfs at KAC and RIM. These conditions likely occurred for at least a portion of the winter, most likely under dry conditions. The Status Quo scenario substantially increased winter flows at all locations except Bumping Dam, especially in dry years. This suggests those analytical tools developed in 2002 to consider both egg incubation and winter rearing have been effective at increasing winter flows.

The Proposed Action makes further refinements to rules for water storage and flood control and provides different flow values for dry, average, and wet conditions. Table 4-1 compares the flows between the Status Quo and Proposed Action scenarios and Table 4-2 compares the percent of years these minimum flow levels were provided.

Table 4-1. Comparison of minimum flows by water year type for status quo and Proposed Action scenarios.

	Dry		Average		Wet	
	Status Quo	**Proposed Action**	**Status Quo**	**Proposed Action**	**Status Quo**	**Proposed Action**
Keechelus	80	80	90	100	100	120
Kachess	30	30	30	30	30	30
Cle Elum	180	180	220	220	230	250
Easton	190	190	220	250	235	300
Rimrock	45	50	60	75	75	90

Table 4-2. Percent of years "high/wet", "average", and "low/dry" year winter minimum flow volumes were provided throughout the winter period, under the 29-year period of record (1981 to 2009) modeled for the Proposed Action.

Date flow examined	High / Wet Flows	Average Flows	Low / Dry Flows
1-Nov	0%	34%	66%
1-Dec	38%	31%	31%
1-Jan, 1-Feb, 1-Mar	21%	34%	45%

Median winter flow conditions tend not to reveal dramatic differences between historic conditions, and the Status Quo and Proposed Action (Figures 4-2, 4-9, 4-16, 4-19, 4-23). This result reflects the Proposed Action being aligned with historic winter flow operations that have been applied during the past decade. Notable exceptions include median flows at KEE, NACW, and EASW, where both the Status Quo and Proposed Action flows are higher than historic (Figures 4-6, 4-12, 4-26). NACW shows significant increases in minimum and median flows the modeled scenarios relative to historic conditions because the Wapatox power water remains instream rather than being diverted (Figures 4-25, 4-26). However, minimum flows at NACW shown in Figure 4-25 are actually higher than expected under the Proposed Action, because in the driest years, the Wapatox water will be used to provide bull trout passage into the South Fork Tieton River. In this situation, minimum flows will be at least 125 cfs.

Maximum flow hydrographs, while provided, have limited utility for illustrating potential changes associated improved minimum flow targets (Figures 4-3, 4-7, 4-10, 4-13, 4-17, 4-20, 4-24, 4-27, 4-30, 4-34). Since modeled results are based on operating rules for flood operations that are not as nuanced as actual operations, winter flow fluctuations and magnitude are often higher than expected outcomes and what has been experienced historically. However, a change in the timing (a delay) and, potentially, the frequency of flood releases and magnitude of flood releases relative to historic conditions, is expected when the two modeled scenarios are compared to historic conditions. This change is attributed to increased flow releases throughout the winter, which changes reservoir refill timing and thus the timing and frequency with which the flood control curve is reached.

Spring Flows (March – June)

Historically, spring flow increases were the incidental result of water released for flood control purposes (Reclamation 2002). In 2005, SOAC developed guidelines recommending when water should be released from storage to stimulate outmigration. Since SOAC can recommend that Reclamation release water for this purpose and Reclamation has done so in response, the Status Quo scenario includes an April water release pulse. The Proposed Action scenario provides outmigration water in both April and May and uses TWSA to determine the amount of water that is released. The frequency with which different volumes of outmigration water were provided under the Proposed Action is presented in Table 4-3.

In the Status Quo and Proposed Action models, the entire amount of water specified for outmigration was released on specified days in April (both scenarios) and May (Proposed Action only) without consideration of hydrologic conditions. This approach enabled the outmigration water to be accounted for in planning purposes, but the resulting hydrographs do not accurately represent how water will be managed in real-time. Outmigration flows provided out of Rimrock Reservoir in particular, will need to be shaped such that they do not result in steelhead redd creation in locations that will not remain wetted through the incubation period. In general, the hydrologic results are illustrative of general trends expected under the Proposed Action.

Table 4-3. Percent of time "wet", "average," and "dry" year outmigration flow volumes were provided under the 29-year period of record (1981 to 2009) modeled for the Proposed Action.

Month	High / Wet Flows	Average Flows	Low / Dry Flows
April Outmigration	41%	34%	24%
May Outmigration	48%	24%	28%

Under historic operations, reservoir management focused on spring filling. In typical years, the reservoirs would fill in early June and inflow would be bypassed until natural flow no longer satisfied water demands, at which point stored water would be released. Under this operational regime, unless releases are required for flood-control purposes, flows are low well into the spring. The historic dataset shows that median flows do not start to rise until early- to mid-May at CLE, KAC, and RIM (Figures 4-2, 4-6, 4-19). KEE median flows started to elevate earlier, in mid-April (Figure 4-9).

When water is instead released throughout the winter to provide higher winter flows, and as part of dedicated outmigration releases in April and May, less water is released for spring flood control and the reservoirs fill later. This result is reflected in reduced late May/early June flows when the median hydrographs for the Proposed Action and historic conditions are compared at CLE, KEE, KAC, and RIM (Figures 4-2, 4-6, 4-9, 4-23).

Flow exceedance curves were prepared for April and May to more closely examine the differences in outmigration flows for this targeted 2-month period as provided under the Status Quo, Proposed Action, and historic conditions. Graphs are provided for CLE, EASW, and RIM because outmigration flows are specified at these locations. A graph is also provided for PARW so that the cumulative effect of these flows lower in the watershed can be examined. Some common trends are apparent in these graphs (Figures 4-4, 4-14, 4-21, 4-31, 4-35). First, the lowest flows experienced during this time period (those flows exceeded nearly the entire time) are consistently higher under the Proposed Action and Status Quo scenarios. This reflects the higher winter target flows that are currently used and applied into the spring period until reservoir releases are increased either for storage or demand

considerations. Second, except for the highest flows, those exceeded about 25 percent of the time, Proposed Action flows are higher than both the Status Quo and Historic flows. This result is reflective of the dedicated water provided for outmigration flows. However, for the highest flows experienced during this period, historic discharge was greater than that predicted by both model runs. This result reflects less water being released for flood control purposes for the Status Quo and Proposed Action model runs. While the patterns described above also apply to the results observed at PARW, the differences between Historic, Status Quo, and Proposed Action are far less pronounced (Figure 4-31). This result reflects that other factors which influence instream flow, such as unregulated runoff patterns and diversion rates, affect observed flow at this location and are consistent between all three datasets. At this location in the watershed, flow released out of the storage reservoirs is a relatively small proportion of the total flow.

The flow exceedance curve for flows below Roza Dam (RDBW) illustrates the net effect of both storage dam and Roza power diversion operations on April and May flows. Here, the Proposed Action flows are higher than the Status Quo operation for all but those exceeded about 10 percent of the time (Figure 4-35). For these highest flows, Status Quo and Proposed Action are very similar. Also, even though the power subordination target is 1,300 cfs under the Proposed Action, this target was met or exceeded about 82 percent of the time. Flows fall below 1,300 cfs for a period because while power is subordinate to meeting the flow target, it is not released from storage when instream flows are less than 1,300 cfs. The model results also indicate that flows just over 1,300 cfs to about 5,500 cfs were exceeded more frequently historically than would have been experienced under the Proposed Action. This result likely reflects that more water was released for flood control, refill, or irrigation operations during this period historically than is expected based on Proposed Action operations. It should be noted that in the past 10 years or so, the actual operations, in coordination with SOAC, has deliberately released water in April or May that could be expected to spill later in the refill season. The Yakima Field Office would determine that amount of available water through forecast modeling of the system. This may also contribute to the higher flows. This operations practice was not incorporated into the RiverWare model. Additionally, naturally-occurring freshets that develop during the outmigration period are allowed to pass through the system without an increase in diversion for power generation at Roza. This operations practice was not modelled, but would result in higher flows downstream of Roza than indicated by the flow exceedance curve (Figure 4-35).

Summer and Fall Flows (July – October)

The primary factors shaping summer flows are the same under all three scenarios. These primary factors include water demand and the implementation of the flip-flop operation. Still, operational differences have evolved which differentiate the two modeled scenarios from historic conditions. These differences include: implementation of the Title XII instream flows and consideration of high flow summer conditions in setting Keechelus Reservoir releases.

The Title XII instream flow requirements are the prime determinant of lower river flow conditions at Parker and Prosser gaging sites. Before Title XII flows were established, Reclamation observed a 200 cfs minimum flow; however, due to variability associated with operations, flows would fall below this level. The historical dataset reflects adherence to the legislated YRBWEP Title XII minimum flow requirement starting in 1994 (Figures 4-28, 4-29, 4-32, 4-33). This Title XII minimum flow requirement is reflected in the entire datasets of both the Status Quo and Proposed Action scenarios. In some years, Title XII flows are lower under the Proposed Action than under Status Quo operations because increased winter flow and dedicated outmigration releases results in lower TWSA. However, this reduction in Title XII flows only rarely occurs. In the 29 years modeled, this reduction occurred in 3 years.

YRBWEP conservation has also contributed flow to the PARW minimum target. Although a portion of this water can be "shaped" and used at other times of the year for other locations and purposes related to fisheries at SOAC's request, the model is set up to provide the instream component of the conserved water uniformly throughout the irrigation season. If the shapeable component of the YRBWEP instream conserved water is used to provide a different flow benefit, then these minimum flows would decrease. In addition to 97 cfs of conserved water applied to the Title XII flows, the model also added 45 cfs of state trust water.

The second operational difference between the two modeled scenarios and historic conditions is that Reclamation started considering high flow concerns and restricting maximum reservoir summer releases at Keechelus. This change is reflected in the maximum daily flow hydrograph (Figure 4-10). While summer irrigation releases in excess of 1,300 cfs were historically released out of Keechelus, and in 1993 reached 2,300 cfs, these flows are not expected as part of the Proposed Action.

The minimum flow hydrograph reveals short-comings of RiverWare calibration and data inputs that particularly affect the modeled datasets at the Prosser gaging site. The minimum flow hydrograph shows summer flows gradually falling below 300 cfs and eventually running out of water in some years (Figure 4-32). Poor calibration of return flows in the lower river is one reason we see this result. This result is therefore a modeling artifact and not representative of expected conditions. In reality, Prosser flows are typically above the minimum flow requirements (Title XII or power subordination flows) because the combination of the water flowing past Parker and the addition of return flows between Prosser and Parker provides more than adequate flows to meet the targets in almost all circumstances. In a very dry July, Reclamation holds Parker flows more tightly to the instream target and there is not as much return flow. Under these circumstances, Parker flows have been and may be tight in the future but should still meet the Title XII requirements without the need to release water from storage. If necessary, water would be released from storage to meet the KID entitlement and the YRPW flow target.

The second reason the model indicates that flows could fall to zero at Prosser in the minimum flow hydrograph is that Rimrock storage is shown as depleted in some years. This result is a modeling artifact and not representative of expected conditions. Actual operations prevent the depletion of storage by doing a better job than the model at accounting for required September 30th storage and balancing water releases out of the five storage reservoirs to ensure that Rimrock retains storage.

The flip-flop and mini flip-flop operations are the main driver in setting fall spawning flows during the outmigration season. In order to increase the likelihood that spawning flows can be maintained throughout the redd incubation period, Reclamation is conservative when setting spawning flows. There is no difference between the Proposed Action and Status Quo in the approach to setting fall spawning flows. Subsequent adjustments are then based on winter flow-setting operations where the high end flows are greater in the Proposed Action scenario than they are in the Status Quo.

Cle Elum Hydrographs

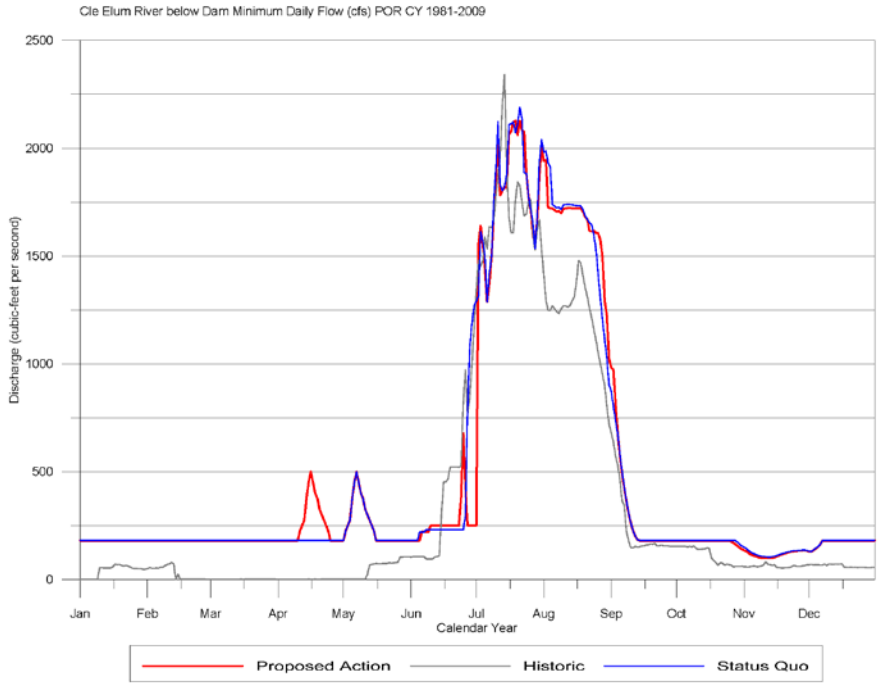

Figure 4-1. Daily minimum flows for the period of 1981 to 2009 at the Cle Elum River below dam gaging site.

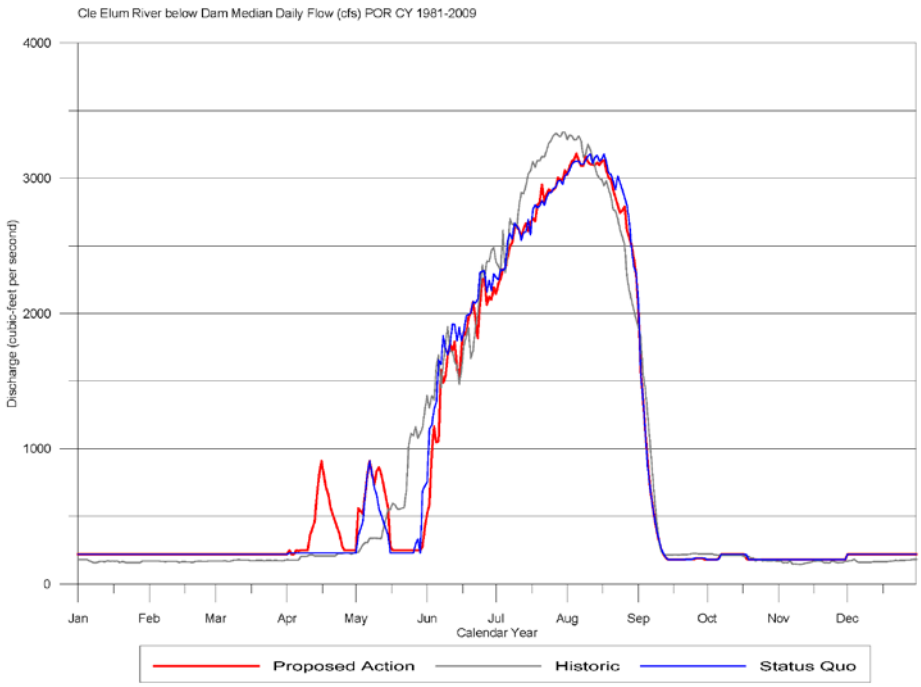

Figure 4-2. Daily median flows for the period of 1981 to 2009 at the Cle Elum River below dam gaging site.

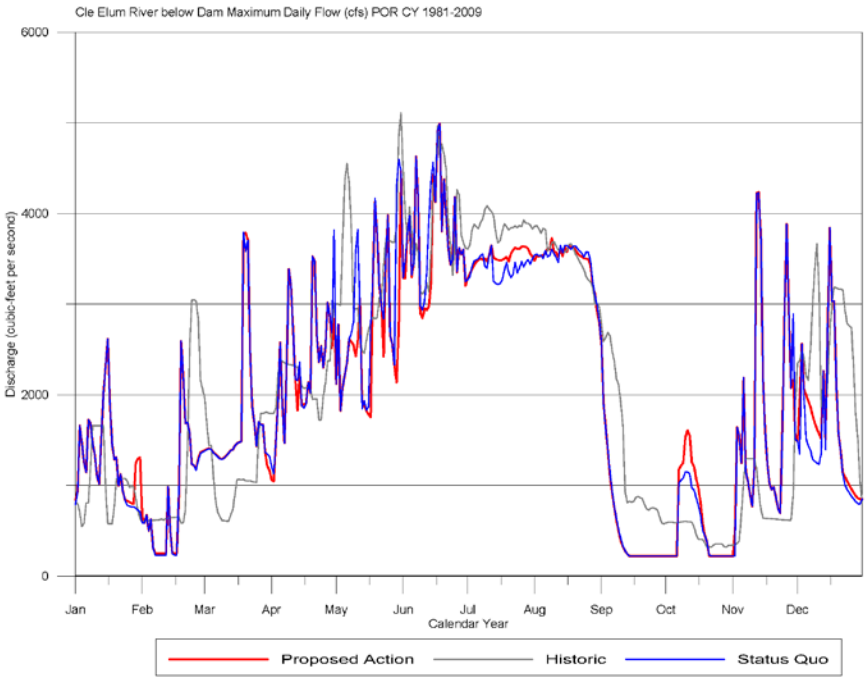

Figure 4-3. Daily maximum flows for the period of 1981 to 2009 at the Cle Elum River below dam gaging site.

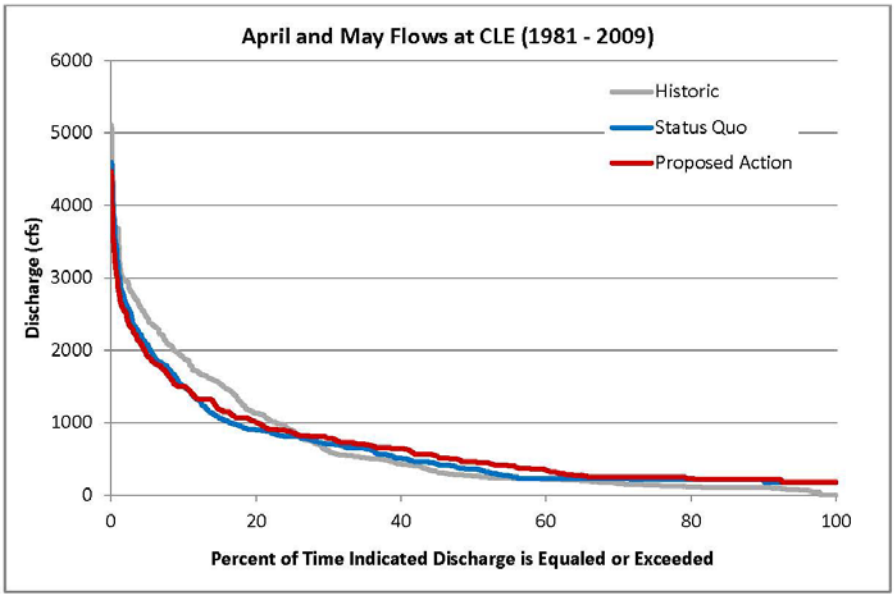

Figure 4-4. Flow duration curve for April and May flows for the period of 1981 to 2009 at the Cle Elum River below dam gaging site.

Kachess Hydrographs

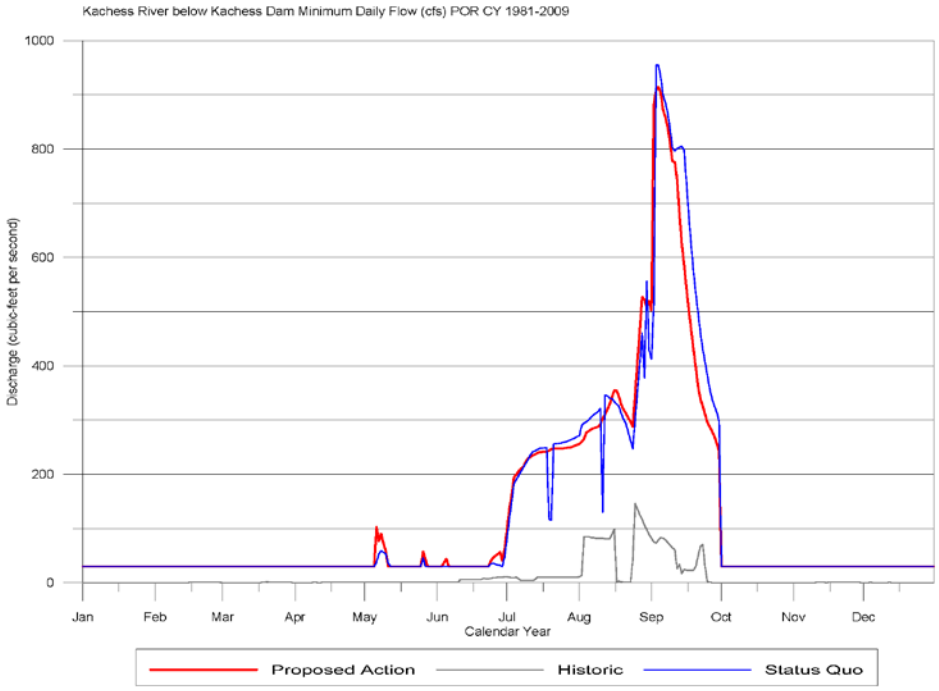

Figure 4-5. Daily minimum flows for the period of 1981 to 2009 at the Kachess River below dam gaging site.

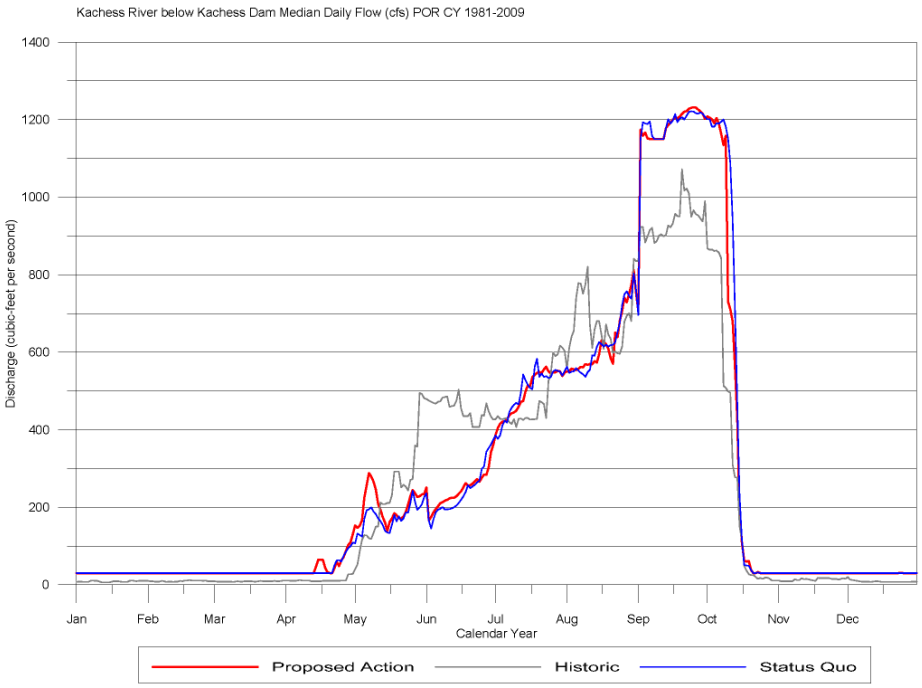

Figure 4-6. Daily median flows for the period of 1981 to 2009 at the Kachess River below dam gaging site.

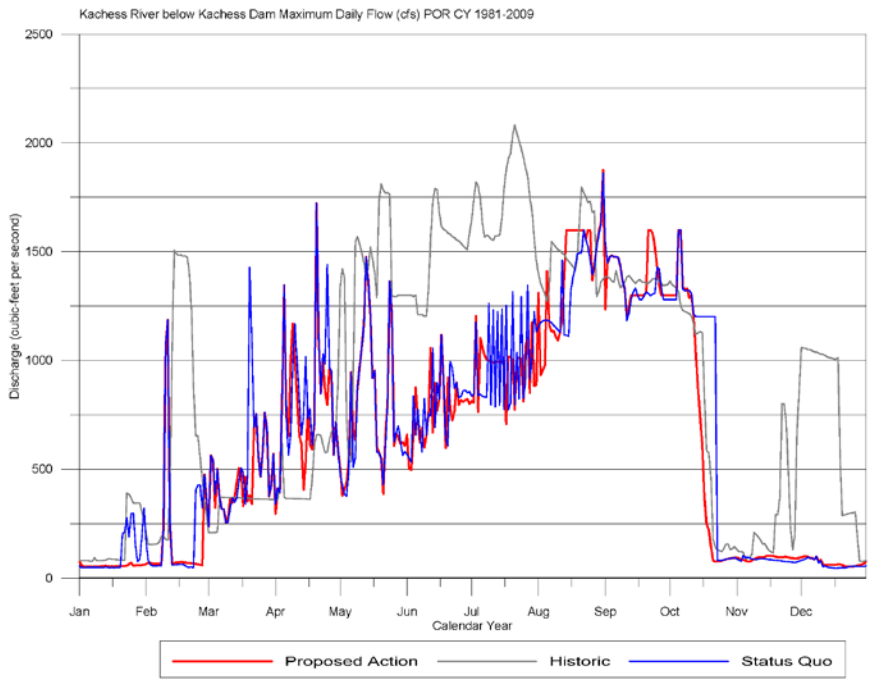

Figure 4-7. Daily maximum flows for the period of 1981 to 2009 at the Kachess River below dam gaging site.

Keechelus Hydrographs

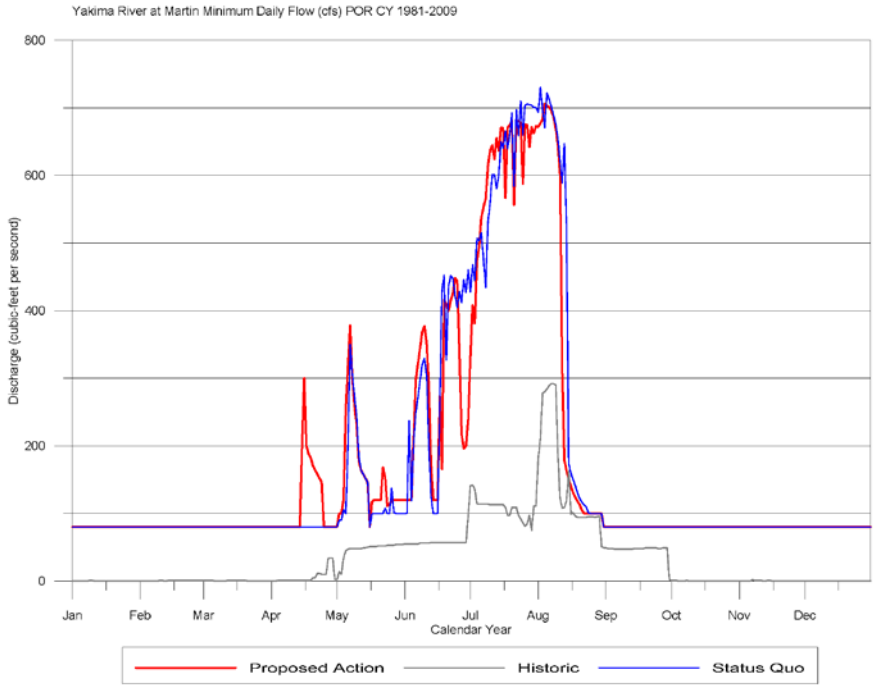

Figure 4-8. Daily minimum flows for the period of 1981 to 2009 at the Yakima River at Marlin (below Keechelus Dam) gaging site.

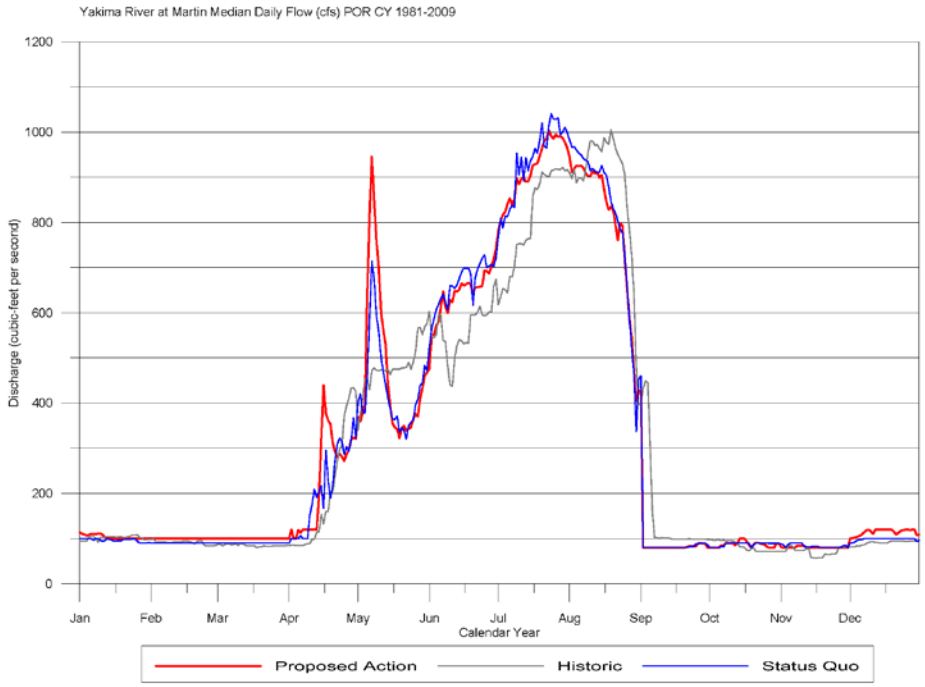

Figure 4-9. Daily median flows for the period of 1981 to 2009 at the Yakima River at Marlin (below Keechelus Dam) gaging site.

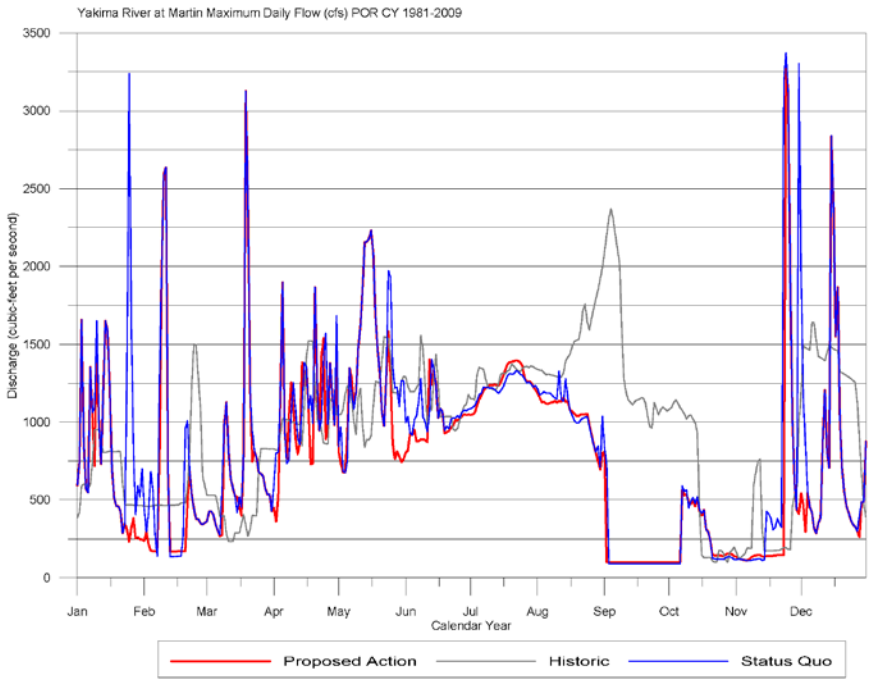

Figure 4-10. Daily maximum flows for the period of 1981 to 2009 at the Yakima River at Marlin (below Keechelus Dam) gaging site.

Easton Hydrographs

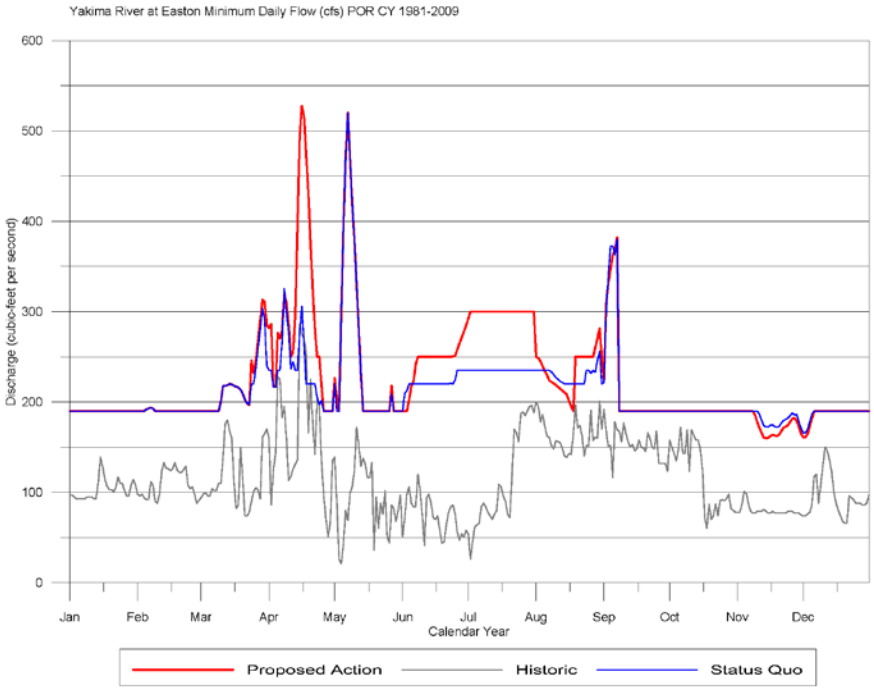

Figure 4-11. Daily minimum flows for the period of 1981 to 2009 at the Yakima River at Easton gaging site.

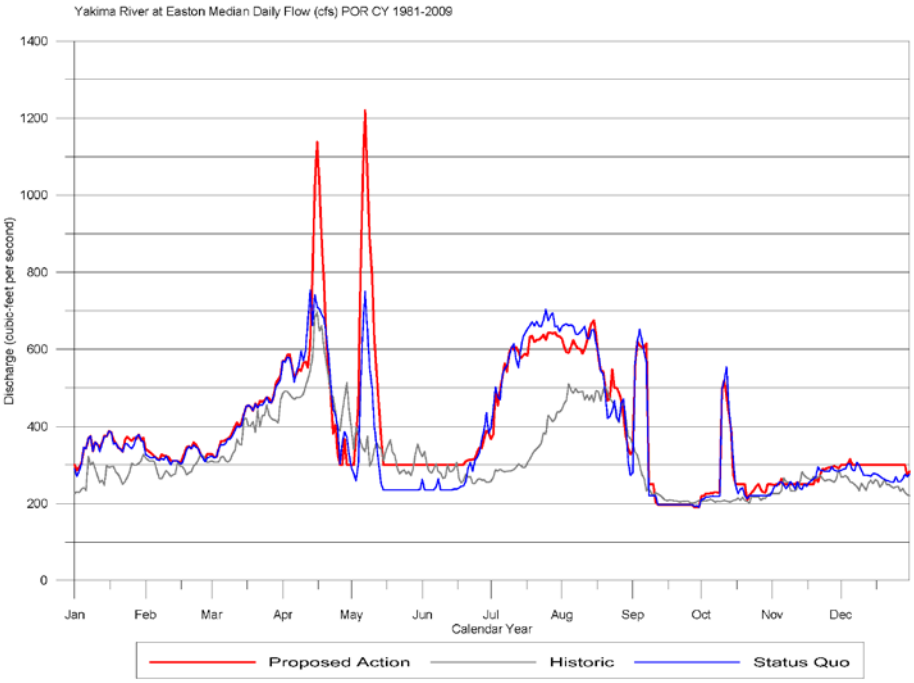

Figure 4-12. Daily median flows for the period of 1981 to 2009 at the Yakima River at Easton gaging site.

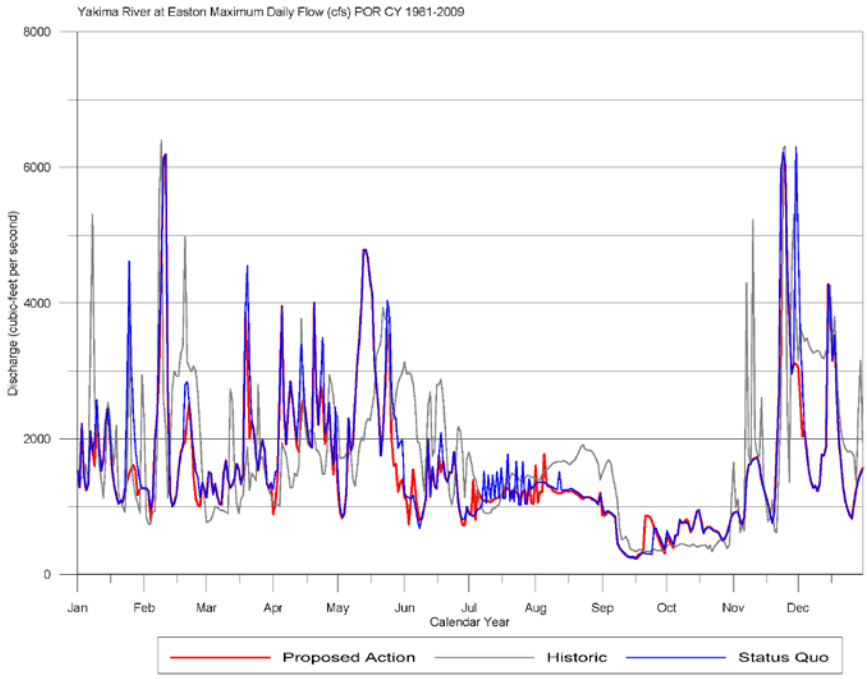

Figure 4-13. Daily maximum flows for the period of 1981 to 2009 at the Yakima River at Easton gaging site.

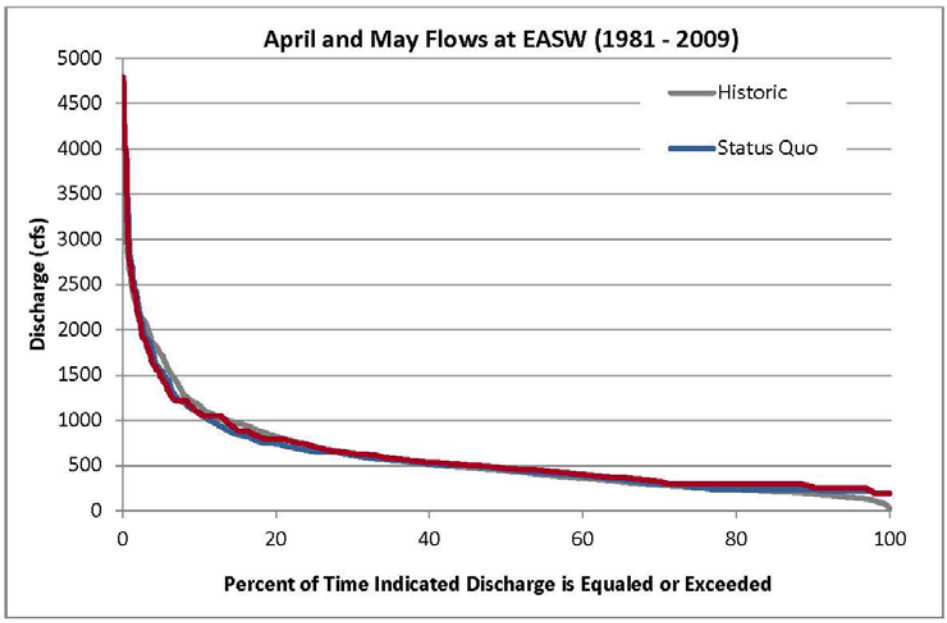

Figure 4-14. Flow duration curve for April and May flows for the period of 1981 to 2009 at the Yakima River at Easton gaging site.

Bumping Hydrographs

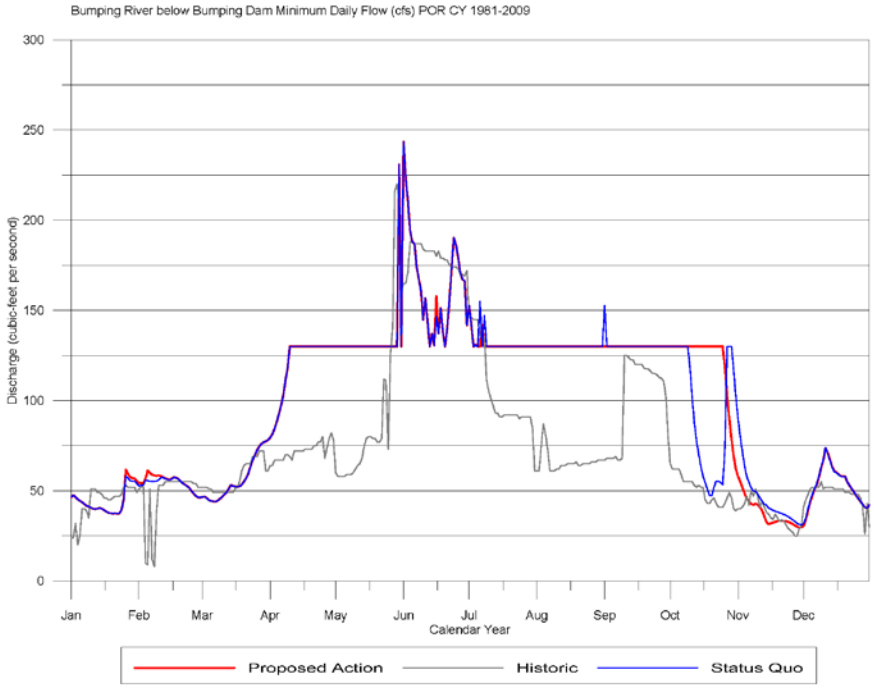

Figure 4-15. Daily minimum flows for the period of 1981 to 2009 at the Bumping River below dam gaging site.

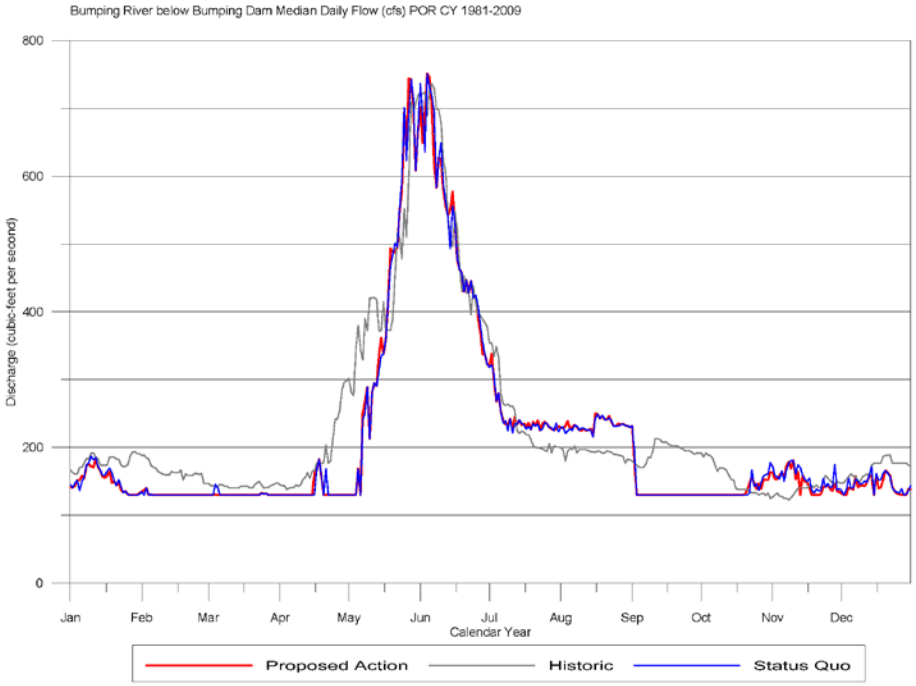

Figure 4-16. Daily median flows for the period of 1981 to 2009 at the Bumping River below dam gaging site.

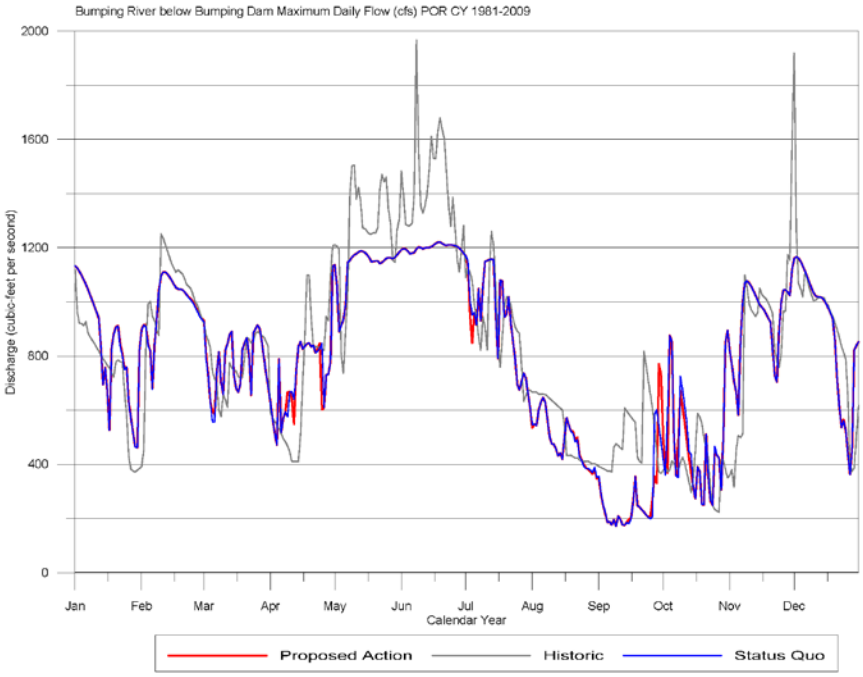

Figure 4-17. Daily maximum flows for the period of 1981 to 2009 at the Bumping River below dam gaging site.

Tieton Hydrographs

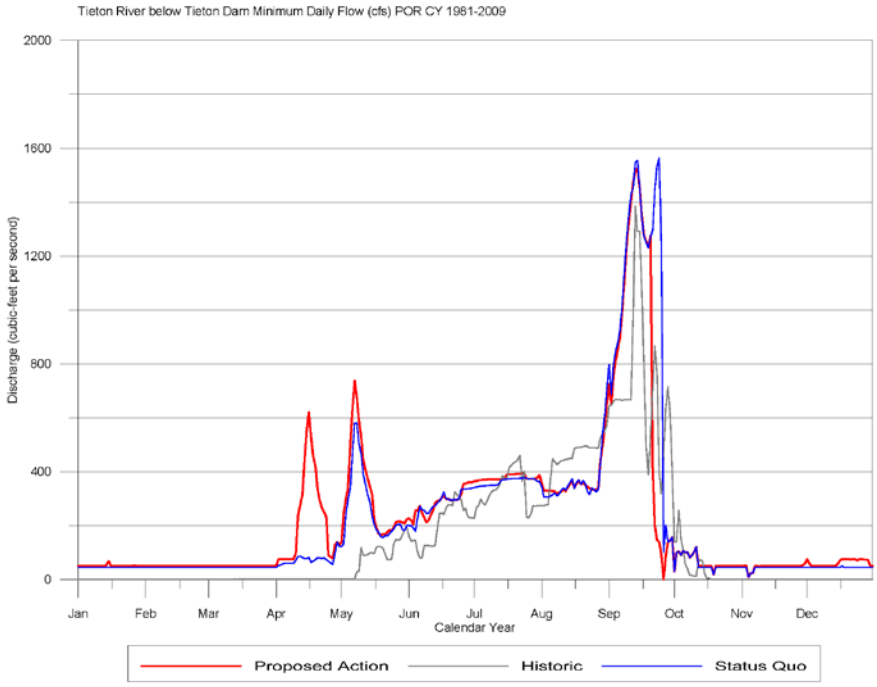

Figure 4-18. Daily minimum flows for the period of 1981 to 2009 at the Tieton River below dam gaging site. Actual operations would need to shape April and May flows to prevent stranding steelhead redds. Actual operations also prevent the depletion of storage. See text for discussion.

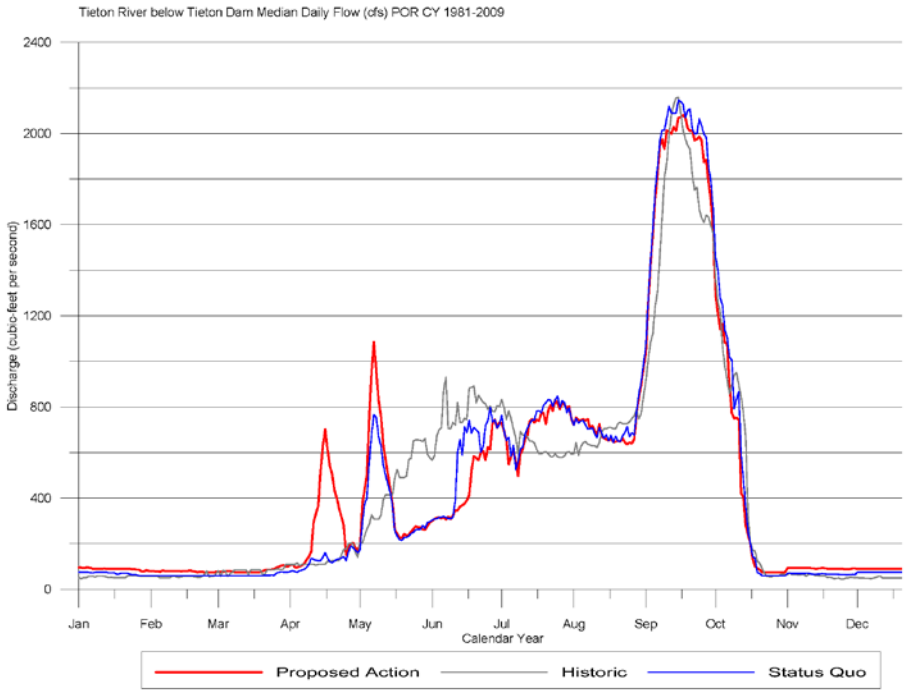

Figure 4-19. Daily median flows for the period of 1981 to 2009 at the Tieton River below dam gaging site. Actual operations would need to shape April and May flows to prevent stranding steelhead redds.

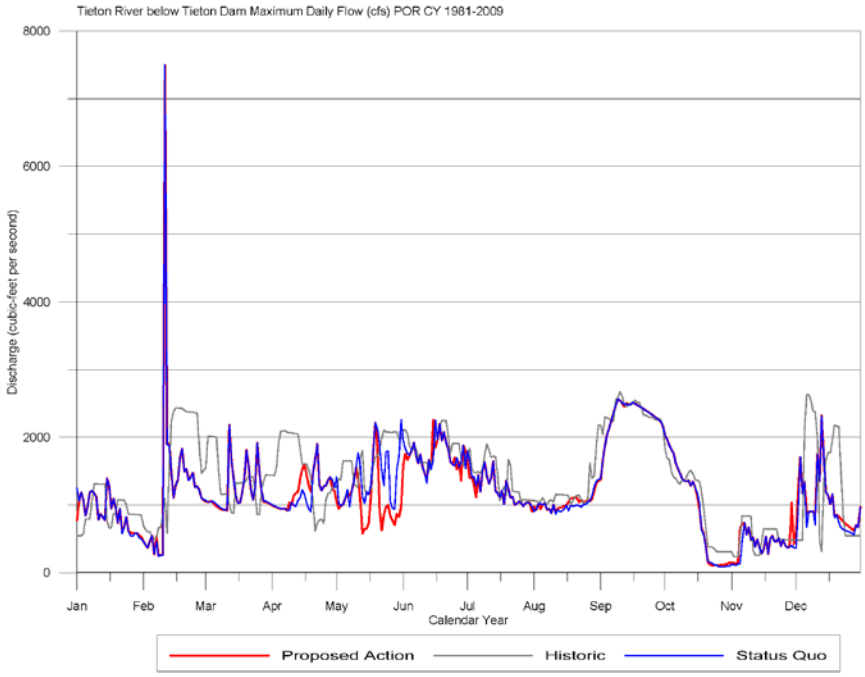

Figure 4-20. Daily maximum flows for the period of 1981 to 2009 at the Tieton River below dam gaging site.

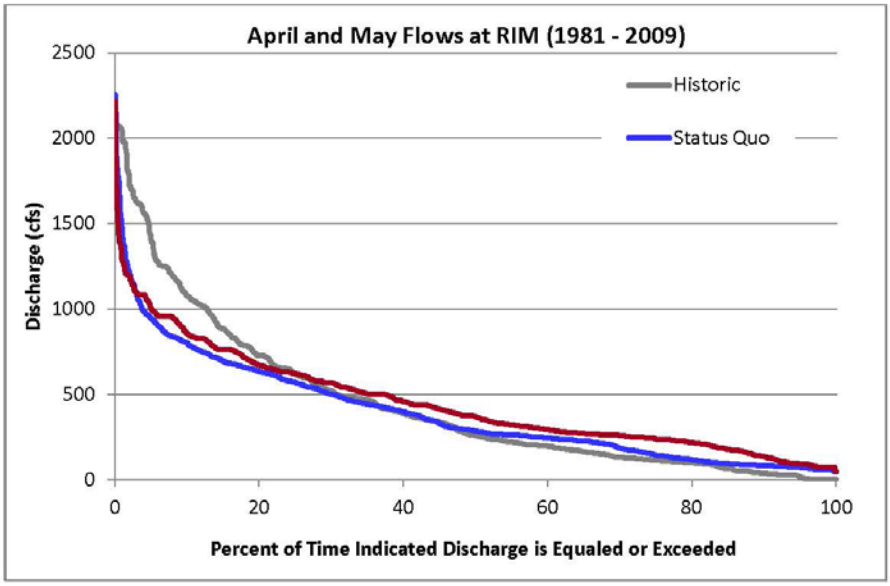

Figure 4-21. Flow duration curve for April and May flows for the period of 1981 to 2009 at the Tieton River below dam gaging site.

Tieton River below Canal Hydrographs

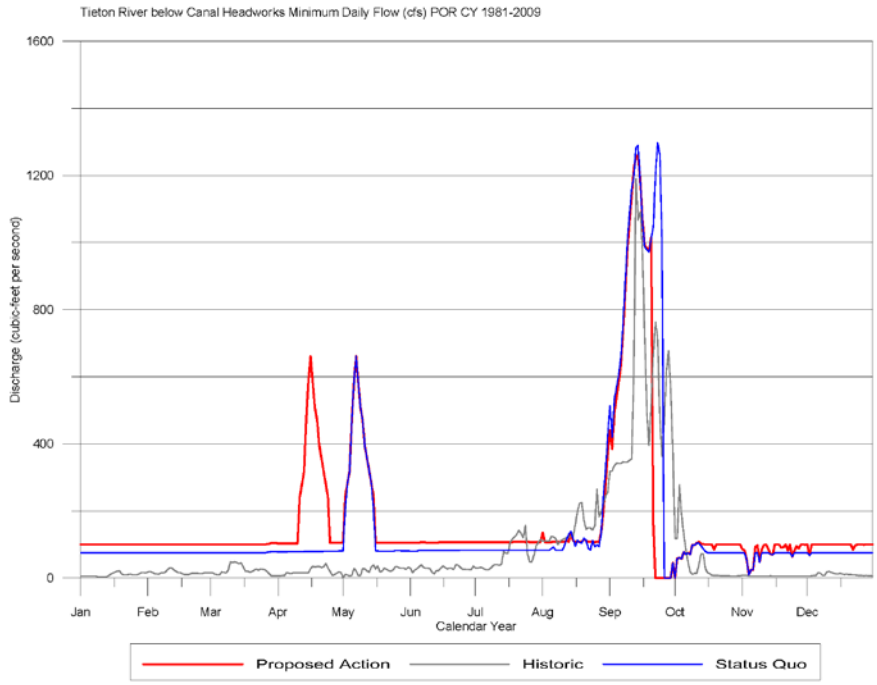

Figure 4-22. Daily minimum flows for the period of 1981 to 2009 at the Tieton River below canal headworks gaging site. Actual operations would need to shape April and May flows to prevent stranding steelhead redds.

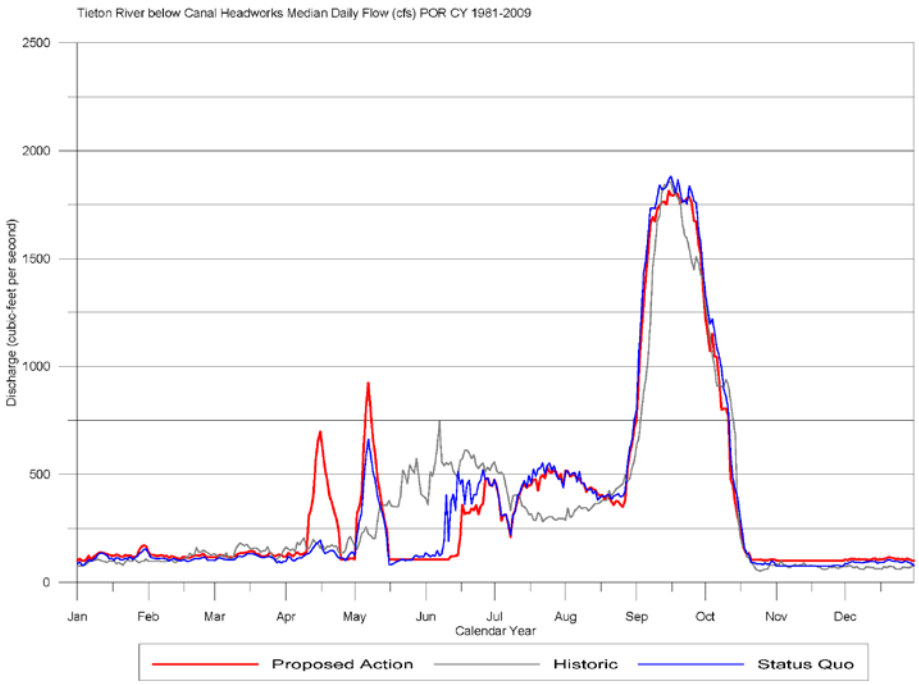

Figure 4-23. Daily median flows for the period of 1981 to 2009 at the Tieton River below canal headworks gaging site. Actual operations would need to shape April and May flows to prevent stranding steelhead redds.

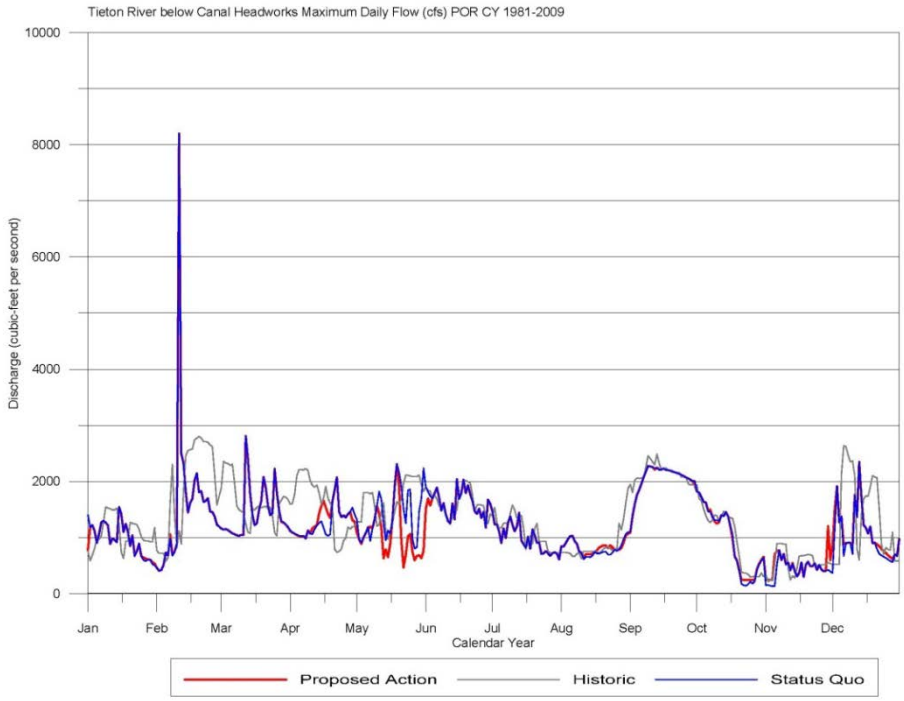

Figure 4-24. Daily maximum flows for the period of 1981 to 2009 at the Tieton River below canal headworks gaging site.

Naches River at Naches Hydrographs

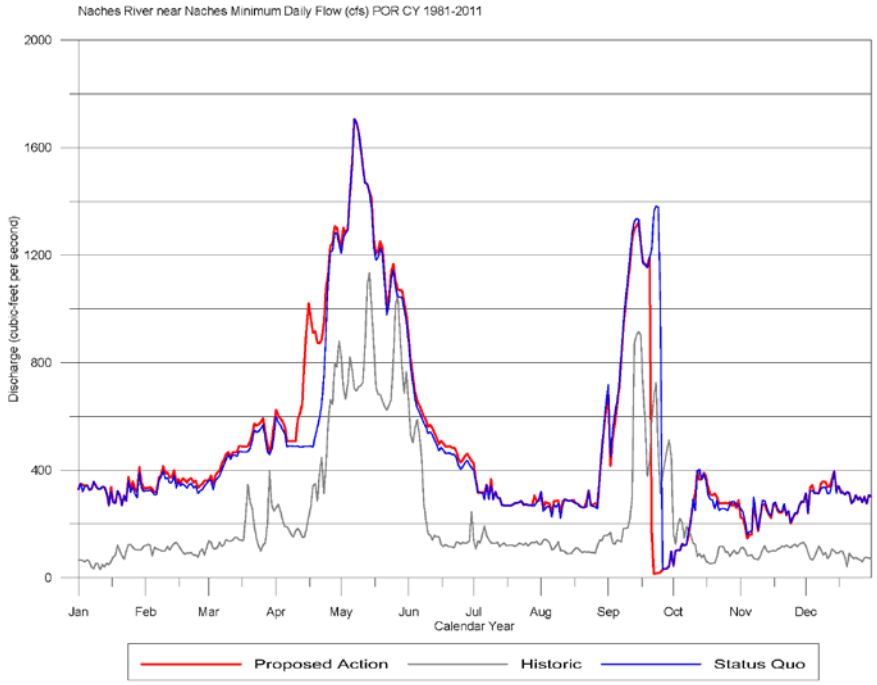

Figure 4-25. Daily minimum flows for the period of 1981 to 2009 at the Naches River near Naches gaging site. The Proposed Action includes provisions to maintain a 125 cfs instream flow target in severe drought years. This provision was not modeled.

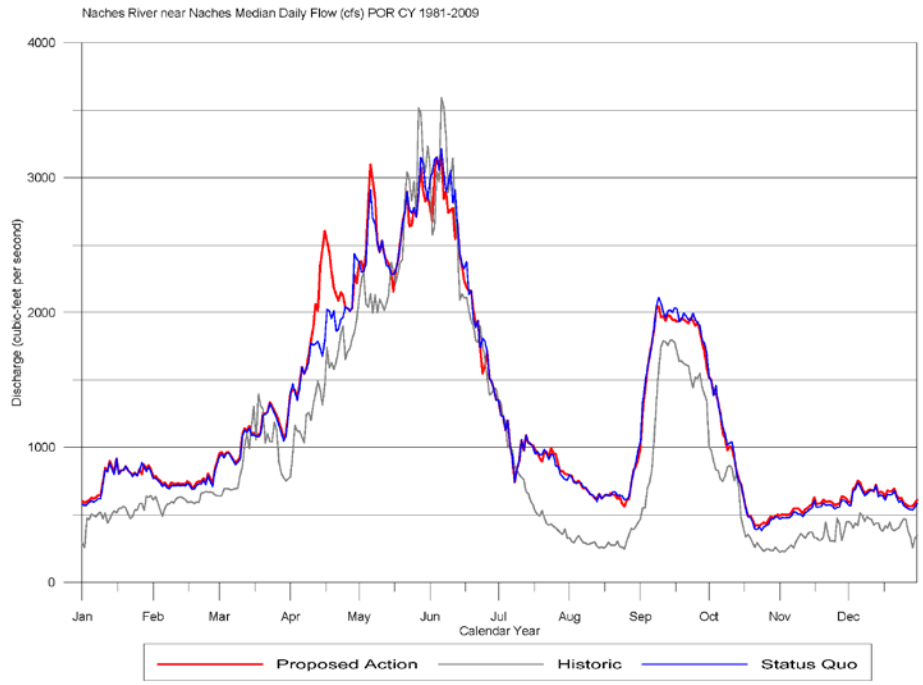

Figure 4-26. Daily median flows for the period of 1981 to 2009 at the Naches River near Naches gaging site.

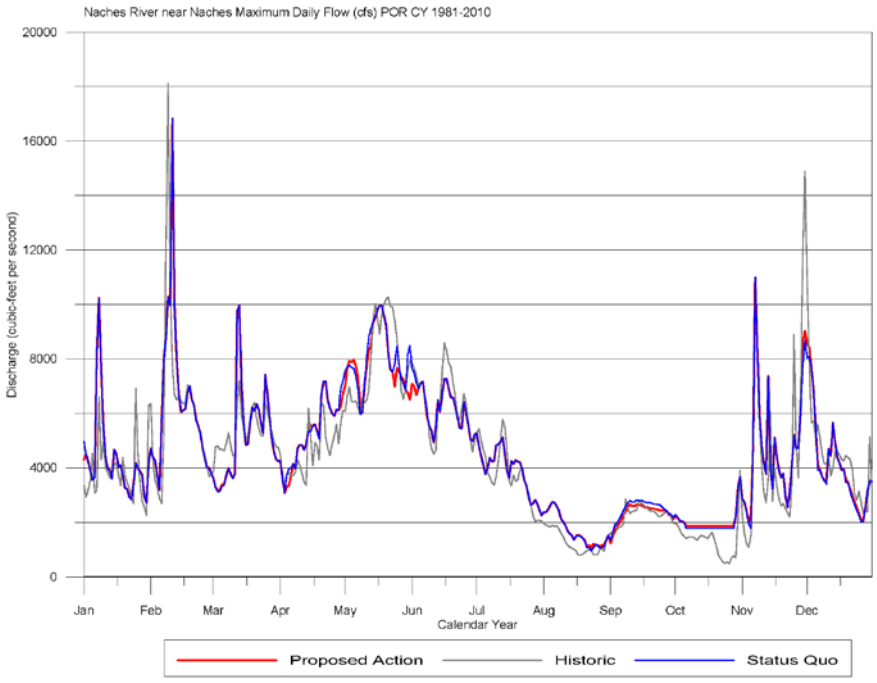

Figure 4-27. Daily maximum flows for the period of 1981 to 2009 at the Naches River near Naches gaging site.

Yakima River near Parker

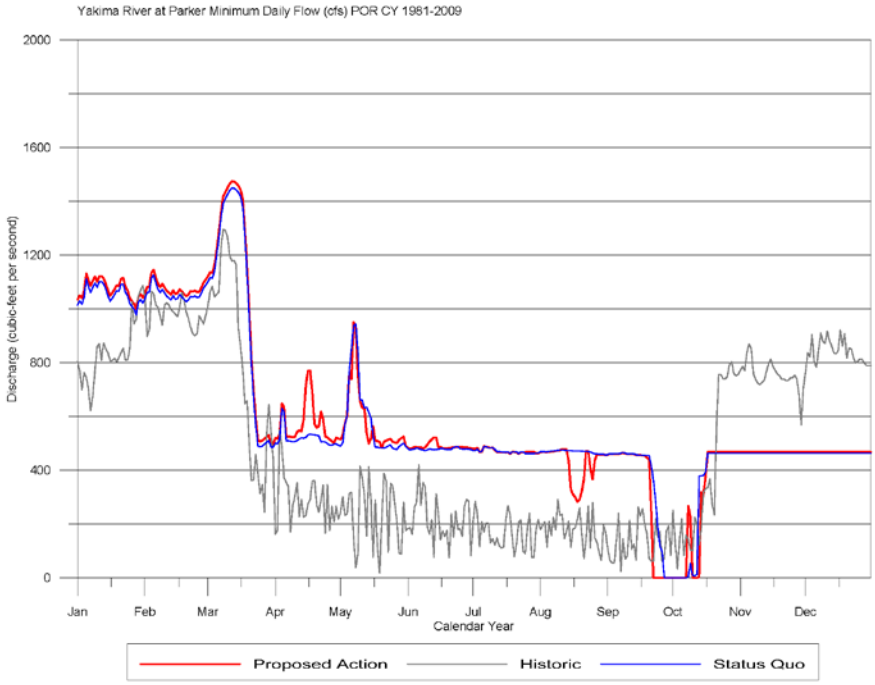

Figure 4-28. Daily minimum flows for the period of 1981 to 2009 at the Yakima River near Parker gaging site. Zero cfs flows presented are a modeling artifact and not represented of expected conditions. See text for discussion.

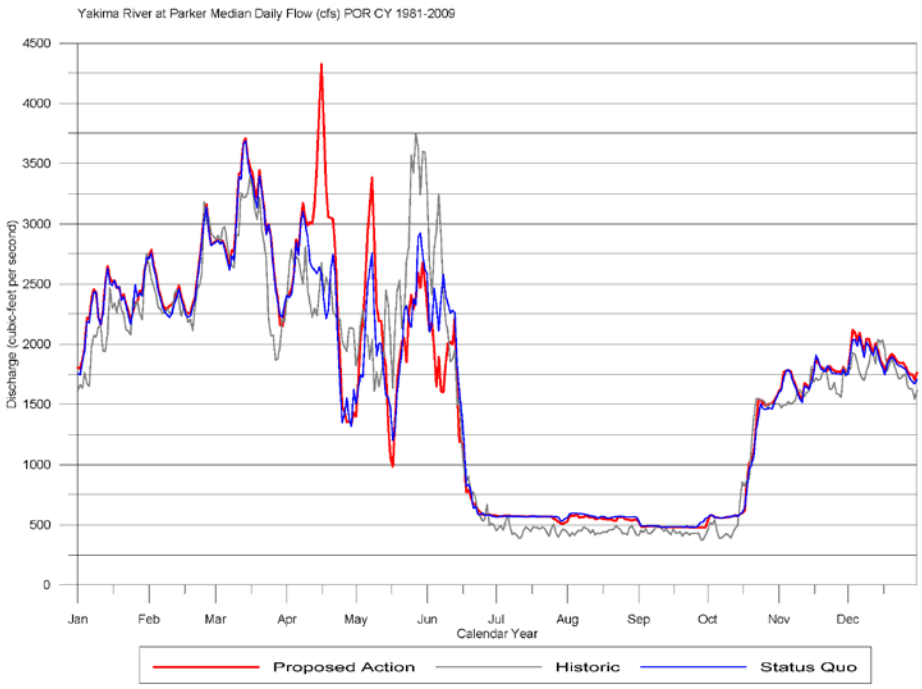

Figure 4-29. Daily median flows for the period of 1981 to 2009 at the Yakima River near Parker gaging site.

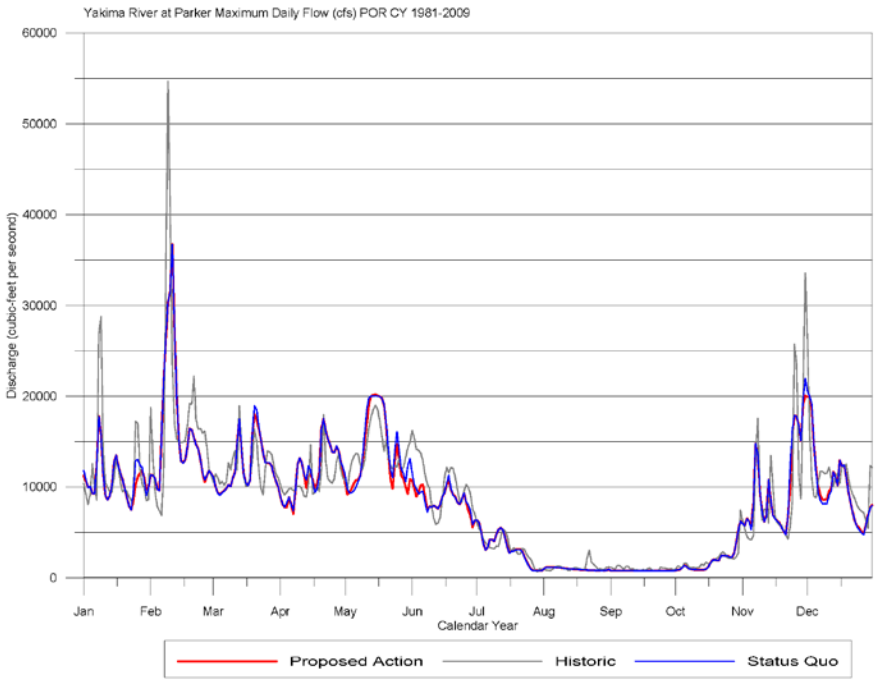

Figure 4-30. Daily maximum flows for the period of 1981 to 2009 at the Yakima River near Parker gaging site.

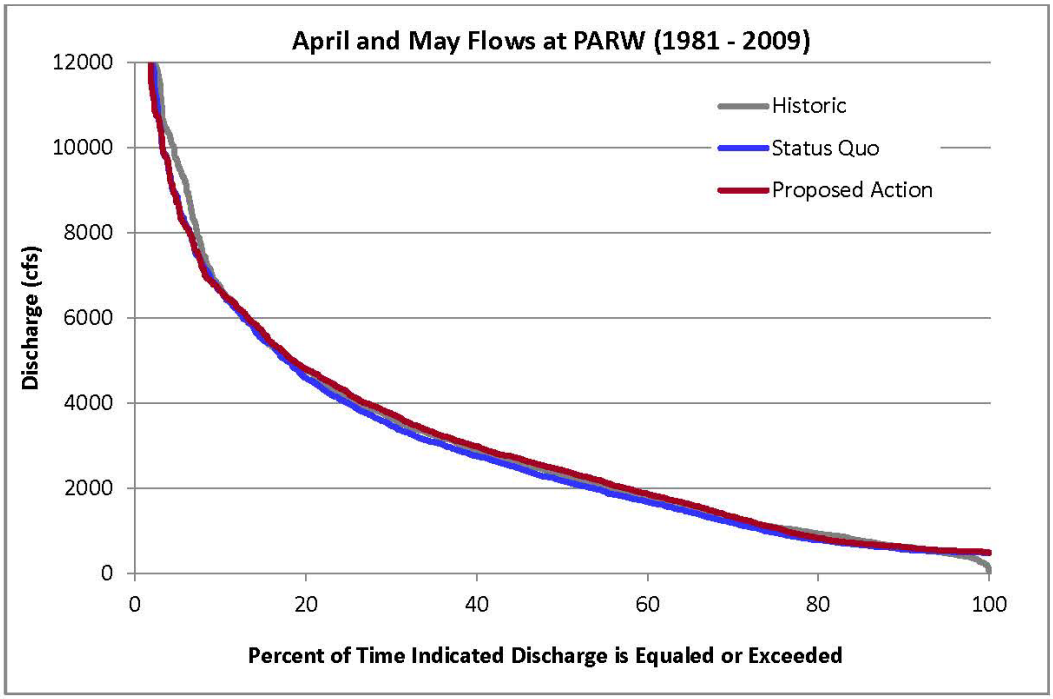

Figure 4-31. Flow duration curve for April and May flows for the period of 1981 to 2009 at the Yakima River near Parker gaging site.

Yakima River at Prosser

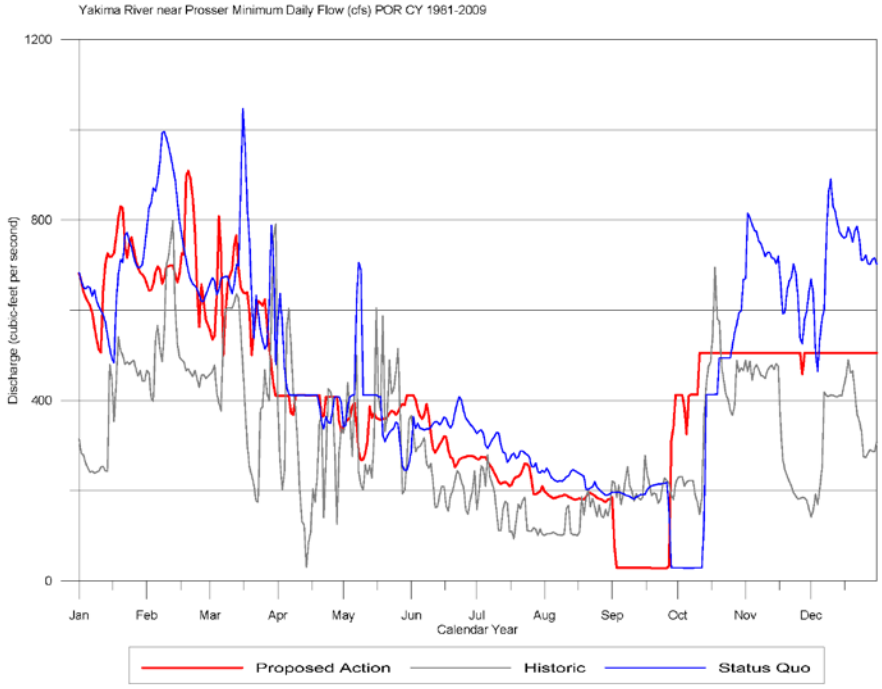

Figure 4-32. Daily minimum flows for the period of 1981 to 2009 at the Yakima River near Prosser gaging site. Zero cfs flows presented are a modeling artifact and not represented of expected conditions. See text for discussion.

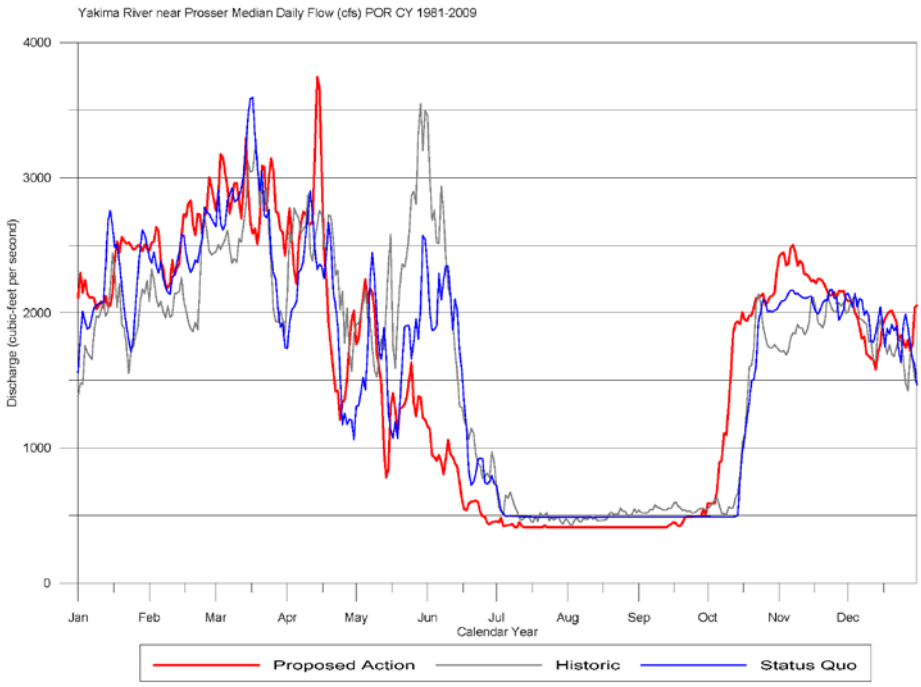

Figure 4-33. Daily median flows for the period of 1981 to 2009 at the Yakima River near Prosser gaging site.

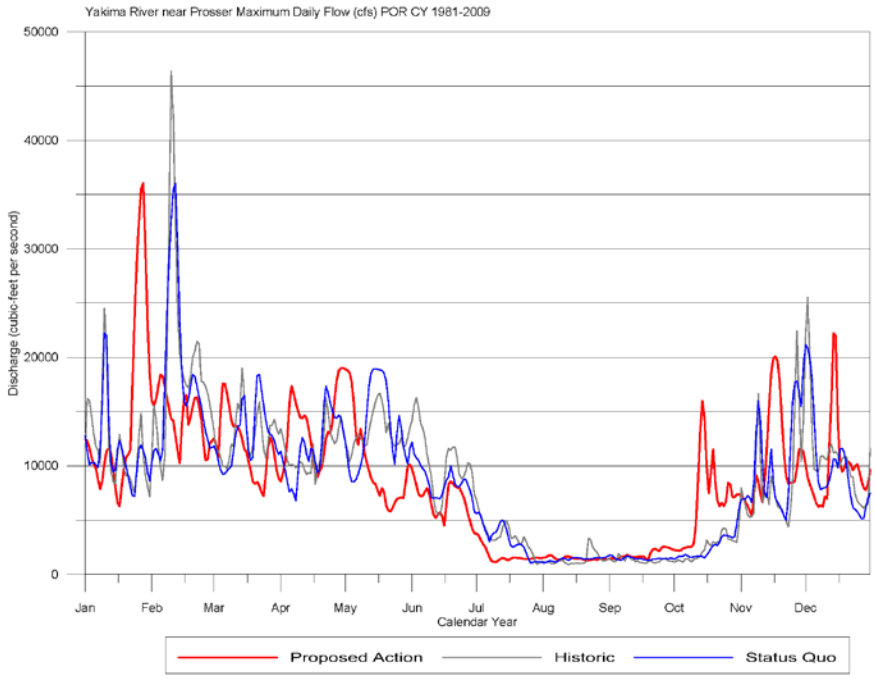

Figure 4-34. Daily maximum flows for the period of 1981 to 2009 at the Yakima River near Prosser gaging site.

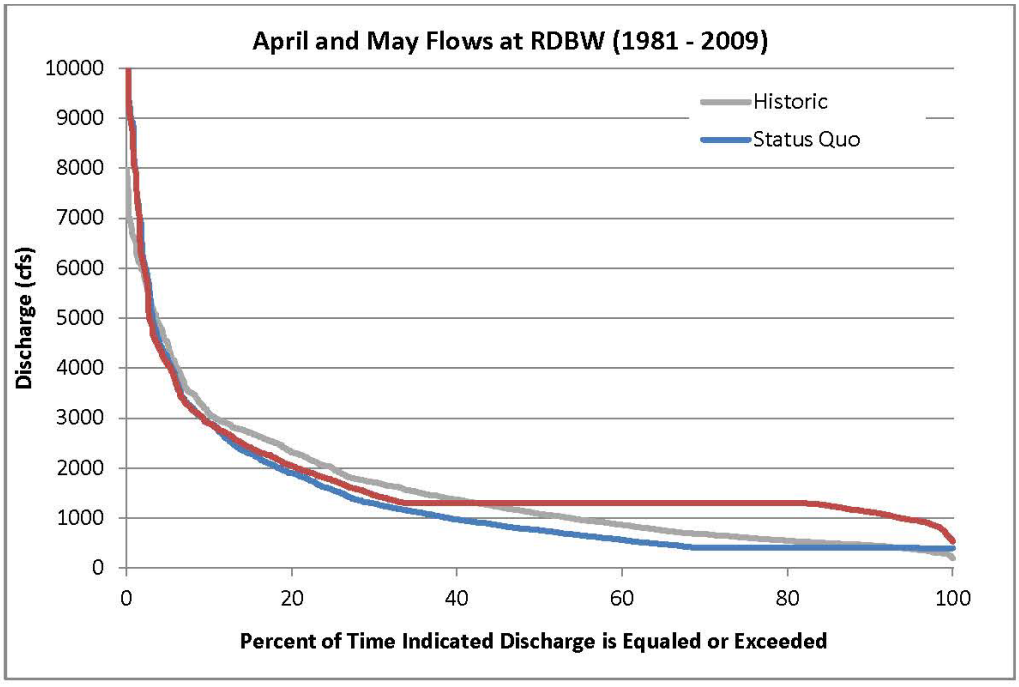

Figure 4-35. Flow duration curve for April and May flows for the period of 1981 to 2009 at the Yakima River below Roza Dam gaging site.

4.1.3 Reservoir Drawdown and Refill Schedule

All five storage reservoirs display the same general patterns of reservoir storage and drawdown across the Historic record and the Status Quo and Proposed Action scenarios. This general pattern, represented by median reservoir storage, reflects that the major drivers to reservoir filling and release remain unchanged (Figures 4-36 through 4-45). These primary drivers include the timing of irrigation demand, the timing of runoff into the reservoirs, and the implementation of the flip-flop and mini flip-flop regimes for the protection of spring Chinook redds.

Under median conditions, all of the reservoirs tend to fill in the late spring or early summer. Keechelus and Bumping tend to fill by late May, Cle Elum by early June, and Kachess and Rimrock Reservoirs by mid-June. Keechelus holds its high pool for a relatively short duration compared to the other reservoirs because it is the primary source for the KRD diversion. Cle Elum and Keechelus are drawn down starting in late June or early July and lasting through August. Kachess is drawn down primarily from early August through September, and Rimrock from early September through mid-October. The combination of providing for downstream demands as natural flows decline and changing the source of the flows through the season (for flip-flop, etc.) shapes the timing and rate of drawdown. The lowest storage for all reservoirs occurs in the fall, generally by mid-September for Cle Elum, late September for Keechelus, mid-October for Rimrock and Kachess, and late October for Bumping Reservoirs.

While the general patterns of reservoir filling and drawdown is similar under the Historic, Status Quo, and Proposed Action scenarios, small differences emerge at specific reservoirs, particularly with the total volume of water stored. At both Keechelus and Kachess, the median values representing maximum storage content in the water year are lower under Status Quo and Proposed Action scenarios relative to historic conditions (Figure 4-39 and Figure 4-41). Under the historic dataset, Rimrock fills more rapidly during the May to mid-June time period and reaches full pool a few weeks later under the two modeled scenarios relative to historic conditions, likely due to the lower early spring storage resulting from increased winter and spring releases (Figure 4-45). Median storage conditions indicate that storage is reduced under both the Status Quo and Proposed Action scenarios at Kachess and Keechelus Reservoirs. At these reservoirs, median storage is lowest under the Proposed Action scenario (Figure 4-39 and Figure 4-41). The modeled scenarios show that minimum storage at Rimrock is significantly reduced compared to historic conditions (Figure 4-44). This result illustrates that when water is bypassed throughout the winter in water tight years to meet the Wapatox instream target, Rimrock volumes are significantly lower than historic conditions. A consequence would be the 127,000 acre-feet needed to provide bull trout passage is never reached. Due to this outcome, the Proposed Action has specified how Wapatox water will be managed to avoid this outcome. This operational change has not been modeled. Additionally, Rimrock tends to be drawn down to lower reservoir storage quantities under the Proposed Action and Status Quo model run than was experienced

historically (Figures 4-44 and 4-45). This result may reflect, in part, differences between real-life operations and model rules in distributing water releases from the five storage reservoirs. In annual operations planning, modeled results are usually lower than actual end-of-season pool volumes at Rimrock Reservoir.

Cle Elum Reservoir Storage

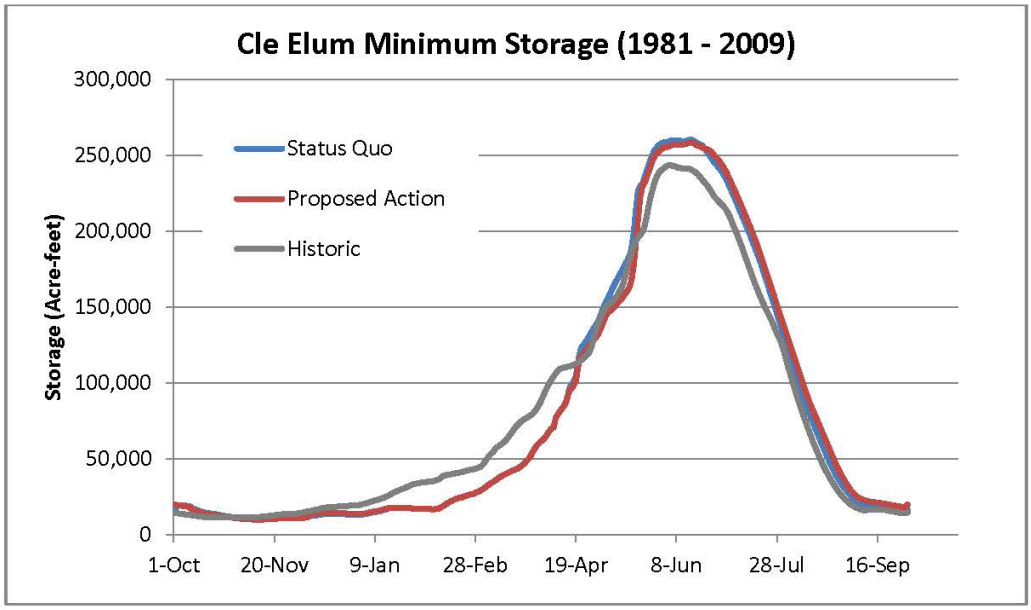

Figure 4-36. Daily minimum storage for the period of 1981 to 2009 at Cle Elum Reservoir.

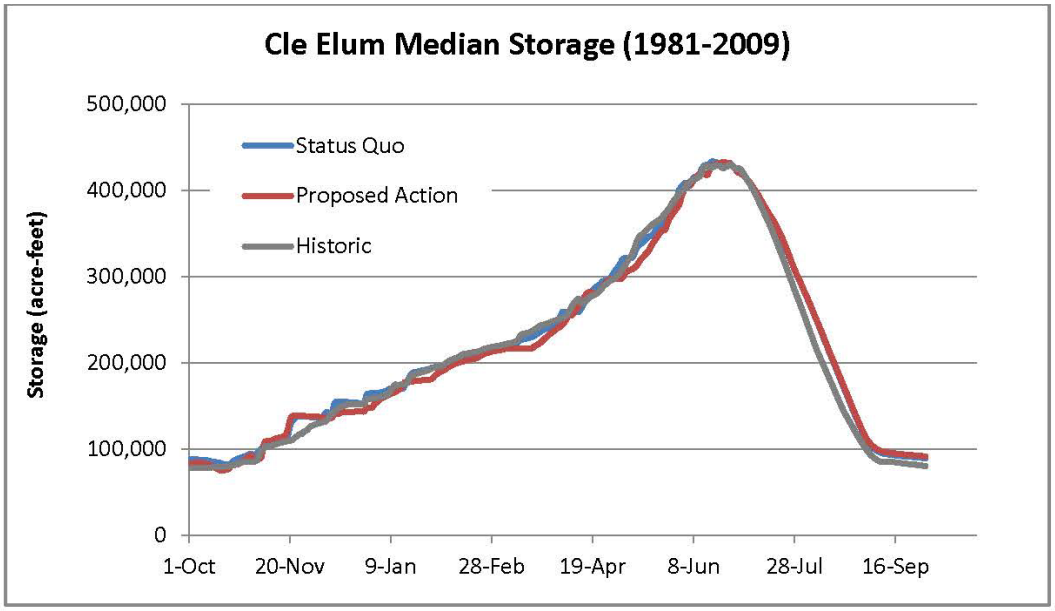

Figure 4-37. Daily median storage for the period of 1981 to 2009 at Cle Elum Reservoir.

Kachess Reservoir Storage

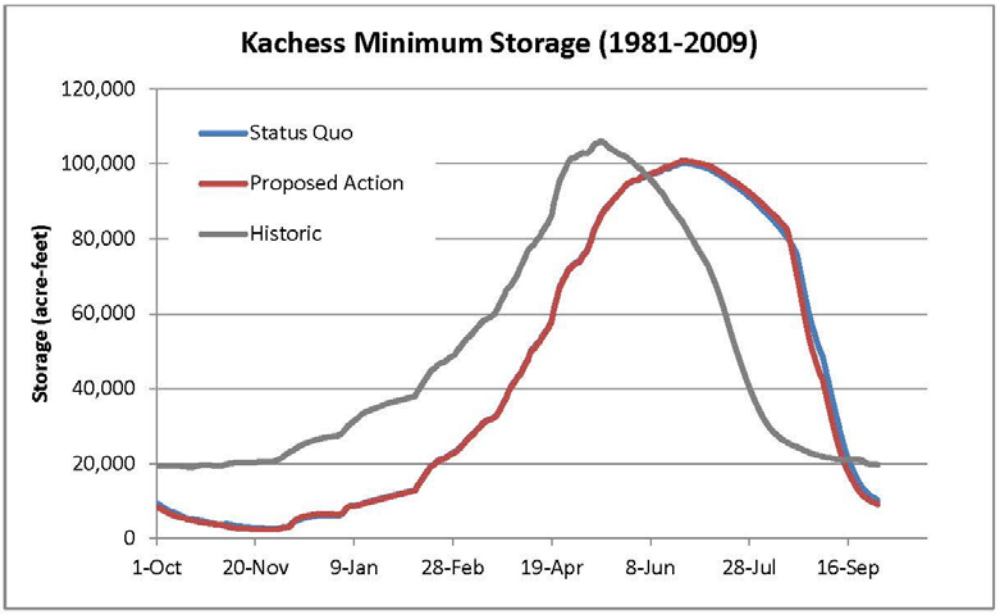

Figure 4-38. Daily minimum storage for the period of 1981 to 2009 at Kachess Reservoir.

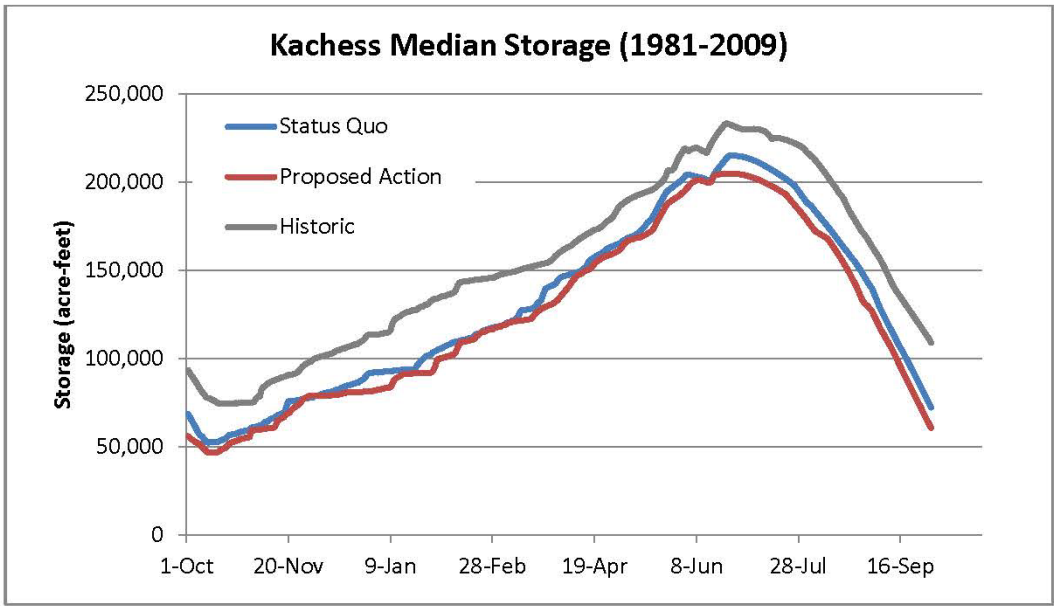

Figure 4-39. Daily median storage for the period of 1981 to 2009 at Kachess Reservoir.

Keechelus Reservoir Storage

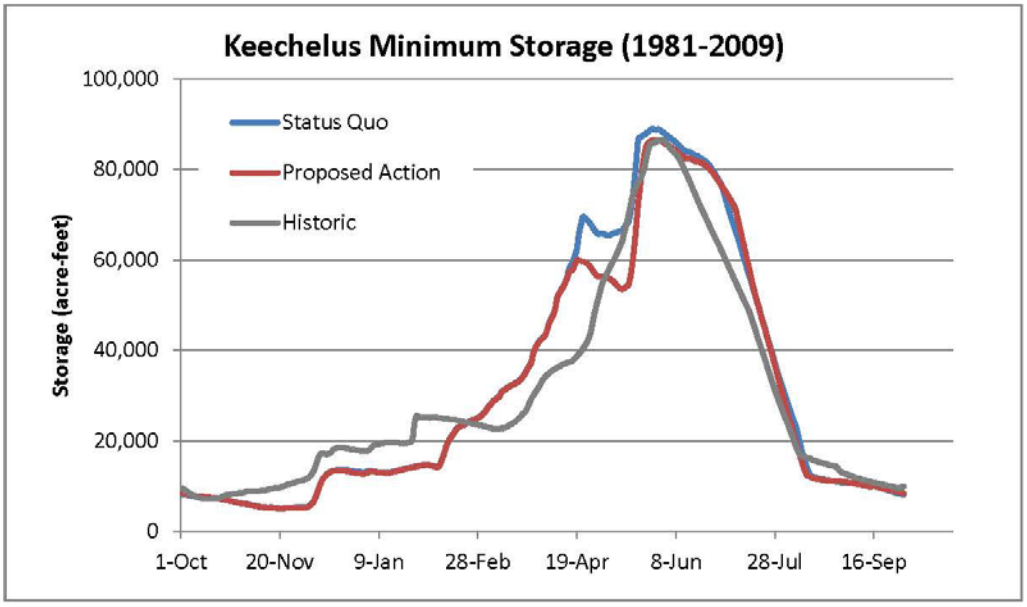

Figure 4-40. Daily minimum storage for the period of 1981 to 2009 at Keechelus Reservoir.

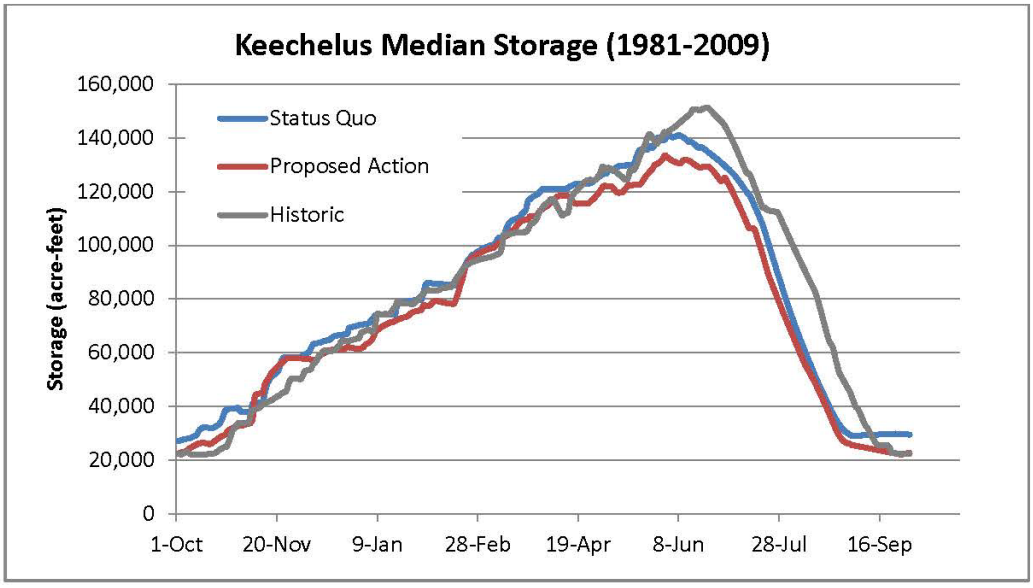

Figure 4-41. Daily median storage for the period of 1981 to 2009 at Keechelus Reservoir.

Bumping Reservoir Storage

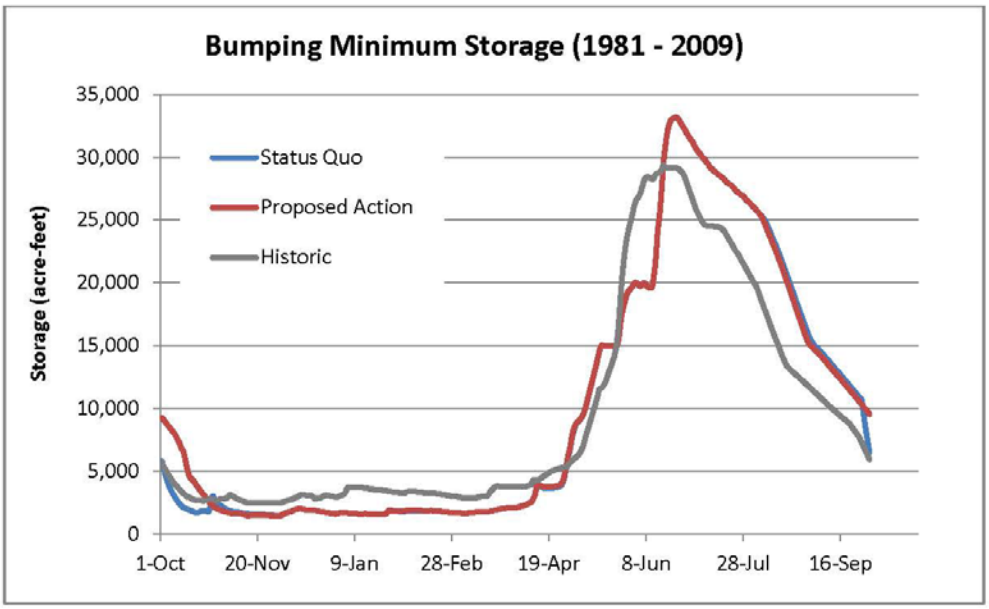

Figure 4-42. Daily minimum storage for the period of 1981 to 2009 at Bumping Reservoir.

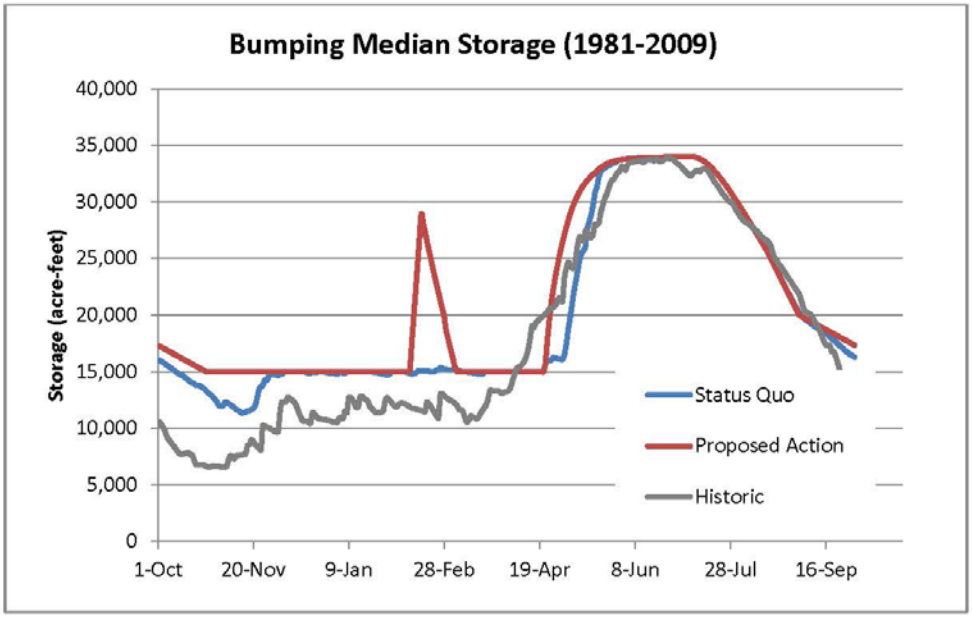

Figure 4-43. Daily median storage for the period of 1981 to 2009 at Bumping Reservoir.

Rimrock Reservoir Storage

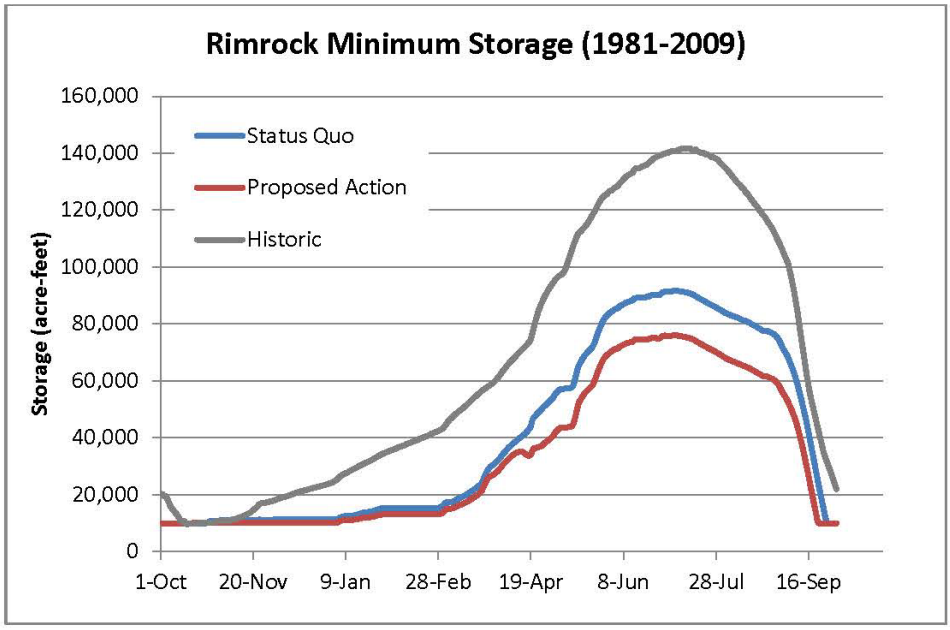

Figure 4-44. Daily minimum storage for the period of 1981 to 2009 at Rimrock Reservoir.

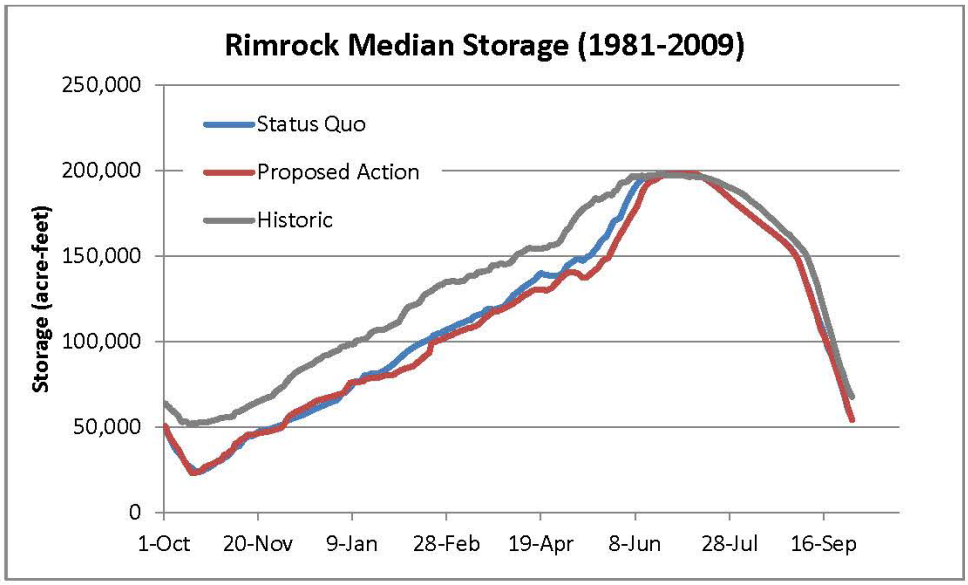

Figure 4-45. Daily median storage for the period of 1981 to 2009 at Rimrock Reservoir.

4.2 Water Quality

4.2.1 Overview

The water quality analysis presented in this section utilizes data collected by Reclamation, irrigation district reports, and Ecology TMDL documents to characterize the local water quality conditions. The hydrological datasets presented in the proceeding sections will be the basis of assessing change from the Status Quo to the Proposed Action. The Status Quo hydrological dataset describes the flow conditions and experienced, thus influencing the water quality baseline conditions. Deviations from the hydrology of the Status Quo and the Proposed Action should indicate the potential magnitude of any water quality changes.

The Clean Water Act requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the Nation's waters. States and tribes must adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Part of the state's responsibilities also include requirements to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards).

States and tribes publish a priority list of impaired waters every 2 years. For waters identified on this list, states and tribes must develop water quality improvement plans known as TMDLs that establish allowable pollutant loads set at levels to achieve water quality standards. These TMDLs describe the current conditions of the watersheds, and also lay out implementation plans for water quality improvements in the Yakima basin.

The 303(d) listing process and subsequent TMDL development is initiated when beneficial uses are not being supported, which is generally identified through exceedance of water or fish tissue based criteria. The most recent approved 303(d) list for the State of Washington is the 2010 Integrated Report that was approved by the EPA on December 31, 2012 (Ecology 2014a).

Primary water quality problems identified in the action areas are elevated water temperature in several of the tributaries to the five reservoirs. The Cle Elum River is also listed for temperature at the outfall from Cle Elum Reservoir. Based on fish tissue samples, the Keechelus Reservoir has been listed for 34 pollutants, ranging from anthracene to pyrene. Many of these toxins are completely banned, such as DDT, or the registrations of the pesticides have been revoked, such as chlordane, which was revoked in 1983. Temperature listing in the mainstem Cle Elum River is the only 303(d) listed water body in the Action Area that the Proposed Action could affect. Consequently, any Proposed Action should address warming in the Cle Elum River. In this case, the Status Quo and Proposed Action hydrographs are very similar, and both have a rapid curtailment of discharge in the fall which should minimize any fall temperature exceedances. Discharge for both scenarios are also similar in the summer and should result in similar cooling of the river. As a result, the Proposed Action should not change the current temperature regime of the Cle Elum River.

In 1998, the State developed the TMDL for the lower Yakima River Suspended Sediments and DDT (Ecology 1998) that includes Yakima River mainstem between the confluence of the Yakima and Naches Rivers (RM 116.3) and the Kiona gage at Benton City (RM 30), and all drains and tributaries within the TMDL Project Area. In this TMDL, the primary constituents that received load and waste load allocations were sediment and DDT. The Department of Ecology used a correlation of TSS concentrations to turbidity values, and TSS targets on the mainstem Yakima River were based on the turbidity standard of 5 NTU above background. To protect aquatic biota, a 25 NTU turbidity, or 56 mg/L TSS target were applied to irrigation return drains and tributaries. A pesticides criterion was based on the correlation of TSS to t-DDT. By achieving the aquatic biota TSS targets, it was assumed that the return drains and tributaries would achieve the t-DDT water quality criterion for protection of aquatic life from chronic toxicity.

The next TMDL that covers the Action Area is the Upper Yakima Suspended Sediment and Organochlorines (Ecology 2002). This TMDL covers the Yakima River from the confluence with the Naches River to Lake Easton. Pollutant targets for these Yakima River segments were turbidity standard of 5 NTU above background, a dieldrin target of 0.65 µg/kg wet weight in fish tissues, and for DDT, its daughter products, and dieldrin not to exceed the human health criteria for water column concentrations.

The Department of Ecology has continued to work on reducing toxins in the Yakima basin. This work continued in the Yakima River Toxins TMDL (Ecology 2010). The TMDL assessment covers the Yakima River from Keechelus Lake to the Columbia River. This TMDL also covers the Naches River and the drains and tributaries of the lower Yakima River. The TMDL contains monitoring information that documents the loading of currently used herbicides and pesticides as well as those legacy pesticides still found in the watershed. Currently used pesticides were not elevated in the watershed; therefore, no load or waste load allocations were developed for these pollutants. Sediment load reductions were established to reduce the loading of the legacy pesticides that were elevated in the watershed.

In conjunction with the toxins TMDLs, Reclamation and the irrigation districts have been working to reduce the quantities of herbicides applied, or to increase the efficiency of the applications. Currently, the Roza Irrigation District applies four chemicals to Reclamation properties. All of Roza's applicators are licensed through the Washington State Department of Agriculture. All of the chemicals are registered under the Federal Insecticide, Fungicide, and Rodenticide Act, and the applicators are limited to labeled uses of the products. The Washington State Department of Agriculture also requires a registration of pesticides and has a pesticide management division that ensures pesticides are used legally and safely. As noted in the Proposed Action, two chemicals are applied as needed at all five dam sites. Reclamation also sprays small areas at dams and facilities with the herbicide Roundup, while herbicide applications for large areas are contracted with Roza Irrigation District.

In addition to the Federal Insecticide, Fungicide, and Rodenticide Act regulations, the Washington Department of Ecology regulates herbicide application for irrigation system aquatic weed control under NPDES General Permit WAG – 991000. This general permit was renewed and effective on June 15, 2012. The general permit limits the type of herbicides that can be used, requires monitoring to occur during the application, and establishes effluent limits needed to protect water quality.

The Proposed Action will not alter the current protections and regulations that are in place regarding herbicide use. In addition, the implementation activities occurring associated with the TMDLs will continue to reduce the loading from legacy herbicides in the watershed. It can be assumed that loadings from current applications that are also sorbed to sediment will be reduced by the TMDL implementation activities as well.

Other TMDLs completed in the Action Area include the Naches River and tributaries temperature TMDL completed in 2008. Ecology continues to develop temperature TMDLs in the Yakima basins as needed.

4.2.2 Reservoirs

Reclamation has collected water quality data periodically throughout the Yakima basin specifically targeting the reservoirs and downstream rivers of the system. This data is meant to provide a simple characterization of the water chemistry and thermal structure of the various reservoirs during the summer critical period. The summer period best represents the thermal stratification that occurs in a lake or reservoir. This period is also when any temperature or dissolved oxygen issues are readily apparent or are beginning to develop. In addition, future nutrient and contaminate issues that can be acerbated by low dissolved oxygen in the hypolimnion, such as phosphorus releasing from lake bed sediments, can be identified.

The data presented in the following sections are those data points collected by Reclamation as a result of the Regional Reservoirs Water Quality monitoring program. Other water quality studies that have assessed full season or monthly water quality conditions are presented by reference.

Water Quality Conditions - Keechelus

Temperature

Reclamation has collected temperature profiles occasionally as part of the regional reservoirs surveillance program. Keechelus Reservoir was sampled once every 3 years beginning in 2002. Profiles are collected during the summer stratification period. These temperature profiles are used to give an indication of temperature and oxygen stratification during the summer critical period.

Keechelus Reservoir is a deep cool reservoir. It strongly stratifies during the summer period, with an epilimnetic depth of approximately 5 to 8 meters in depth (Figure 4-46). The thermocline is very pronounced, and transitions to a cold hypolimnion at approximately 15 meters.

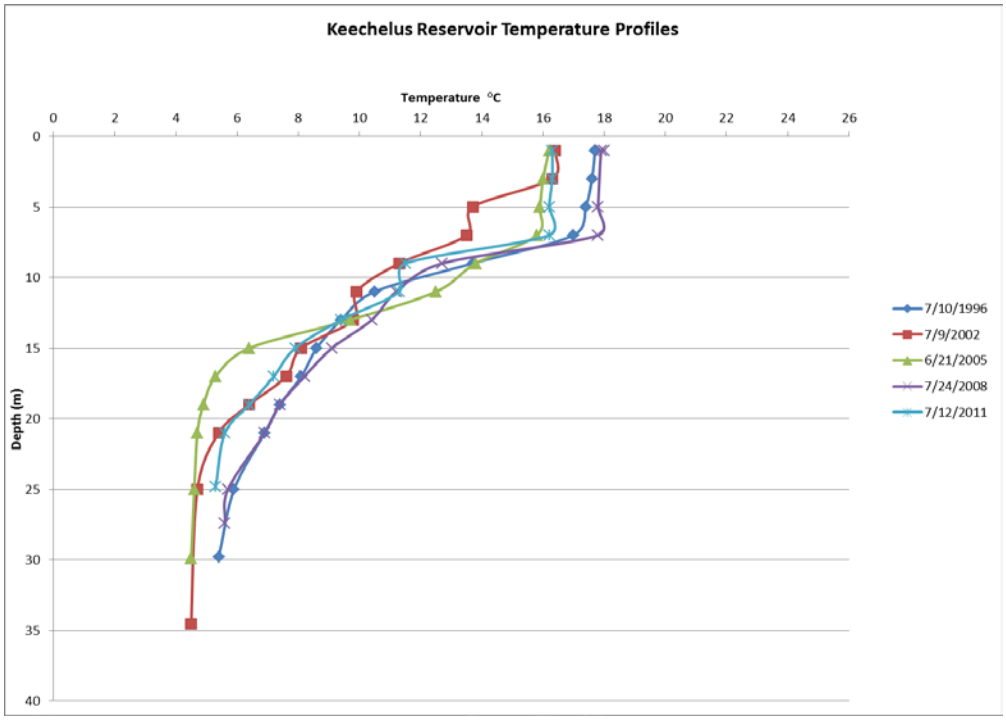

Figure 4-46. Temperature profiles for June and July for the period of 1996 to 2011 at the Keechelus Reservoir, 100 meters upstream of the dam.

Dissolved Oxygen

Dissolved oxygen profiles were also collected along with the temperature profiles. However, there does not appear to be a well-established chemocline of oxygen concentration (Figure 4-47). Throughout the summer, dissolved oxygen levels were suitable for aquatic life throughout the water column. Generally, it appears that the reservoir contains a thermal and oxygen refugia during the summer critical period throughout the water column.

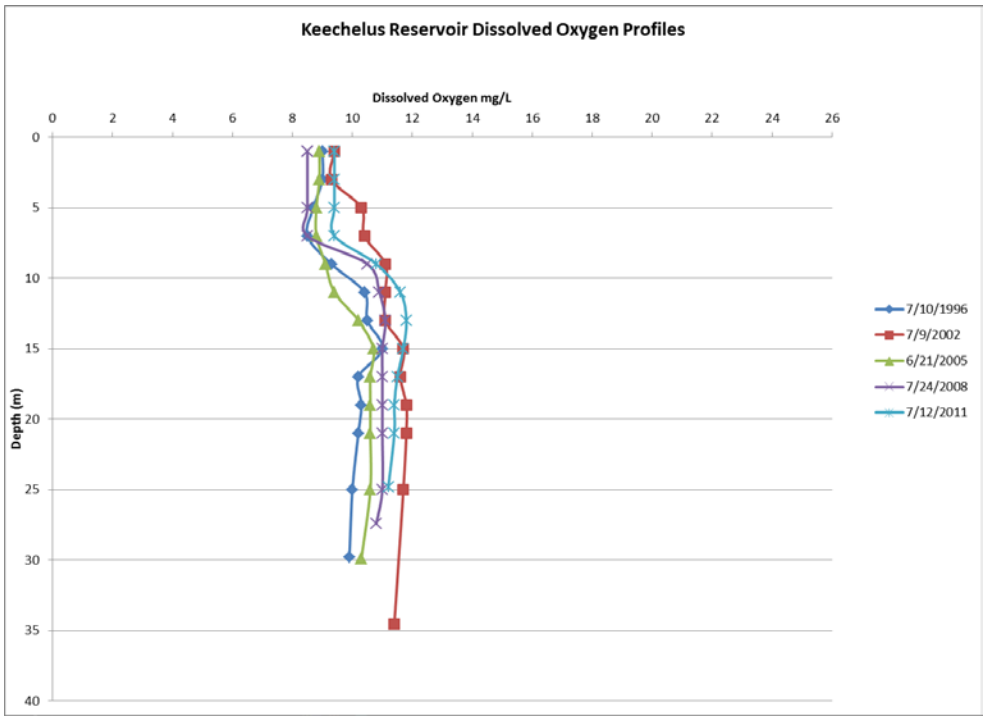

Figure 4-47. Oxygen profiles for June and July for the period of 1996 to 2011 at the Keechelus Reservoir, 100 meters upstream of the dam.

Sediment/Turbidity

Reclamation has periodically collected sediment/turbidity samples from Keechelus Reservoir and from below the reservoir in the Yakima River. Total suspended solids (TSS) levels were very low in the set of samples from the reservoir, with a mean concentration of less than 1 mg/L for the period of record. From below the reservoir, the mean concentration was 1.19 mg/L. The range of TSS samples was less than 1 to 3 mg/L.

In addition, Reclamation measured turbidity and Secchi depths of the reservoir waters. Both measures are an indication of water clarity. Turbidity values were very low; mean reservoir turbidity was less than 1 to 5 NTU, indicating very clear water. Secchi depths were variable and ranged from clear, near 6 meters deep, to very clear at 9 meters deep. Chlorophyll a samples were also very low, and ranged from less than detection limits (less than .05 µg/L) to 1.8 µg/L.

Other Water Chemistry

Nutrient retention in an oligotrophic reservoir is common. At depth, the nutrient cycling in a reservoir liberates nutrients generally only under anoxic conditions. Anoxic conditions are rare in Keechelus Reservoir (see the dissolved oxygen profiles). Under well oxygenated situations reservoirs can act like nutrient traps, retaining most of the nutrients.

The levels of the measured constituents in Keechelus Reservoir are low to very low. These levels in most all cases indicate a lower loading and pristine water quality. The total phosphorus (TP) concentrations from the surface waters (less than 5 meters) were most often below 0.01 mg/L. At depth (greater than 10 meters), TP concentrations during the summer stratification period averaged 0.012 mg/L. Total Nitrogen (TN) concentrations were also very low, approximately 0.087 mg/L.

In the reservoir, the TN:TP ratio was well balanced. Generally, lakes are phosphorus limited with TN:TP ratios greater than 15, and nitrogen limited for TN:TP ratios less than 7. For ratios of TN:TP between 15 and 7, either TP or TN, or both, are limiting. In Keechelus Reservoir, the average TN:TP ratio for all surface samples was 15.75, which would indicate a slight TP limitation. This is likely the result of TP depletion from the reservoir's epilimnion. Biologically this indicates that blue green algae and other unpalatable forms of nitrogen fixing algae should not occur, as nitrogen is in balance or slightly more common than phosphorus. Furthermore, the types of algae that are often associated with TN:TP ratios such as these should provide suitable forage for zooplankton and other aquatic invertebrates.

For lakes, Carlson's TSI can be used to determine if a lake is undergoing cultural eutrophication (Carlson 1977); however, a certain tradeoff exists between fish production and water quality. Mesotrophic reservoirs are often seen as well balanced in terms of fish production and water quality. Therefore, mesotrophic lakes are viewed by many as the ideal target; as a result, many states and water quality entities use a TSI target of 50 as their management goals. In more oligotrophic lakes, such as Keechelus Reservoir, fish production is lower while water clarity is higher. The same tradeoff exists for eutrophic waters with higher fish production and lower water clarity. However, often the fish production seen in eutrophic waters in the west is towards less desirable species of fishes, as the water quality is such that the higher temperatures or lower dissolved oxygen levels seen in eutrophic waters stress salmonids, which are the more desirable species.

Average TSI value calculated for Keechelus Reservoir was 27.61. This measure of eutrophication is below the mesotrophic break point of 50, indicating the reservoir is oligotrophic. In general, this indicates that a nutrient loading from the watershed is balanced with the nutrient cycling within the reservoir.

Water Quality Conditions - Kachess

Temperature

Reclamation collects temperature profiles as part of the regional reservoirs surveillance program. Kachess Reservoir was sampled occasionally beginning in 2002. Profiles are collected during the summer stratification period. These temperature profiles are used to give an indication of temperature and oxygen stratification during the summer critical period.

Kachess Reservoir is a cool reservoir. It strongly stratifies during the summer period, with an epilimnetic depth of approximately 10 meters (Figure 4-48). The thermocline is very pronounced, and transitions to a cold hypolimnion at approximately 15 meters. It is smaller than Keechelus and as a result the hypolimnion warms more and the epilimnion is thicker.

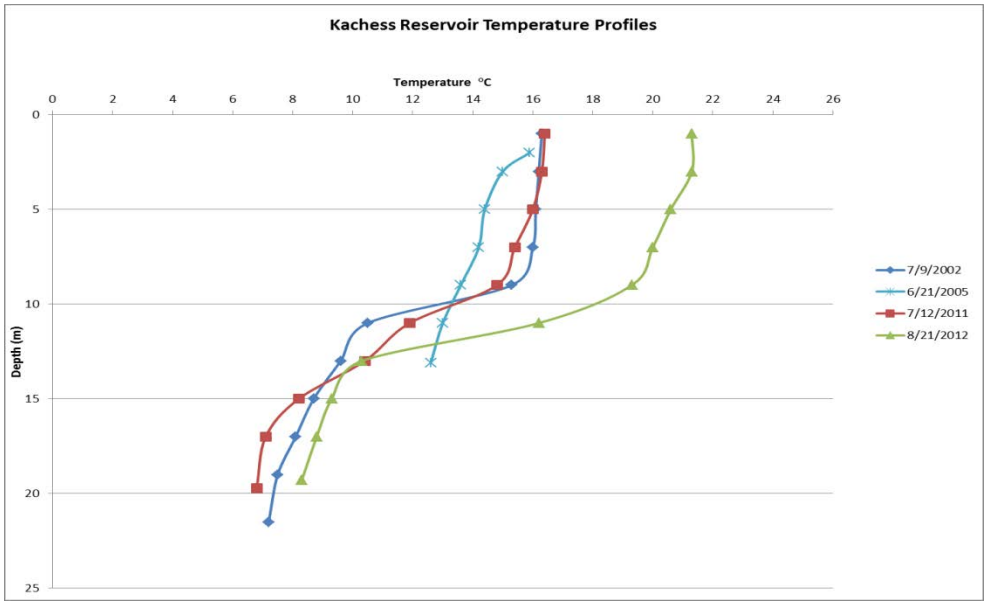

Figure 4-48. Temperature profiles for June, July, and August for the period of 2002 to 2012 at the Kachess Reservoir, 100 meters upstream of the dam.

Dissolved Oxygen

Dissolved oxygen profiles were also collected along with the temperature profiles. However, there does not appear to be a well-established chemocline of oxygen concentration (Figure 4-49). Throughout the summer, dissolved oxygen levels were suitable for aquatic life throughout the water column. Generally, it appears that the reservoir contains a thermal and oxygen refugia during the summer critical period below 10 meters. As seen in the temperature profiles, the hypolimnion warms as the summer progresses. This could potentially lead to late summer dissolved oxygen depletion. However, the data has not been collected to confirm or refute this hypothesis.

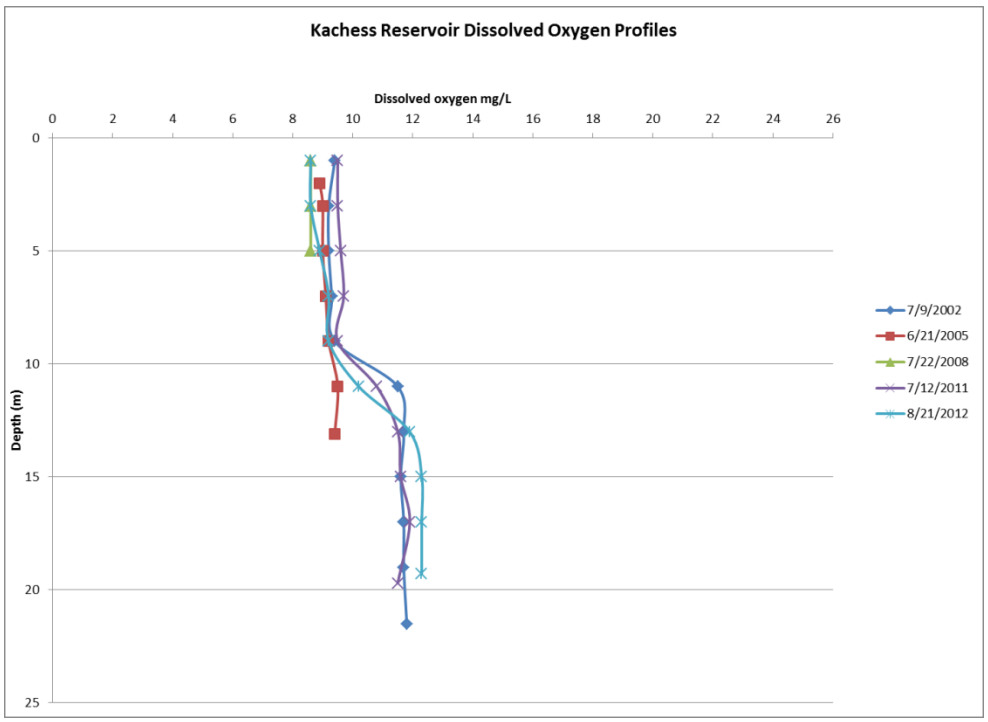

Figure 4-49. Oxygen profiles for June, July, and August for the period of 2002 to 2012 at the Kachess Reservoir, 100 meters upstream of the dam.

Sediment/Turbidity

Reclamation has periodically collected sediment/turbidity samples from Kachess Reservoir and from below the reservoir in the Yakima River. TSS levels were very low in the set of samples from the reservoir, with a mean concentration of 4.91 mg/L for the period of record. The range of TSS samples was less than 1 to 36 mg/L. From below the reservoir, the mean concentration was 3.11 mg/L. The range of TSS samples was less than 1 to 13 mg/L.

In addition, Reclamation measured turbidity and Secchi depths of the reservoir waters. Both measures are an indication of water clarity. Turbidity values were very low, mean reservoir turbidity was less than 1 to 5 NTU, indicating very clear water, Secchi depths were variable. Secchi depths ranged from clear, near 6 meters deep, to very clear at 11.6 meters deep. Chlorophyll a samples were also very low, and ranged from less than detection limits (less than .05 µg/L) to 1.6 µg/L.

Other Water Chemistry

The levels of the measured constituents in Kachess Reservoir are low to very low. These levels in most all cases indicate a lower loading and pristine water quality. The TP concentrations from the surface waters (less than 5 meters) were most often below 0.009 mg/L. At depth (greater than 10 meters), TP concentrations during the summer stratification period averaged 0.015 mg/L. Total nitrogen concentrations were also very low, approximately 0.091 mg/L.

In the reservoir, the TN:TP ratio is out of balance. Generally, lakes are phosphorus limited with TN:TP ratios greater than 15, and nitrogen limited for TN:TP ratios less than 7. For ratios of TN:TP between 15 and 7, either TP or TN, or both, are limiting. In Kachess Reservoir, the average TN:TP ratio for all surface samples was 11.04, which would indicate a slight nitrogen limitation. In some cases the TN:TP ratio was well below 7, clearly indicating nitrogen limitation. This is likely the result of nitrogen depletion from the reservoir's epilimnion rather than excess phosphorus loading from the watershed. Biologically, this indicates that blue green algae and other unpalatable forms of nitrogen-fixing algae could occur.

Average TSI value calculated for Kachess Reservoir was 27.69. This measure of eutrophication is below the mesotrophic break point of 50, indicating the reservoir is oligotrophic. In general, this indicates that a nutrient loading from the watershed is balanced with the nutrient cycling within the reservoir.

Water Quality Conditions - Rimrock

Temperature

Reclamation collects temperature profiles as part of the regional reservoirs surveillance program. Rimrock Reservoir was sampled occasionally beginning in 1996. Profiles are collected during the summer stratification period. These temperature profiles are used to give an indication of temperature and oxygen stratification during the summer critical period.

Rimrock Reservoir is a warm reservoir. It strongly stratifies during the late summer period, mixing to depth during the early summer. The epilimnetic depth is approximately 10 meters in some summers and nearly absent in others (Figure 4-50). The thermocline can be very pronounced, and transitions to a warm hypolimnion at approximately 20 meters.

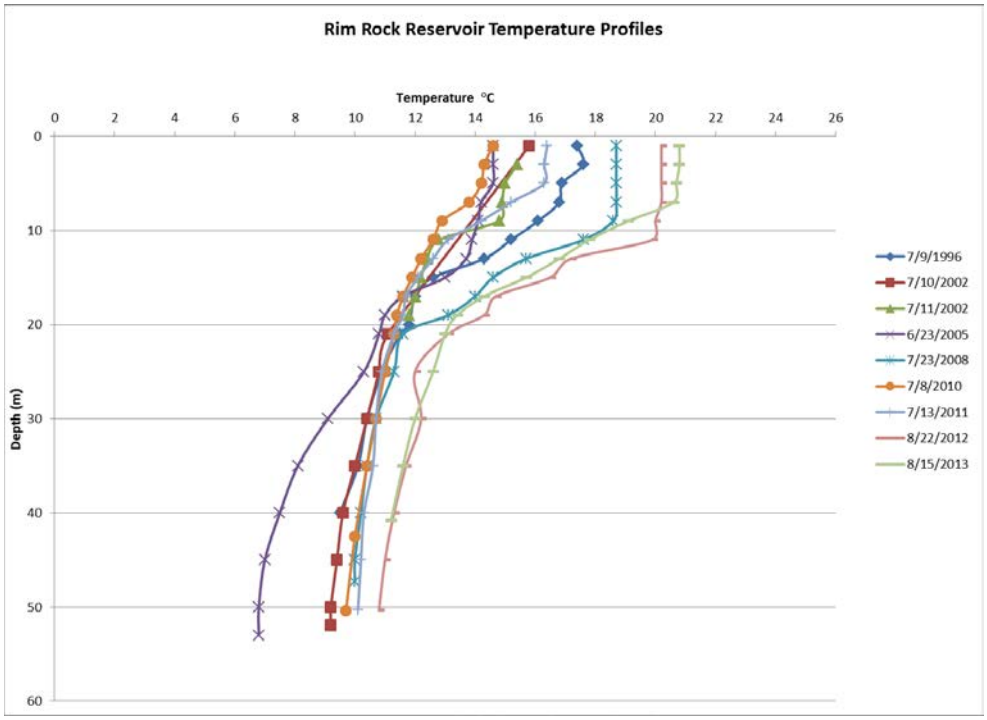

Figure 4-50. Temperature profiles for June, July, and August for the period of 1996 to 2013 at the Rimrock Reservoir, 100 meters upstream of the dam.

Dissolved Oxygen

Dissolved oxygen profiles were also collected along with the temperature profiles. However, there does not appear to be a well-established chemocline of oxygen concentration (Figure 4-51). Throughout the summer, dissolved oxygen levels were suitable for aquatic life throughout the water column. Generally, it appears that the reservoir contains a thermal and oxygen refugia during the summer critical period below 10 meters.

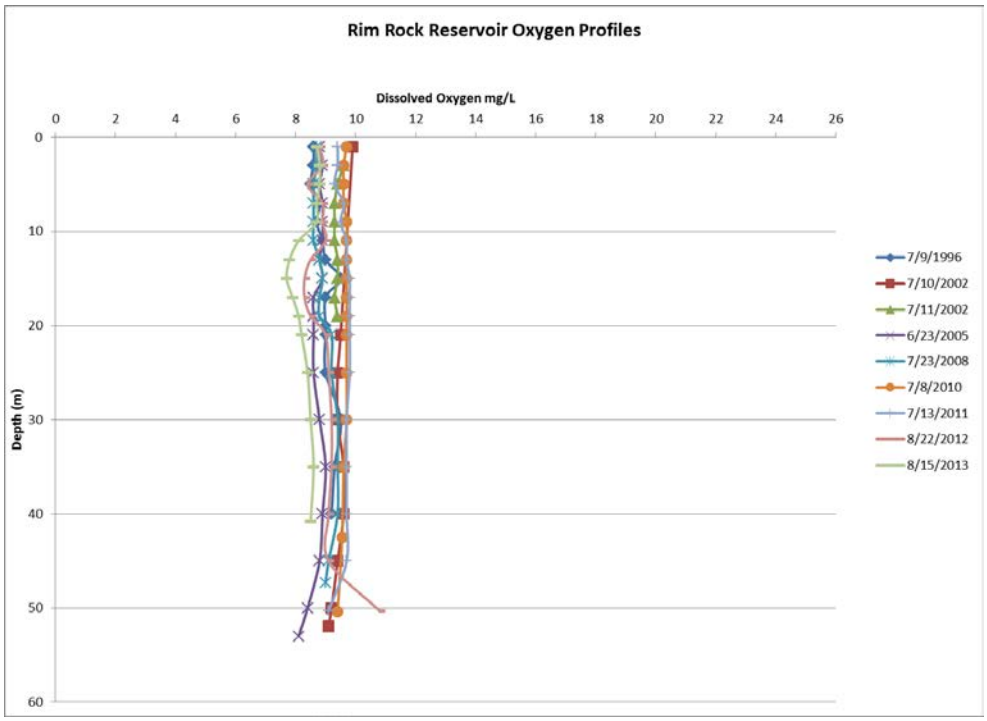

Figure 4-51. Oxygen profiles for June, July, and August for the period of 1996 to 2013 at the Rimrock Reservoir, 100 meters upstream of the dam.

Sediment/Turbidity

Reclamation has periodically collected sediment/turbidity samples from Rimrock Reservoir and from below the reservoir in the Tieton River. TSS levels were very low in the set of samples from the reservoir, with a mean concentration of 3.39 mg/L for the period of record. The range of TSS samples was less than 1 to 10 mg/L. From below the reservoir, the mean concentration was 4.88 mg/L. The range of TSS samples was less than 2 to 12 mg/L.

In addition, Reclamation measured turbidity and Secchi depths of the reservoir waters. Both measures are an indication of water clarity. Turbidity values were very low; mean reservoir turbidity was less than 1 to 14 NTU, indicating clear water. Secchi depths were variable ranging from 1.2 meters deep, to clear at 3.8 meters deep. Chlorophyll a samples ranged from 0.3 µg/L to 6.6 µg/L. Generally, Rimrock Reservoir is less clear than Keechelus and Kachess Reservoirs, but may also be more productive in terms of primary and secondary production.

Other Water Chemistry

The levels of the measured constituents in Rimrock Reservoir are moderate to low levels. These levels in most all cases indicate a higher loading and more productive water quality. The TP concentrations from the surface waters (less than 5 meters) averaged 0.02 mg/L. At depth (greater than 10 meters), TP concentrations during the summer stratification period

averaged 0.026 mg/L. Mesotrophic or moderately productive reservoirs generally have TP levels near 0.025 mg/L. Total Nitrogen concentrations from surface samples; however, were very low, approximately 0.177 mg/L, and from depths greater than 10 meters TN concentrations averaged 0.1 mg/L. In mesotrophic reservoirs TN is typically near 0.74 mg/L.

The average TN:TP ratio for all surface samples was 13.82, which would indicate a slight nitrogen limitation. However, in most cases the TN:TP ratio was well below 7, clearly indicating nitrogen limitation. The range of TN:TP ratios in Rimrock Reservoir were between 1.45 and 29. The wide range, with extremely low nitrogen concentrations would lead to periods when blue green algae and other unpalatable forms of nitrogen fixing algae may dominate the system.

Average TSI value calculated for Rimrock Reservoir was 36.13. This measure of eutrophication is below the mesotrophic break point of 50, indicating the reservoir is oligotrophic. In addition, the Carlson's TSI can be broken into its individual components in order to determine mechanisms of impairment.

One such mechanism the individual components of Carlson's TSI can be used to determine is if nutrients are in excess. A TSI for TP above 50 has been used in other states as a threshold for excess nutrients. A TSI of 50 corresponds with 0.024 mg/L of TP and 0.734 mg/L of TN and with a 2 meter Secchi depth and a concentration of 7.23 µg/L for chlorophyll a. The source of clarity issues can also be extracted from a review of the individual TSI components.

In Rimrock Reservoir, the average TSI for the individual components were 47.38 for TP, 22.90 for TN, 31.06 for chlorophyll a, and 47.19 for Secchi depth. Based upon these numbers, Rimrock Reservoir exhibits very low TN numbers, indicating a possibility of nitrogen fixing algae blooms. The TSI components for Secchi and TP were elevated in comparison with the remaining metrics.

Water Quality Conditions - Cle Elum

Temperature

Reclamation collects temperature profiles as part of the regional reservoirs surveillance program. Cle Elum Reservoir was sampled occasionally beginning in 1996. Profiles are collected during the summer stratification period. These temperature profiles are used to give an indication of temperature and oxygen stratification during the summer critical period.

Cle Elum Reservoir is a cool reservoir. It strongly stratifies during the late summer period; the stratification begins to develop in the early summer (Figure 4-52). The epilimnetic depth is approximately 10 to 15 meters in some summers. The thermocline can be very pronounced, and transitions to a cool hypolimnion at approximately 20 to 30 meters.

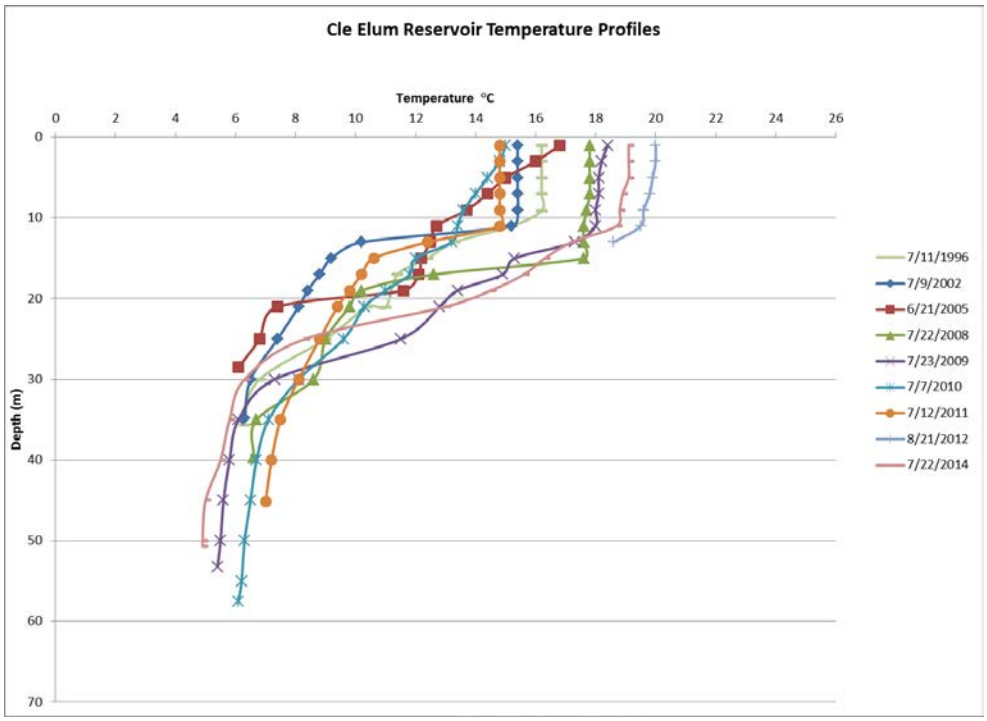

Figure 4-52. Temperature profiles for June, July, and August for the period of 1996 to 2014 at the Cle Elum Reservoir, 100 meters upstream of the dam.

Dissolved Oxygen

Dissolved oxygen profiles were also collected along with the temperature profiles. However, there does not appear to be a well-established chemocline of oxygen concentration (Figure 4-53). Throughout the summer, dissolved oxygen levels were suitable for aquatic life throughout the water column. Generally, it appears that the reservoir contains a thermal and oxygen refugia during the summer critical period below 10 meters.

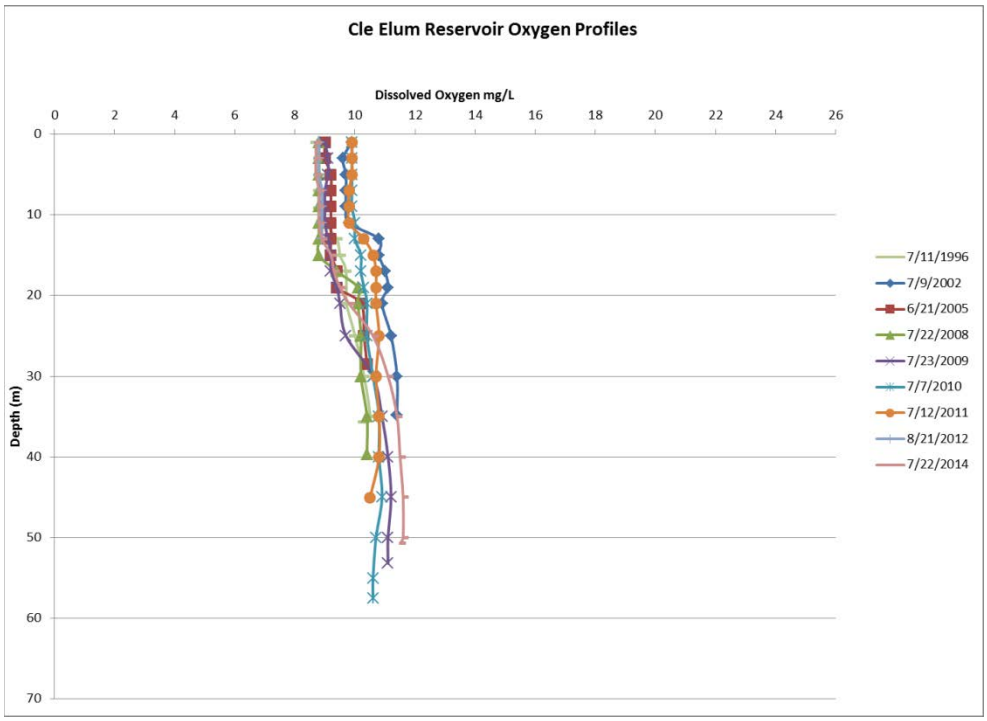

Figure 4-53. Oxygen profiles for June, July, and August for the period of 1996 to 2013 at the Cle Elum Reservoir, 100 meters upstream of the dam.

Sediment/Turbidity

Reclamation has periodically collected sediment/turbidity samples from Cle Elum Reservoir and from below the reservoir in the Cle Elum River. TSS levels were very low in the set of samples from the reservoir, with a mean concentration of 1.54 mg/L for the period of record. The range of TSS samples was less than 1 to 4 mg/L. From below the reservoir, the mean concentration was 2.15 mg/L. The range of TSS samples was less than 1 to 5 mg/L.

In addition, Reclamation measured turbidity and Secchi depths of the reservoir waters. Both measures are an indication of water clarity. Turbidity values were very low, reservoir turbidity was less than 1 to 14 NTU, indicating clear water, Secchi depths were variable. Secchi depths ranged from 1.2 meters deep, to clear at 3.8 meters deep. Chlorophyll a samples ranged from 0.3 µg/L to 6.6 µg/L. Generally, Rimrock Reservoir is less clear than Keechelus and Kachess Reservoirs, but may also be more productive in terms of primary and secondary production.

Other Water Chemistry

The levels of the measured constituents in Cle Elum Reservoir are very low levels. These levels in most all cases indicate a low loading from the watershed and less productive water quality. The TP concentrations from the surface waters (less than 5 meters) averaged 0.006 mg/L. Similar concentrations were measured at depth (greater than 10 meters), indicating little TP liberation for the sediments during the summer stratification period. Total Nitrogen concentrations from surface samples were also very low, approximately 0.09 mg/L, and from depths greater than 10 meters TN concentrations averaged 0.1 mg/L.

The average TN:TP ratio for all surface samples was 15.3, which would indicate a balanced nutrient ratio in the reservoir. However, in most cases the TN:TP ratio was above 15, clearly indicating phosphorus limitation. The range of TN:TP ratios in Cle Elum Reservoir were between 7 and 54. The wide range, with extremely low phosphorus concentrations would indicate very low productivity with most of the productivity associated with reservoir turn-over, or near tributary sources of phosphorus.

Average TSI value calculated for Cle Elum Reservoir was 24.79. This measure of eutrophication is well below the mesotrophic break point of 50, indicating the reservoir is very oligotrophic. In addition, the Carlson's TSI can be broken into its individual components in order to determine mechanisms of impairment.

In Cle Elum Reservoir, the average TSI for the individual components were 29.24 for TP, 17.74 for TN, 25.57 for chlorophyll a, and 32.12 for Secchi depth. Based upon these numbers, Cle Elum Reservoir exhibits very low TN numbers, indicating a possibility of nitrogen fixing algae blooms.

Water Quality Conditions - Bumping

Temperature

Reclamation collects temperature profiles as part of the regional reservoirs surveillance program. Bumping Reservoir was sampled occasionally beginning in 1996. Profiles are collected during the summer stratification period. These temperature profiles are used to give an indication of temperature and oxygen stratification during the summer critical period.

Bumping Reservoir is a warm shallow reservoir. It weakly stratifies and is prone to mixing events; the stratification can break down with any moderately strong wind event. The epilimnetic depth ranges from full thickness to 5 meters in some summers. The thermocline is weak, and transitions to a warm hypolimnion at approximately 6 to 7 meters (Figure 4-54).

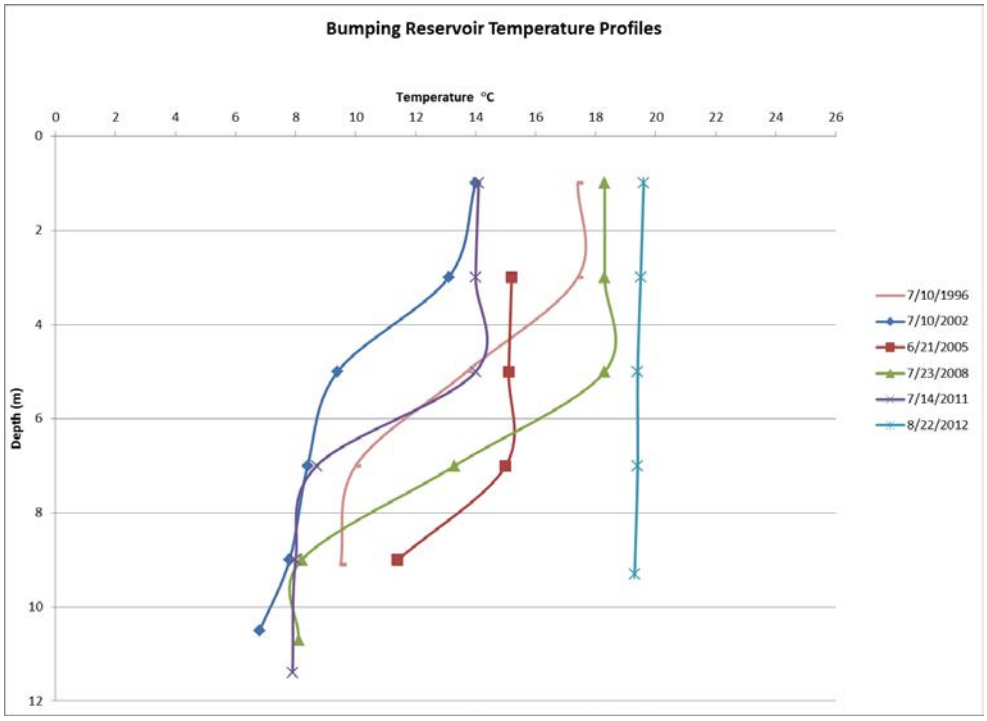

Figure 4-54. Temperature profiles for June, July, and August for the period of 1996 to 2012 at the Bumping Reservoir, 100 meters upstream of the dam.

Dissolved Oxygen

Dissolved oxygen profiles were also collected along with the temperature profiles. Due to the full thickness mixing dissolved oxygen is uniform throughout the reservoir (Figure 4-55). Throughout the summer, dissolved oxygen levels were suitable for aquatic life throughout the water column.

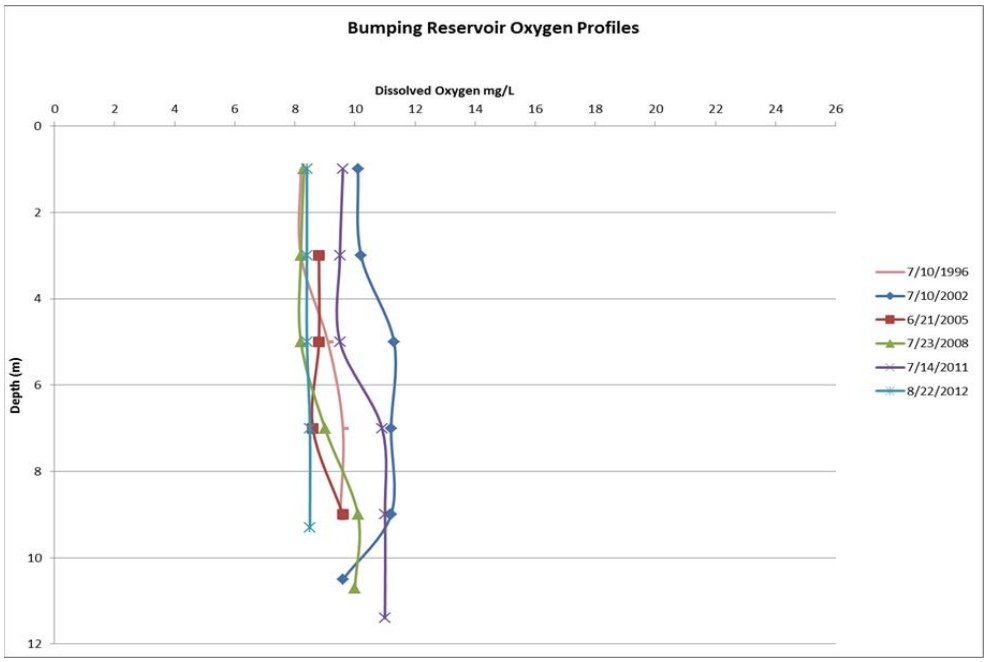

Figure 4-55. Oxygen profiles for June, July, and August for the period of 1996 to 2012 at the Bumping Reservoir, 100 meters upstream of the dam.

Sediment/ Turbidity

The levels of the measured constituents in Bumping Reservoir are also very low like the other reservoirs in the Yakima system. The TP concentrations from the surface waters (less than 5 meters) averaged 0.01 mg/L. At depth (greater than 5 meters), TP concentrations during the summer stratification period averaged 0.011 mg/L. Total nitrogen concentrations from surface samples were also very low, approximately 0.07 mg/L, and from depths greater than 5 meters TN concentrations averaged 0.051 mg/L.

The average TN:TP ratio for all surface samples was 10.61, which would indicate some nitrogen limitation. In most cases the TN:TP ratio was well below 7, clearly indicating nitrogen limitation. The range of TN:TP ratios in Bumping Reservoir were between 1.6 and 22. The wide range, with extremely low nitrogen concentrations would lead to periods when blue green algae and other unpalatable forms of nitrogen fixing algae may dominate the system.

Average TSI value calculated for Rimrock Reservoir was 26.38. This measure of eutrophication is below the mesotrophic break point of 50, indicating the reservoir is oligotrophic. In addition, the Carlson's TSI can be broken into its individual components in order to determine mechanisms of impairment.

In Rimrock Reservoir, the average TSI for the individual components were 33.91 for TP, 14.78 for TN, 26.07 for chlorophyll a, and 32.44 for Secchi depth. Based upon these numbers, Rimrock Reservoir exhibits very low TN numbers, indicating a possibility of nitrogen fixing algae blooms. The TSI components for Secchi and TP were elevated in comparison with the remaining metrics.

4.2.3 Rivers

Reclamation has a very small set of samples collected in the rivers below the five reservoirs in the Yakima system. For the most part, the oligotrophic nature of the reservoirs and the local geological setting drives the water quality in the rivers below the dams. In addition the nutrient and sediment retention that occurs due to the impoundments can strongly influence the water quality of the rivers in the reaches below the impoundments. As a result, sediment and nutrient issues are often not present below the reservoirs. As noted by Ecology's 303 (d) listing of the Cle Elum River below the reservoir, some cases of elevated temperature are seen. This is usually due to the temperature regime of the reservoir delivering warmer water than the tributaries during the fall as it takes longer for the reservoir to cool than the downstream tributaries. However, with bottom withdrawal reservoirs, the summer time temperatures are usually much cooler than background conditions, and this usually offsets any fall temperature issues.

Temperature

In most streams, a major source of temperature impairment is the removal of near stream vegetation leading to increased solar radiation reaching the water. Removal of near stream vegetation has resulted from various agricultural practices, logging, and urban/rural development. Other sources of impairment include facilities that release heated waste water, channel modification, reservoirs, removal of water, and return of irrigation water. Operations of the Yakima Project Reservoirs, generally lead to cooler temperatures in the Yakima River during the summer, at times offsetting the impact of other sources. However, there is concern about the reservoirs' impact during the fall prior to the reservoir cooling to background conditions.

Ecology and its local partners collected extensive water temperature data in tributaries of the upper Yakima River. In general, the Ecology found that the effective shade produced by full potential streamside vegetation is needed to meet water quality standards for temperature in the upper Yakima tributaries. They developed a draft TMDL (Ecology 2014b) to reduce water temperatures in certain portions of upper Yakima tributaries.

Streams listed for temperature on the 303(d) list and that are included in this TMDL include Big Creek, Cabin Creek, Caribou Creek, Cooke Creek, Little Creek, Log Creek, South Fork Manastash Creek, Naneum Creek, Swauk Creek, Taneum Creek, Umtanum Creek, and Williams Creek. However, they did not include the Mainstem Yakima River or the lower

Cle Elum River (Ecology 2014b). As a result, the Temperature TMDL will alleviate temperature issues of many of the tributaries to the Reclamation Reservoirs, while further work will be needed to address temperature issues in the lower tributaries and mainstem rivers in the Yakima basin.

In addition to the temperature studies and draft TMDL developed for the upper watersheds, Reclamation and the USGS have collected temperature data at several of the discharge gages located downstream from the project reservoirs. Data is presented from January 2000 through March 2015 to illustrate the temperature regime of the system below the project reservoirs. The data shows annual differences in peak temperatures with some years several degrees Celsius warmer than other years. Reclamation briefly investigated if there were correlations with high water years and cooler or warmer river temperatures, and there seems to be a slight correlation with system storage. For example 2001, 2004, and 2005 were three of the lowest storage years in the system and were also three of the warmest years for peak daily maximum water temperature. Conversely, 2011 and 2012 were two of the highest water storage years and the peak temperatures in those two years were two of the coolest for daily maximum temperatures. Average maximum temperatures recoded in low water years were approximately 22.07°C; in high water years the temperature at the Cle Elum gage were 18.87°C. The relationship breaks down as you move downstream from the Cle Elum gage. For example, 2001 and 2004 were both very low water years but the maximum temperature near Prosser were 26.75 and 20.94°C in each year, respectively. Similarly, in high water years annual maximum temperatures ranges from 24.00 to 29.13°C in the five high water storage years. Consequently, it appears that the further from the reservoirs one travels downstream the greater atmospheric factors play in water temperatures.

The daily maximum temperatures (°C) data are presented along the Yakima River from the gage near Cle Elum (YUMW) in comparison with the daily maximum temperatures at the gage near Horlick (YRWW). In this series only a small amount of heat is gained in the river during the summer and some heat is lost during the winter. The data clearly show the reservoirs cooling effects have not yet been overcome by atmospheric or anthropogenic heat sources. Similar heat gains occur between each subsequent gaging station as shown in Figures 4-56 through 4-60. The overall heat change between the gages downstream from Cle Elum and near Prosser are shown in Figure 4-61.

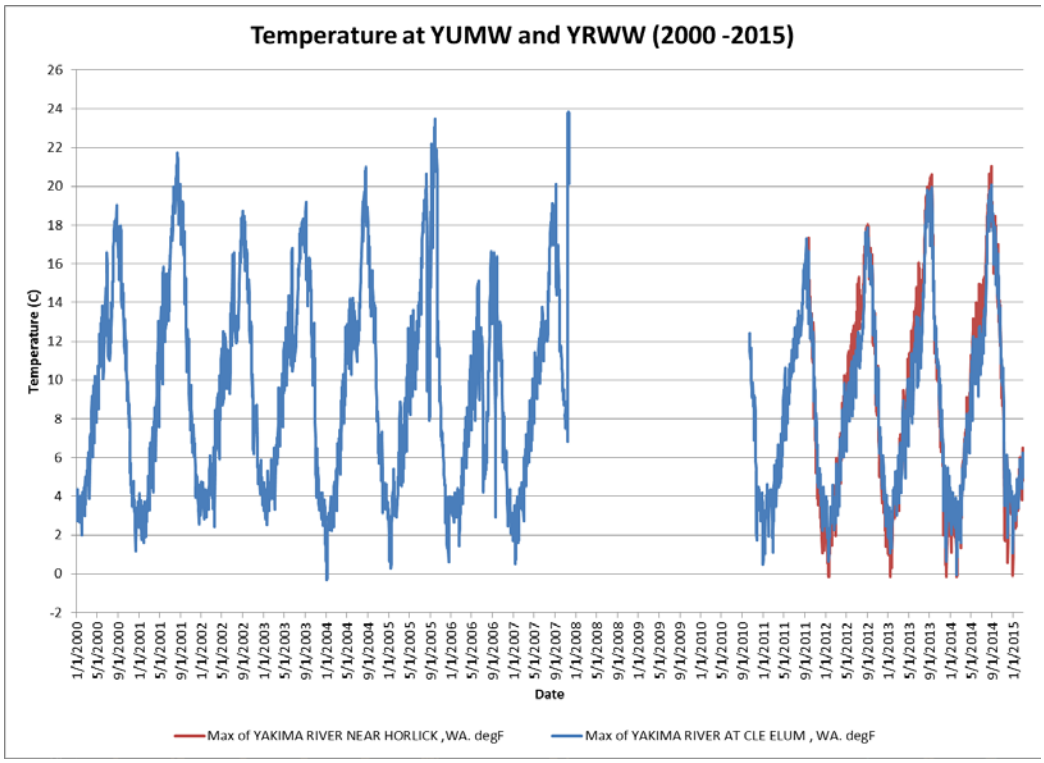

Figure 4-56. Daily maximum temperature for the period of 2000 to 2015 at gage location YUMW and YRWW.

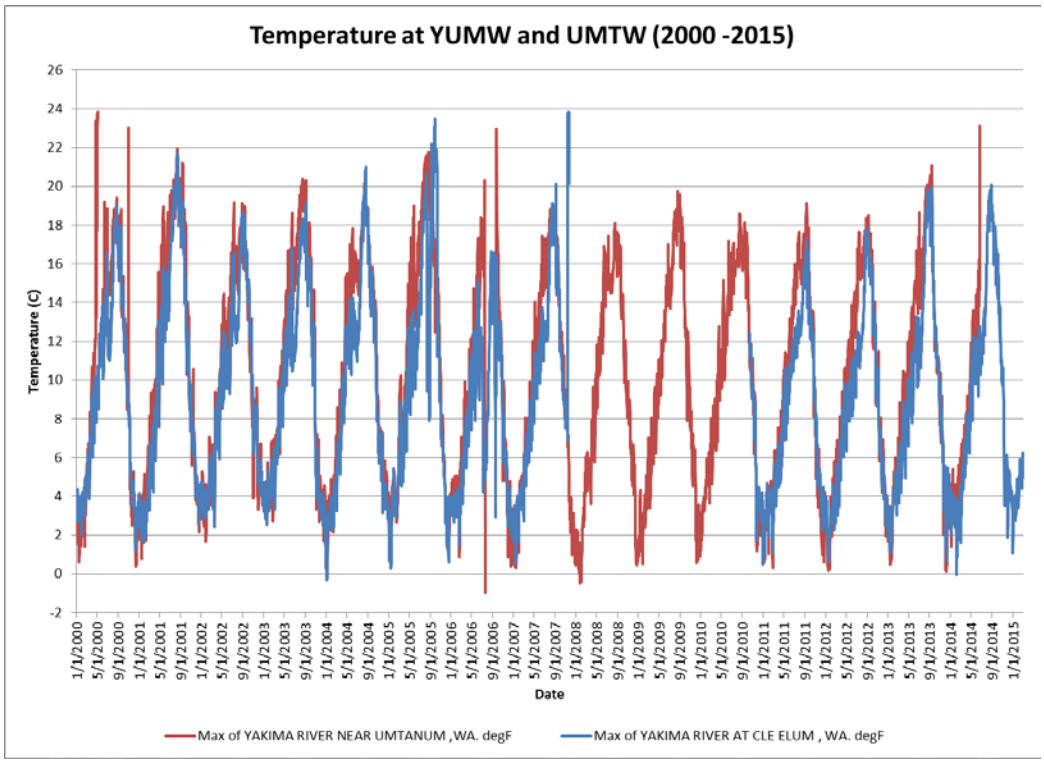

Figure 4-57. Daily maximum temperature for the period of 2000 to 2015 at gage location YUMW and UMTW.

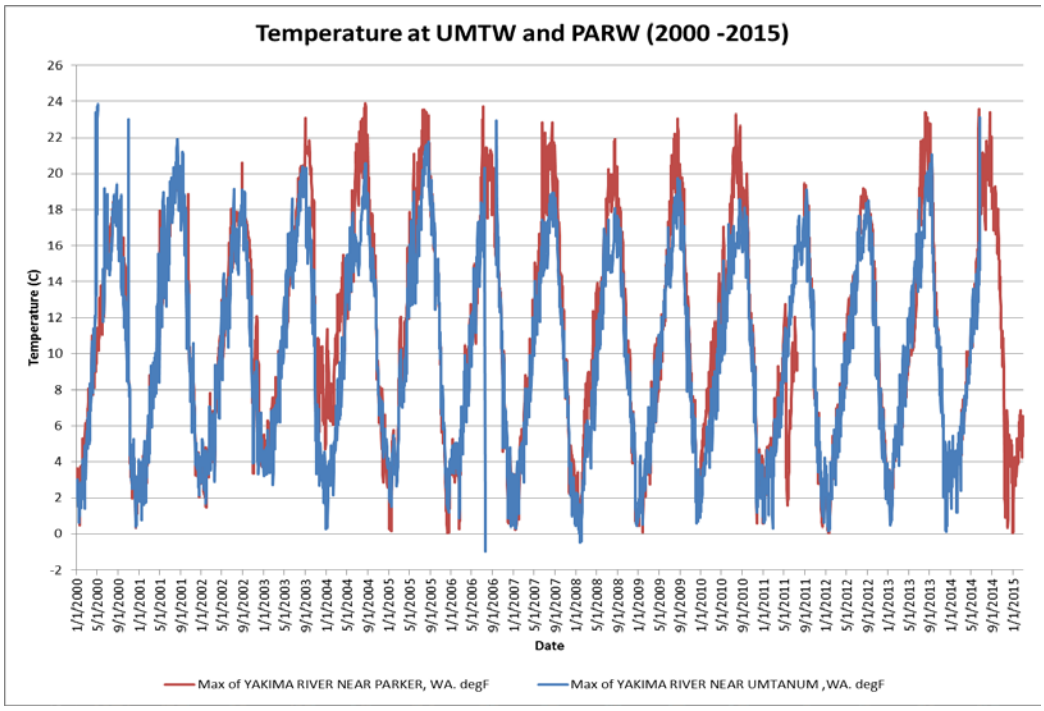

Figure 4-58. Daily maximum temperature for the period of 2000 to 2015 at gage location UMTW and PARW.

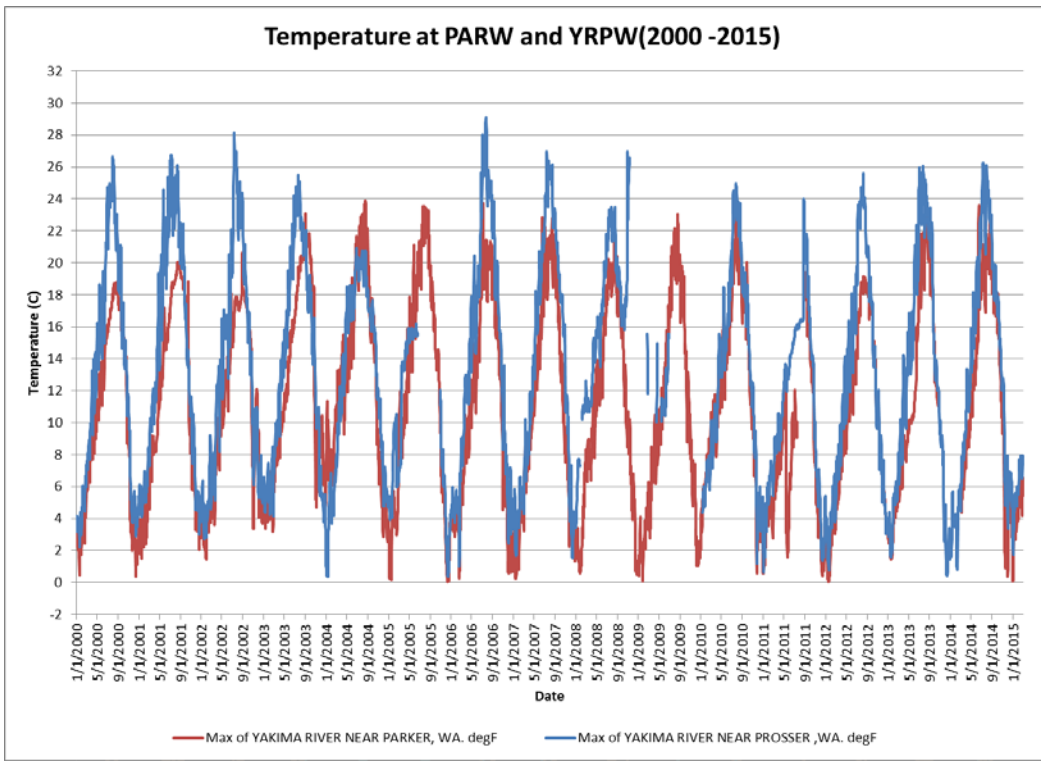

Figure 4-59. Daily maximum temperature for the period of 2000 to 2015 at gage location PARW and YRPW.

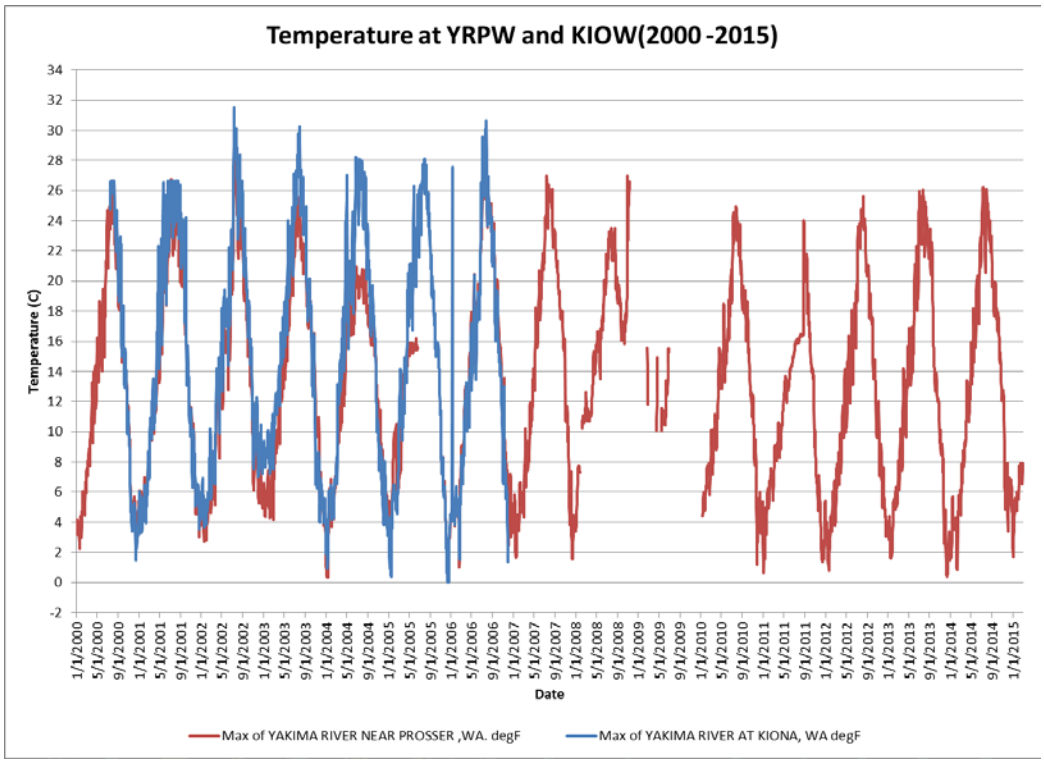

Figure 4-60. Daily maximum temperature for the period of 2000 to 2015 at gage location YRPW and KIOW.

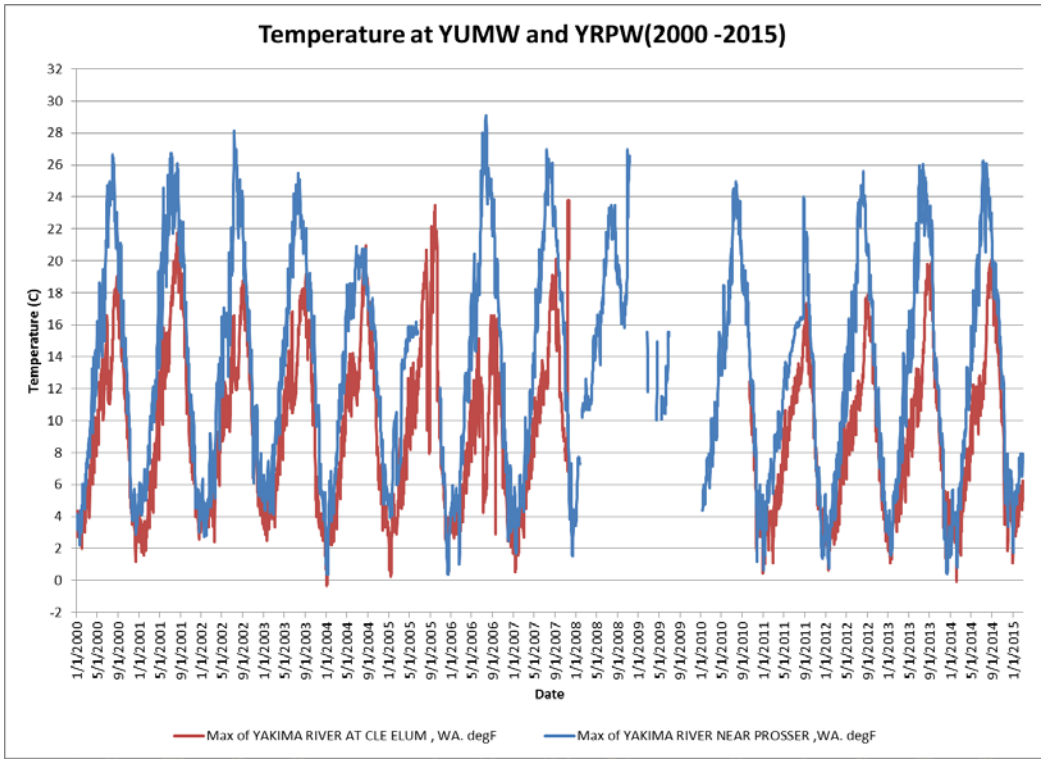

Figure 4-61. Daily maximum temperature for the period of 2000 to 2015 at gage location YUMW and YRPW.

Sediment/Turbidity

Once irrigation returns begin to appear in the river systems, the water quality conditions can change rapidly. Typically, the pollutants added to return flows are sediments, nutrients, bacteria, and in some cases herbicides and pesticides. In many basins throughout the west, these pollutant additions are proportional to water deliveries. Many TDMLs use this discharge sediment relationship to develop sediment rating curves that express sediment load as a unit of discharge. Consequently, the Proposed Action can appear to directly influence water quality conditions in the drains, wasteways, and rivers below return flows. However, as TMDLs and best management practices are applied, the correlation between water deliveries and water quality conditions in the downstream water bodies begins to deteriorate quickly. Specifically, the Upper Yakima River Sediment TMDL indicated that sediment pollutant load correlation would likely change significantly once most of the suspended sediment was removed from the river (Ecology 1997).

Several studies and TMDLs have been developed for the upper and lower Yakima River systems that encompass the affected area of the Proposed Action. Most notably the Washington Department of Ecology has developed two sediment and pesticide TMDLs for the Yakima River. Load and waste load allocations were established for sediment for the upper river in 2002 and in 1997 for the lower Yakima River. The TMDL for the upper Yakima River established critical periods for sediment and turbidity in April through October.

Following the development of the sediment TMDLs and implementation of sediment reducing best management practices (Ecology 2003), sediment loads were significantly reduced in many of the tributaries and drains of the upper Yakima River basin (Ecology 2008). In addition, sediment discharge correlations were much higher in 1999 than they were in the 2006 data set, which would indicate that the TSS discharge relationship is beginning to break down in the upper Yakima River system as predicted.

Similar results were seen in response to the TMDL implementation activities in the lower Yakima River.

> "Since 1995, turbidity levels have declined considerably in the four major irrigation return flows – Moxee Drain, Granger Drain, Sulphur Creek, and Spring Creek – identified by Joy and Patterson in their 1994-95 TMDL evaluation study. Additionally, sediment loading and turbidity in the mainstem lower Yakima River have declined." Ecology 2006.

As these TMDLs are fully implemented, the Sediment relationship with flow should become more disconnected and as a result the Proposed Action will have less influence on water quality in the lower Yakima River as well.

Other studies conducted in the watershed also investigated the flow pollutant relationship.

The RSBOJC has sponsored long-term water quality monitoring of the drains and return flows to assess the water quality impacts from their operations. In 1997, the RSBOJC began collecting data and established an accredited in-house laboratory. They have summarized the water quality data for the lower Yakima River in several reports. The first of these synthesized water quality data collected in 1997 through 2008 (RSBOJC 2009). The Joint Board of Control assessed the water quality conditions in four irrigation waterways – Granger Drain, Sulphur Creek Wasteway, Spring Creek Wasteway, and Snipes Creek Wasteway. Most of the data was collected during the summer months, due to the irrigation influence on the lower Yakima River. They determined that the quality of water in the waterways can strongly influence the quality of water in the river. Based on previous studies, it was determined that the four waterways were the major contributors of total suspended solids to the Yakima River. The assessment indicates improving water quality conditions somewhat correlated with improvement projects occurring in the watershed.

They also reviewed the hydrological linkage in the basin with water quality responses in the four waterways. In response to decreased water supplies during two drought years and after a re-regulation reservoir was installed to improve the efficiency of the Sunnyside Canal, some water quality parameters, such as total suspended solids concentrations, decreased. Other parameters did not change or may have increased slightly (RSBOJC 2009).

State and federal agencies have also collected water quality information in the Yakima River system. In 1999, the U.S. Geological Survey initiated the National Water-Quality Assessment Program in the Yakima basin. They initiated an intensive fixed site monitoring program at the Moxee Drain, the Granger Drain, and the Yakima River at Kiona. The reports and publication are available at the USGS web site http://or.water.usgs.gov/projs_dir/yakima/pubs.html.

The USGS (1999) determined that the various river reaches' water quality conditions were related to the different geological sources of contaminate and land use. For example, the Naches River subbasin had relatively low concentrations of pollutants, while the Cle Elum and Teanaway River basins had higher geological loads of some pollutants. As the river basin transitions into more intensive land use practices the pollutant loads also increased, notably for nutrients, suspended sediments, and bacterial indicators. Temperature and dissolved oxygen problems also became more common in the lower river basin (USGS 1999).

In 2004, the USGS summarized data collected in the Yakima basin from 1999 to 2000. In this report they found, again, that the extensive irrigation-water delivery and drainage system in the Yakima basin greatly controls water quality conditions and aquatic health in agricultural streams, drains, and the Yakima River. However, concentrations of total phosphorus had begun to decrease in the major agricultural tributaries in the lower valley due

to the combination of BMPs and improvements resulting from TMDL assessments. In addition historically used organochlorine insecticides were still frequently detected in agricultural streams and drains in the Yakima basin. DDT, DDE, DDD, dieldrin, and heptachlor epoxide exceeded the EPA chronic water-quality criteria for the protection of aquatic life. Similar to the nutrient and sediment reductions due to BMPs and TMDL implementation activities concentrations of total DDT in water have decreased since 1991 (USGS 2004)

Season – Specific Water Quality

Winter (November – February)

As indicated in the proceeding hydrology section, there is no change proposed between "dry" year winter reservoir releases as measured at gaging sites between the Status Quo and Proposed Action scenario. Thus, the minimum winter flows in the hydrographs look practically identical. Relative to Status Quo operations, minimum instream flows are slightly higher under the Proposed Action for RIM (50 versus 45 cfs) and TICW (75 versus 60 cfs). Because these changes are relatively small in dry water years, it is expected that limited water quality changes should also occur in these reservoir systems during dry years under the Proposed Action.

Spring (March – June)

In the Status Quo and Proposed Action models, the entire amount of water specified for outmigration was released on specified days in April (both scenarios) and May (Proposed Action only) without consideration of hydrologic or water quality conditions.

Under historic operations, reservoir management focused on spring filling. In typical years, the reservoirs would fill in early June and inflow would be bypassed until natural flow no longer satisfied water demands, at which point stored water would be released. When water is instead released throughout the winter to provide higher winter flows, and as part of dedicated outmigration releases in April and May, less water is released for spring flood control and the reservoirs fill later which may slightly alter the thermal regimes of the reservoirs. The later filling could increase epilimnetic temperatures, and may also result in warmer hypolimnion temperature. However, these changes should not be large enough to reduce the thermal and oxygen refugia currently present in all of the reservoirs.

Summer and Fall (July – October)

The primary factors shaping summer irrigation releases are the same under all three scenarios. These primary factors driving summer releases are water demand and the implementation of the flip-flop operation. As a result, the water quality conditions in the reservoirs and rivers should not change from the Status Quo operations that are represented by the water quality data presented above.

The flip-flop and mini flip-flop operations are the main driver in setting fall spawning flows during the outmigration season. In order to increase the likelihood that spawning flows can be maintained throughout the redd incubation period, Reclamation is conservative when setting spawning flows. There is no difference between the Proposed Action and Status Quo in the approach to setting fall spawning flows; as a result there should be no differences in fall water quality conditions.

4.3 Channel Conditions and Dynamics

4.3.1 Fluvial Geomorphology Downstream from Dams

Overview

The fluvial geomorphology of the rivers and creeks in the Yakima River Watershed are a mix of those influenced partially or fully by dams and those with a more natural function. Those that are influenced by dams are affected in two ways; 1) by a lack of sediment supply and 2) by a change in hydrology and subsequent hydraulics. Both change the geomorphic form and function of channels when the changes are of a substantial magnitude. The Proposed Action will not change the sediment supply into the Yakima River system; that change has already occurred as a result of the construction of the dams. However, hydrologic changes under the Proposed Action may influence geomorphic conditions. This section uses modeled hydrology to estimate the magnitude of these geomorphic changes.

The Proposed Action's (see Section 4.2) winter and early spring flows for winter rearing and have essentially no influence on the geomorphic form or processes of river channels. However, releasing water during these periods may affect flood control operations, as it affects reservoir space and potentially the timing and frequency that the flood control curve is reached. As a result, the corresponding high outflow that may have otherwise occurred historically may not occur to the same extent under the Status Quo and Proposed Action scenarios. In such cases, and as a result of other small adjustments to high flows, higher flows with the potential for geomorphic change may be altered.

Andrews (1994) found that bedload transport may begin at flows less than half of bankfull discharge in some cases, but that most begins to occur at flows over 75 percent of bankfull discharge. Initially, 75 percent of bankfull discharge was assumed to be a threshold at which bedload transport begins; therefore, 75 percent of bankfull is assumed to be the threshold flow for when the river begins to do work (in a true physical sense) in the channel. At these flows and above, geomorphic change can occur in the form of erosion, deposition, and transport, all of which work to develop the form of the channel including width, depth, floodplain connectivity, side channels, and other macro and micro scale habitats important for aquatic species of all lifestages.

Bankfull discharge corresponds well with an annual peak flow return interval of 1.5 years (Q1.5) in the Yakima River Watershed (Castro and Jackson 2001). Therefore, bankfull discharge is estimated here as Q1.5, or the annual peak event that has a 66.7 percent chance of occurring in any one year. Typically, this calculation is done using the annual instantaneous peak flow which is not available from RiverWare output. Annual peak daily average discharge data were used instead, but this provides a lower estimate of return interval flows. To prevent underestimating the flows at which sediment transport begins, the Q1.5 estimate using daily average data was used directly rather than calculating 75 percent of Q1.5 value as could be done if the instantaneous peaks were available.

To estimate the amount of geomorphic work done by flows daily discharge data were used to develop flow duration curves (see Figure 4-62) for an example, using Cle Elum Reservoir data which indicate the amount of time a discharge of a particular magnitude is equaled or exceeded. Applying the estimate of Q1.5 as a threshold for when work begins, then the amount of time when a discharge capable of doing work on the channel occurs can be estimated as the time discharge is above a threshold on the flow duration curve. If the difference in the amount of time that work is done between any two scenarios (e.g., Status Quo v. Proposed Action) is "small" then it can be assumed that the geomorphology will not change, or will be insignificant, as a result of the changes between the actions.

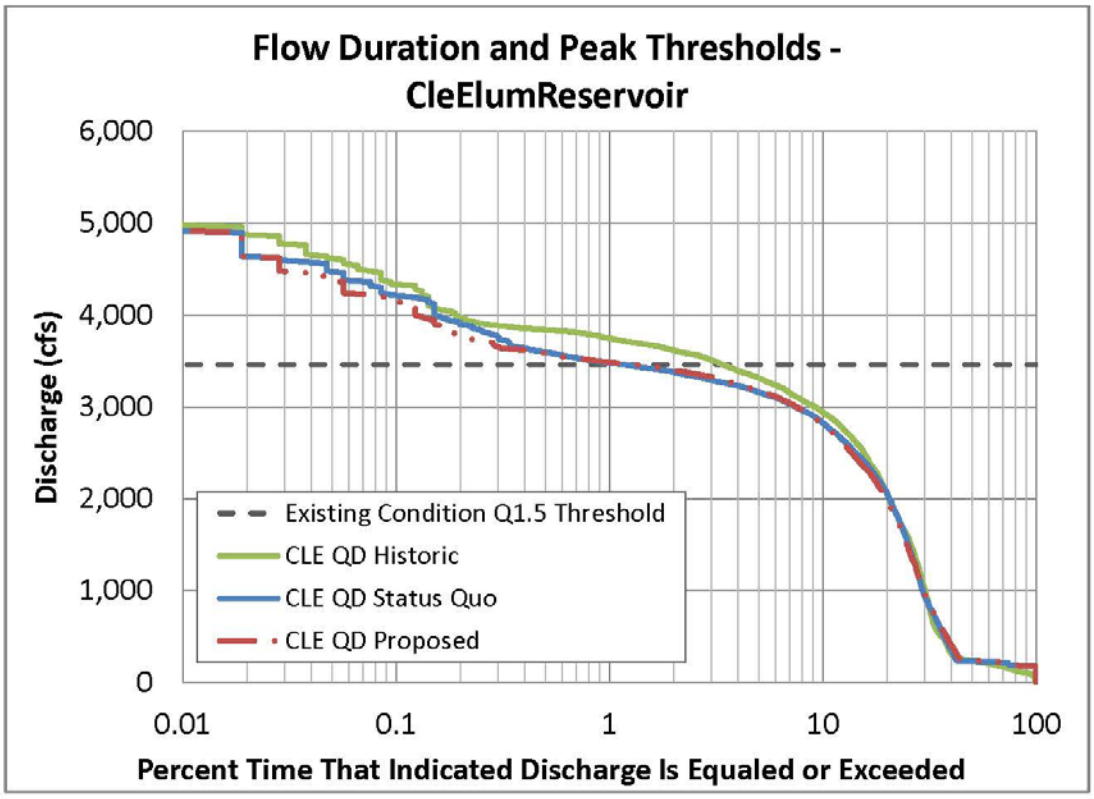

Figure 4-62. Flow duration curve for Cle Elum Reservoir. Similar graphs were developed for all ten stream gages.

What constitutes "small" changes is subjective but could be taken to be differences that are less than 10 percent. The typical quality of stream discharge measurements (a rating of "good") are within 5 percent of true discharge (Turnipseed and Sauer 2010). If we assume that the discharges used as the basis for modeling in RiverWare are of this same quality then we must assume that the output has at least 5 percent error from the input. In addition, there is further error as a result of the simplification of reservoir operations in the models and the lack of key professional and real-time judgment that is used in real-world operations (see Section 4.2). Therefore, if the differences in the durations of flows that do work are less than 5 percent, then the two scenarios are considered to be the same. Differences between 5 and 10 percent are considered small and would likely have a discountable effect on channel geomorphology. Differences greater than 10 percent are likely to have a noticeable adjustment in geomorphic form.

Changes in Geomorphically Significant Events

Two hydrologic metrics, time and magnitude, were examined to predict relative geomorphic work associated with historic conditions and the two modeled scenarios (Status Quo and Proposed Action). Changes in Q1.5 indicate a change in the magnitude of flow events. A change in the number of days when discharge equaled or exceeded Q1.5 indicates a change in the amount of time when geomorphic work could occur. Geomorphic analysis was conducted for the 10 gaging sites used to represent hydrology throughout the basin (see Section 4.2.2). Summary results are available in Table 4-4 and detailed results are located in Appendix H.

Operational changes included in the Proposed Action generally targets minimum flows during the winter period that are too low to result in geomorphic change and higher pulse flows during the spring outmigration period that may have geomorphic potential. Flows with the most potential to cause a geomorphic response are likely associated with large storm events or spring snowmelt. In the Yakima basin, these flows are provided by tributaries without reservoir regulation and flood control operations at the storage dam.

A comparison of the historic dataset to modeled outcomes under Status Quo operations indicates that the magnitude of flow events does not significantly change at gaging stations located just downstream from storage reservoirs (Table 4-4). Significant changes in magnitude are suggested at six stream gage locations. Because these changes are not consistent with results at sites that are immediately downstream from storage reservoirs; therefore, subject to the highest flow regulation, suggesting that these results may instead indicate poor calibration of unregulated flows in the modeled data.

When Status Quo operations are compared to historic conditions, results indicate that geomorphically significant flows are provided for fewer days. This result is observed downstream from each storage reservoir except Bumping (Figure 4-2). Significant differences in the time metric may reflect, in part, that the model was more reactive to flood control releases than real-life operations, essentially spilling water in fewer days.

Since data from throughout the year was used for this analysis, the time metric is not sensitive to whether the timing of geomorphic flows is consistent with the timing of geomorphically significant events under a normative hydrograph. For instance, summer flow operations have been modified at Keechelus to avoid very high releases (greater than 1,300 cfs). Similarly, flip-flop operations result in late-summer high flows out of Rimrock and are included in the historic and modeled datasets. Rimrock outflows are often near geomorphically significant thresholds in September and are of ecological concern due to the timing.

While there are limitations associated with the comparison of modeled and historic data for this analysis, the magnitude of change in the time metric downstream the upper Yakima basin reservoirs suggests that flow changes that have evolved over time may have inadvertently resulted in fewer days with geomorphically active flows when compared to historic conditions. More detailed investigation would be necessary to distinguish modeling artifacts from representative flow changes, and better characterize the suite of ecologically significant components of these flow events: timing, duration, magnitude, frequency, rate of change (Poff et al. 1997).

Table 4-4. Percent changes for geomorphically significant high flow metrics. Significant differences (greater than [>] 10%) are highlighted in red text.

		% Change	
Streamgage Location	**Scenario**	**Time (Days Q >= $Q_{1.5\ baseline}$)**	**Magnitude ($Q_{1.5}$)**
Upper Yakima			
Cle Elum Reservoir	Historic (to Status Quo)	-79%	-6%
	Status Quo (to Proposed)	19%	<1%
Kachess Reservoir	Historic (to Status Quo)	-44%	7%
	Status Quo (to Proposed)	-4%	-2%
Keechelus Reservoir	Historic (to Status Quo)	-70%	-8%
	Status Quo (to Proposed)	-10%	2%
Yakima River at Easton	Historic (to Status Quo)	-38%	-32%
	Status Quo (to Proposed)	-4%	4%
Naches			
Bumping Reservoir	Historic (to Status Quo)	2%	-2%
	Status Quo (to Proposed)	0%	0%
Rimrock Reservoir	Historic (to Status Quo)	20%	5%
	Status Quo (to Proposed)	-16%	-3%
Tieton Below Canal	Historic (to Status Quo)	16%	7%
	Status Quo (to Proposed)	-15%	-10%
Naches River near Naches	Historic (to Status Quo)	-8%	-12%
	Status Quo (to Proposed)	-<1%	2%

		% Change	
Streamgage Location	**Scenario**	**Time (Days Q >= $Q_{1.5\ baseline}$)**	**Magnitude ($Q_{1.5}$)**
Lower Yakima			
Yakima River at Parker	Historic (to Status Quo)	-10%	-20%
	Status Quo (to Proposed)	-3%	18%
Yakima River near Prosser	Historic (to Status Quo)	-2%	-10%
	Status Quo (to Proposed)	-<1%	13%

Ecological Implications

Stanford et al. (2002) highlighted channel avulsion and cut and fill avulsion as key alluvial processes maintaining a dynamic mosaic of instream and hyporheic habitat (p. 6). Maintaining this shifting mosaic is dependent on both the ability of a river to move freely (for example, lack of revetments or natural constrictions) balanced with stream power to accomplish geomorphic work. Sufficient sediment supply is also required to create habitat features in depositional areas and prevent channel incision and resulting floodplain disconnection.

Available geomorphic analysis suggests that habitat creation and maintenance would benefit through the increased duration during which sediment is reworked and scoured. Deeper and larger pools could form in and around large woody material, large rocks, and in other high velocity areas. Improvements would likely be in spawning gravels, backwater habitats, and other important in-channel and riparian habitats. This would have a net positive influence on fluvial geomorphologic form and processes in biologically important reaches while moving towards more “normative flows” in biologically vital ways (Snyder and Stanford 2001; Stanford et al. 2002). Higher bankfull discharges and higher duration high flow events would also improve floodplain and riparian habitats and improve surface and groundwater connectivity which are noted to be in poor condition in many reaches (Reclamation 1999; SOAC 1999; Snyder and Stanford 2001; Stanford et al. 2002).

4.4 Upland Habitat

The five major storage dams, plus Clear Creek, Easton and French Canyon Dams, and some HydroMet stations are facilities located in or near suitable habitat for terrestrial T&E species. Other Yakima Project facilities such as fish screens, fish ladders, canals, and irrigation diversion dams at Prosser, Roza, and Chandler require considerable maintenance, but are located in lower elevation areas outside suitable habitat for the five terrestrial T&E species. Similarly, the 1,820 acres of YRBWEP-purchased land managed by Reclamation is located in lower elevation areas, outside suitable habitat.

No new road construction, facility development, or facility expansion is planned under the Proposed Action. Maintenance activities are expected to be limited to areas currently disturbed by periodic access or maintenance needs. Vegetation clearing to maintain these areas is expected to primarily target smaller diameter trees (less than 14 inches diameter at breast height), shrubs, and herbaceous vegetation. Occasionally, larger hazard trees may be removed. No significant changes to upland habitat are anticipated under the Proposed Action.

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Chapter 5 Middle Columbia River Steelhead

This chapter provides Reclamation's biological assessment of the effects of the Proposed Action on the MCR DPS of steelhead (*Onchorynchus mykiss*) and MCR steelhead critical habitat. This chapter begins with an overview of MCR steelhead and its range-wide status. Next, this chapter identifies the environmental baseline for MCR steelhead and its critical habitat in the Yakima basin. Finally, this chapter identifies the localized and population scale effects of the Proposed Action on MCR steelhead and its critical habitat and concludes the Proposed Action is likely to adversely affect MCR steelhead and designated critical habitat.

5.1 Middle Columbia River Steelhead Overview

5.1.1 Status and Distribution

Steelhead refers to the anadromous form of *Onchorynchus mykiss*. Phylogenetically and ecologically complex, steelhead exhibit perhaps the most diverse life history patterns of any Pacific salmonid species (Shapovalov and Taft 1954; Barnhart 1986). *O. mykiss* display varying degrees of anadromy, differences in reproductive biology, and plasticity of life history between generations (Busby et al. 1996).

NOAA Fisheries recognizes steelhead populations as distinct from rainbow trout, the non-anadromous freshwater form of *O. mykiss*, which are under the jurisdiction of the USFWS. NOAA Fisheries recognizes that many steelhead populations co-occur with conspecific resident rainbow trout populations, and that the resident form may mitigate short-term extinction risk for some steelhead DPSs (71 FR 834). NOAA Fisheries assumes that benefits to an anadromous population resulting from the presence of a conspecific resident form will be reflected in direct measures of the anadromous populations (Ford 2011).

NOAA Fisheries listed the MCR Evolutionarily Significant Unit (ESU) of steelhead as Threatened on March 25, 1999. NOAA Fisheries reaffirmed the threatened status of west coast steelhead, but redefined the MCR ESU as a distinct population segment (71 FR 834). NOAA Fisheries reaffirmed the threatened status of west coast steelhead, but redefined the MCR ESU as a distinct population segment (71 FR 834). The MCR DPS includes all naturally spawned populations of steelhead in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington (64 FR 14517). Steelhead from the Snake River basin are not part of this DPS.

The Interior Columbia Basin Technical Recovery Team (ICTRT) identified 17 extant populations and 3 extirpated populations in the MCR steelhead DPS (ICTRT 2008). The populations fall into four major population groups: the Yakima basin (four extant populations), the Umatilla/Walla Walla drainages (three extant and one extirpated populations), the John Day River drainage (five extant populations), and the Eastern Cascades group (five extant and two extirpated populations).

5.1.2 Factors Contributing to Species Decline

Steelhead on the west coast of the U.S. have experienced declines in abundance in the past several decades as a result of natural and human factors (NOAA Fisheries 1996, 1998). Forestry, agriculture, mining, and urbanization have degraded, simplified, and fragmented habitat (NRCC 1996). Water diversions for agriculture, flood control, domestic, and hydropower purposes have greatly reduced or eliminated historically accessible habitat. Loss of habitat complexity, such as reductions in wetlands and deep pools, has contributed to the decline of steelhead (NOAA Fisheries 1996). Studies estimate that during the last 200 years, the lower 48 states have lost approximately 53 percent of all wetlands and the majority of the remaining wetlands are severely degraded (Dahl 1990; Tiner 1991). Washington and Oregon's wetlands are estimated to have diminished by one-third, while California has experienced a 91 percent loss of its wetland habitat (Dahl 1990; Jensen et al. 1990; Barbour et al. 1991; Reynolds et al. 1993). In national forests in Washington, there has been a 58 percent reduction in large, deep pools due to sedimentation and loss of pool-forming structures such as boulders and large wood (Federal Ecosystem Management Assessment Team (FEMAT). Similarly, in Oregon the abundance of large, deep pools on private coastal lands has decreased by as much as 80 percent (FEMAT 1993). Sedimentation from land use activities is recognized as a primary cause of habitat degradation in the range of west coast steelhead.

Human impacts and current limiting factors for Columbia River steelhead come from multiple sources: hydro passage, habitat degradation, hatchery effects, fishery management and harvest decisions, predation, and other sources. Salmon and steelhead have been adversely affected over the last century by many activities including human population growth, introduction of exotic species, overfishing, developments of cities and other land uses in the floodplains, water diversions for all purposes, dams, mining, farming, ranching, logging, hatchery production, predation, ocean conditions, loss of habitat, and other causes (NRCC 1996; Lackey et al. 2006).

5.1.3 Population Structure

When examining the status of a species, NOAA Fisheries uses criteria that describe a Viable Salmonid Population (VSP) (McElhany et al. 2000). Attributes associated with a VSP are the levels of abundance (number of adult spawners in natural production areas), productivity (adult progeny per parent), and the spatial structure and diversity necessary to 1) safeguard

the genetic diversity of the listed ESU or DPS, 2) enhance its capacity to adapt to various environmental conditions, and 3) allow it to become self-sustaining in the natural environment. In 2007, the ICTRT further defined population-level viability criteria to address, in combination, all four of the key parameters: 1) Abundance, 2) Productivity, 3) Spatial structure, and 4) Diversity (ICTRT 2007). These viability attributes are influenced by survival, behavior, and experiences throughout the entire life cycle, characteristics that are influenced in turn by habitat and other environmental conditions. The present risk faced by the ESU/DPS informs NOAA Fisheries' determination of whether additional risk will appreciably reduce the likelihood that the ESU/DPS will survive or recover in the wild. The greater the present risk, the more likely any additional risk resulting from the Proposed Action's effects on the abundance (population size), productivity, distribution, or genetic diversity of the ESU/DPS will be an appreciable reduction (McElhany et al. 2000).

MCR steelhead abundance is substantially lower than historic levels. Based on historic estimates, the run size of the MCR DPS could have been in excess of 300,000 fish (Busby et al. 1996) although this figure may be an overestimate since it is largely based on historical estimates of steelhead returns to the Yakima basin.

Abundance estimates were calculated for 14 of the 17 extant MCR steelhead populations when the most recent 5-year status review was completed in 2009. Three of the 14 populations are currently above the average abundance thresholds that the ICTRT identifies as a minimum for low risk. The remaining 11 populations were at moderate or high risk of extinction due to low abundance (Ford 2011). Relative to the brood cycle just prior to listing (1992 to 1996 spawning years), 2005 to 2009 brood cycle (5-year geometric mean) natural abundance was substantially higher (more than twice) for seven of the MCR steelhead population data series, lower for three populations, and at similar levels for the remaining four populations (Ford 2011).

Populations in all four of the MCR steelhead Major Population Groups (MPGs) exhibit similar temporal patterns in returns per spawner. Return rates for broodyears 1995 to 1999 generally exceeded replacement (one returner for each spawner). Spawner-to-spawner ratios for broodyears 2001 to 2003 were generally well below replacement for many populations. Broodyear productivity estimates returned to levels at or above 1:1 for the most recent 1 to 2 broodyears examined (2004 to 2005) for populations in the Yakima and John Day River MPGs, but remained below replacement for the eastern Cascades and Umatilla/Walla Walla populations (Ford 2011). Broodyear return rates reflect the combined impacts of year-to-year patterns in marine life history stages, upstream and downstream passage survivals, and density dependent effects resulting from capacity or survival limitations on tributary spawning or juvenile rearing habitats (Ford 2011).

At the time the MCR Steelhead Recovery Plan was developed in 2009, NOAA Fisheries characterized five MCR steelhead populations as being at high risk of extinction in terms of abundance based on 1995 to 2004 spawner numbers. Two of those high-risk populations, the

Naches and upper Yakima, are in the Yakima MPG. The remaining populations in the Yakima MPG were rated at moderate risk of extinction in terms of abundance. However, newer analysis (Ford 2011) uses more recent spawner numbers from 2000 to 2009 and rates the Naches population as a moderate risk of extinction in terms of abundance.

The ICTRT characterizes the spatial structure risk to MCR steelhead populations as "very low" to "moderate" for all populations in the DPS except the upper Yakima. This population was rated as "high" spatial structure risk because seven of 10 historical major spawning areas are not thought to be occupied. Similarly, the ICTRT characterized the diversity risk to all but one MCR steelhead population as "low" to "moderate." The upper Yakima was rated as having "high" diversity risk because of introgression with resident *O. mykiss* and loss of presmolt migration pathways within and between tributaries, and hampering of mainstem rearing strategies (ICTRT 2007). There was no change to spatial structure and diversity metrics for any of the MCR steelhead populations during the 2011 5-year status review (Ford 2011).

The most recent ICTRT Risk Summary characterized one of the 17 MCR steelhead populations as highly viable, 4 as viable, 7 as maintained, and 4 at high-risk (Ford 2011). The Klickitat River population was believed to be at or near viable, but did not have sufficient data for a rating. The 4 high risk populations were West Side Deschutes, Rock Creek (provisional due to limited data), upper Yakima, and Touchet River (provisional due to limited data).

5.1.4 Designated Critical Habitat

Designated critical habitat for the MCR steelhead DPS includes all Columbia River estuarine areas and river reaches in the following subbasins: upper Yakima, Naches, lower Yakima, Middle Columbia/Lake Wallula, Walla Walla, Umatilla, Middle Columbia/Hood, Klickitat, upper John Day, North Fork John Day, Middle Fork John Day, lower John Day, lower Deschutes, Trout, and Upper Columbia/Priest Rapids (NOAA Fisheries 2005). There are 114 watersheds within the range of the MCR steelhead DPS. Nine watersheds received a low conservation rating, 24 received a medium rating, and 81 received a high rating of conservation value to the DPS (NOAA Fisheries 2004). The lower Columbia River rearing/migration corridor downstream from the spawning range is considered to have a high conservation value and is the only habitat area designated in three of the high value watersheds identified above. This corridor connects every steelhead population in the MCR DPS with the ocean and is used by rearing/migrating juveniles and migrating adults. In addition, the Columbia River estuary is a unique and essential area for juveniles and adults making the physiological transition between life in freshwater and marine habitats. Of the 6,529 miles of habitat areas eligible for designation, 5,815 miles of stream are designated critical habitat.

The final West Coast salmon and steelhead critical habitat designation (70 FR 52630) lists a total of six PCEs that are designed to incorporate what is essential for salmon and steelhead conservation within the entire range of West Coast anadromous salmonid stocks in Washington, Oregon, and Idaho. PCEs include sites that are essential to support one or more life stages of species within individual DPSs (sites for spawning, rearing, migration, and foraging). These sites in turn contain physical or biological features essential to the conservation of the DPSs (for example, spawning gravels, water quality and quantity, side channels, forage species). The six PCEs and their associated influencing factors are:

1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development. These features are essential to conservation because without them the species cannot successfully spawn and produce offspring. **Factors Influencing Spawning Sites: streamflow, water storage, geology, channel form and complexity, floodplain connectivity, channel gradient, sediment inputs, gravel recruitment rates, topography, woody debris, stream temperatures, stream size, elevation, shade, groundwater inputs**.
2) Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams, and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. These features are essential to conservation because without them juveniles cannot access and use the areas needed to forage, grow, and develop behaviors that help ensure their survival. **Factors Influencing Rearing Sites: streamflow, topography, channel complexity, floodplain connectivity, woody debris, riparian structure, shade, channel gradient, sediment inputs, stream size, invertebrate and forage fish production, stream temperatures**.
3) Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival. These features are essential to conservation because without them juveniles cannot use the variety of habitats that allow them to avoid high flows, avoid predators, successfully compete, begin the behavioral and physiological changes needed for life in the ocean, and reach the ocean in a timely manner. Similarly, these features are essential for adults because they allow fish in a non-feeding condition to successfully swim upstream, avoid predators, and reach spawning areas on limited energy stores. **Factors Influencing Migration Corridors: streamflow, water temperature, diversion dams, tributary barriers, woody debris, topography, channel gradient**.

4) Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation. These features are essential to conservation because without them juveniles cannot reach the ocean in a timely manner and use the variety of habitats that allow them to avoid predators, compete successfully, and complete the behavioral and physiological changes needed for life in the ocean. Similarly, these features are essential to the conservation of adults because they provide a final source of abundant forage that will provide the energy stores needed to make the physiological transition to fresh water, migrate upstream, avoid predators, and develop to maturity upon reaching spawning areas. **Factors Influencing Estuarine Areas: streamflow, channel form and complexity, floodplain connectivity, woody debris, riparian structure, shade, aquatic vegetation, water temperatures, invertebrate and forage fish production, climate (flood and drought cycles), marine currents and tide cycles**.

5) Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. As in the case with freshwater migration corridors and estuarine areas, nearshore marine features are essential to conservation because without them juveniles cannot successfully transition from natal streams to offshore marine areas. **Factors Influencing Nearshore Marine Areas: marine water quality, riparian structure, climate (flood and drought cycles), aquatic invertebrate and forage fish production, aquatic vegetation**.

6) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation. These features are essential for conservation because without them juveniles cannot forage and grow to adulthood. **Factors Influencing Offshore Marine Areas: marine water quality, climate (flood and drought cycles), aquatic invertebrate and forage fish production**.

Although all stocks of anadromous salmonids use estuarine and nearshore marine habitats during a portion of their life cycle, not all Proposed Actions will affect all of the PCEs listed in the final critical habitat rule. Notably, human activities that occur in inland watersheds are not likely to directly affect estuarine and/or nearshore/offshore marine PCEs. As a result, some DPSs are influenced by different PCEs depending on their proximity to the ocean. Because the MCR steelhead DPS is located in an inland watershed, human activities in this watershed will not affect critical habitat in estuarine, nearshore, or offshore marine areas. As a result, the last three PCEs described above (PCEs 4 through 6), will not be affected by the future operation of the Yakima Project and will not be discussed further in this document.

5.2 Yakima MPG Life History Characteristics

5.2.1 Spawning Populations

The ICTRT has further subdivided the Yakima MPG into the Satus Creek, Toppenish Creek, Naches River, and upper Yakima River populations (ICTRT 2003, 2005). The Satus Creek population consists of steelhead that spawn in the Satus Creek drainage on the Yakama Reservation, the mainstem Yakima River below Satus Creek, and tributaries to the lower mainstem. The Toppenish population, which is located exclusively on the Yakama Reservation, consists of steelhead that spawn in Toppenish Creek, its tributaries, and the short stretch of the mainstem between Toppenish and Satus Creeks. The Naches population includes steelhead spawning in the Naches River and its tributaries (including the Tieton, Little Naches, American, and Bumping Rivers and Cowiche, Rattlesnake and Nile Creeks), the mainstem Yakima from the Naches confluence to the Toppenish Creek confluence, and the tributaries to that reach of the Yakima, including Ahtanum Creek. The upper Yakima population consists of all steelhead that spawn in the Yakima River and its tributaries upstream of the Naches confluence.

5.2.2 Run and Spawn Timing

MCR steelhead are identified as summer-run based on July through September run timing at Bonneville Dam (ODFW/WDFW 2014). While at least some adult steelhead movement into the Yakima basin and past Prosser Dam has been documented in every month of the year, the main migration past Prosser Dam occurs from September through April (Figure 5-1). Passage from the McNary Pool and/or lower Yakima River past Prosser Dam appears to be driven by flow and temperature cues, with fish generally moving rapidly following increased flow and moderating water temperatures. Yakima steelhead generally spend between 1 and 3 years in the ocean before returning to spawn. Data from 2002 to 2003 and 2004 to 2005 return years indicates that the majority of steelhead returning to the basin spent 2 years in freshwater and 1 to 2 years in the ocean (YBFWRB 2009).

Generally, adult MCR steelhead migration into the Yakima basin has a bimodal distribution with peaks in late October and again in late January or early March (Figure 5-1). Minimal numbers of adult steelhead pass Prosser Dam during July and August, with numbers beginning to increase in September. Peak passage timing above Prosser Dam occurs in October and November when a combined 50 percent of the steelhead run occurs at this location. Steelhead abundance over Prosser Dam declines slightly in December and early-January, due to the onset of cold water temperatures and low streamflows. Usually by the end of December, about 70 percent of the run has passed Prosser Dam. During this time, about one-third of the run holds between McNary Pool in the Columbia River and Prosser Dam in the Columbia River. These fish are thought to be using habitat in both the McNary Pool of the Columbia (where temperatures are lower through the summer) and the lower

Yakima River, which cools off faster than the McNary Pool after September 1. The steelhead migration over Prosser Dam resumes in February through April, coincident with behavioral cues related to the spawning run and physical cues associated with increases in water temperatures and streamflows. While most steelhead pass Prosser Dam by April, migrants continue to be detected into May and sometimes June.

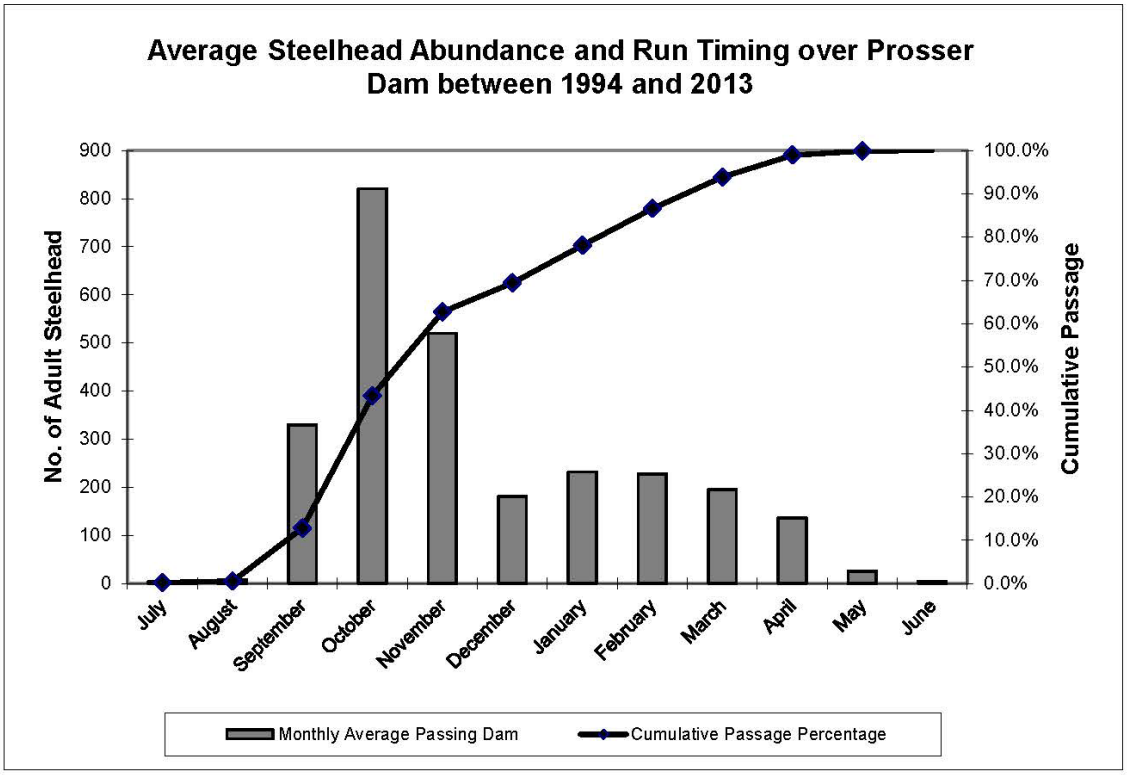

Figure 5-1. Average steelhead abundance by month and cumulative passage timing of steelhead passing Prosser Dam between 1994 and 2014. Data are from the YKFP website and Haring 2001.

After entry into the Yakima River, approximately 60 percent of adult steelhead overwinter in the mainstem river between Prosser (RM 47.1) and Sunnyside Dams (RM 103.8), while 28 percent use areas downstream of Prosser Dam for overwintering before moving upstream into tributary or mainstem spawning areas (Hockersmith et al. 1995). The remaining 12 percent of tagged steelhead from the Hockersmith study were observed overwintering in the Yakima River between Sunnyside Dam and the Naches River confluence. A small proportion of steelhead headed to upper Yakima spawning grounds will overwinter in the Yakima River between the Naches River confluence and Roza Dam, or upstream of Roza Dam (Frederiksen 2014). The final upstream migration from mainstem holding or overwintering areas to the spawning grounds begins between January and May, with fish that spawn in lower elevation tributaries generally beginning to move earlier.

Annual monitoring of steelhead passage upstream of Roza Dam at the Yakama Nation adult counting facility as well as data collected for the radio tracking study have provided new and important information on the timing of steelhead migrations into the upper Yakima basin. For example, of the 669 wild adult steelhead that ascended the Roza Dam fish ladder from fall 2002 to spring 2006, the vast majority showed a peak arrival time of March and April, but could occur anytime between September and late June (Reclamation 2003, 2005, 2009). Eighty-eight percent of steelhead passage past Roza into the upper Yakima occurs in March, April, and May with the remaining 12 percent scattered from September through February (Figure 5-2). This migration timing information coincides well with the existing spawn timing information for the upper Yakima River and tributaries which suggests that spawning occurs from late March through early June, with a peak in May (NPPC 2001; Reclamation 2009).

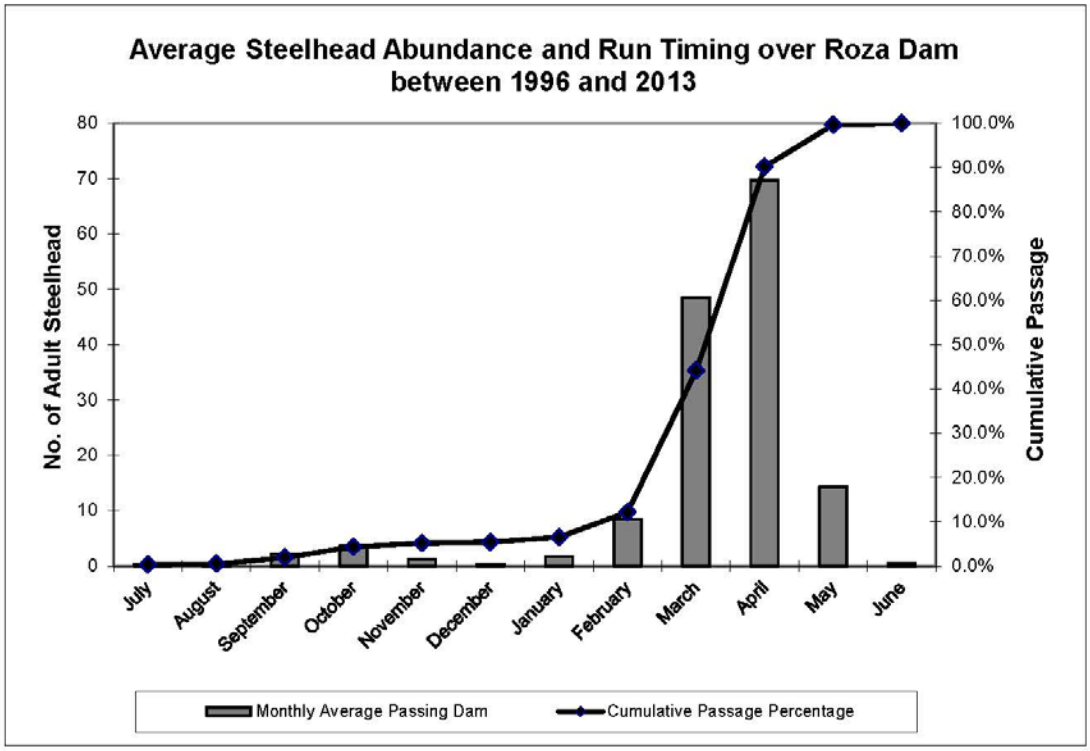

Figure 5-2. Average steelhead abundance by month and cumulative passage timing of steelhead passing Roza Dam between 1996 and 2008. Data are from the YKFP website.

Steelhead spawning varies across temporal and spatial scales in the Yakima basin, although the current spatial distribution is significantly diminished from historic times. Yakima basin steelhead spawn in intermittent streams, mainstem, and side channel areas of larger rivers, and in perennial streams with moderate to relatively steep gradients (Hockersmith et al. 1995; Pearsons et al. 1996).

Typically, steelhead spawn earlier at lower, warmer elevations than higher, colder waters. Overall, most spawning is completed within the months of January through May (Hockersmith et al. 1995). In Toppenish Creek, spawning primarily occurs in March and April. Naches River and higher elevation tributary spawning occurs later, generally in April and May.

5.2.3 Emergence, Rearing, and Outmigration

Steelhead eggs take about 30 days to hatch at 10 ^{o}C (50 ^{o}F), and another 2 to 3 weeks before fry emerge from the gravel. However, time required for incubation varies significantly with water temperature. Fry emergence typically occurs between mid- to late May and early July, depending on time of spawning and water temperature during incubation (Table 5-1). Subsequent rearing can be divided into five categories; emergent rearing, fry rearing, sub-yearling overwinter rearing, yearling and older spring and summer rearing, and yearling and older winter rearing.

Table 5-1. Fry emergence timing for Yakima steelhead (YBFWRB 2009).

Geographic area	Fry emergence timing
Upper Yakima Tributaries	Late June through early August
Upper Yakima Mainstem above Yakima Canyon:	Mid June through early July
Yakima mainstem in Yakima Canyon (incl. tributaries)	Early June through early July
Middle Yakima and tributaries	Early June through early July
Upper Naches	Mid June through mid July
Upper Naches tributaries	Late June through late July
Lower Naches and Cowiche	Early June through mid July
Toppenish Creek	Late May through early July
Satus Creek	Early May to early June

Juvenile steelhead use tributary and mainstem reaches throughout the Yakima basin as rearing habitat. Upon emergence from the gravel, the steelhead fry move to shallow protected areas associated with the stream margin (Royal 1972; Barnhart 1986, both as cited in McEwan and Jackson 1996). During this time period of swim up from the gravel, the fry are dependent on low velocities and shallow water with cover. As they grow, the habitat requirements of the fish change. They are not so dependent on shallow stream margins, but also begin to use other stream habitat such as riffles, pools, deep runs, and transitional areas between the habitat types.

Fry rearing commences shortly after swim up and emergent rearing. This life stage extends from May in the lower river and August in the upper river through October. As the fish grow, their habitat use continues to expand to incorporate more areas of the stream and is not

confined to low velocities and shallow water associated with streambanks and overhanging cover. The larger fry use pools, areas out in the main channel near habitat transitional areas and large structures like root wads, and shear zones between fast and slow water.

During winter, subyearling steelhead hide in coarse substrate when the water temperature drops below 8 °C (46 °F) (Bustard and Narver 1975). Overwintering juveniles may emerge from the substrate and move short distances at night. Winter habitat includes abundant streamside rubble and boulders with very little or no embeddedness. It is thought that juveniles seek out thermal refugia (areas greater than 8 °C [46 °F]) in the winter. Mortality during the winter is primarily associated with cold temperatures, anchor ice, floods, and predation. Flows should be relatively steady, and should not decrease to the extent that streamside cover is partially or completely dewatered.

Yearling and older spring and summer rearing habitat preferences, in terms of depth and adjacent velocities, continues to increase with fish size. Depth should be at least 1 to 2 feet, and substantially greater depths are acceptable as long as they are associated with feeding foci. Preferred near-surface velocities would be in the range of 2.5 to 3 feet per second (Everest and Chapman 1972). Yearling and older steelhead are very adaptable during spring and summer rearing. Yearling fish will utilize riffles, cascades, and pools, frequently near mid-channel. A common feature of good habitat for older fish is structural complexity in moderately high gradient reaches. This structure, often consisting of large boulders, provides needed feeding foci and cover in the relatively swift areas.

In winter, yearling and older parr still conceal themselves in interstitial habitat once water temperatures fall below 8 to 10 °C (46 to 50 °F). The fish no longer require moderate depths nor exclusively inhabit the interstices of rubble as daytime hiding cover. Deep backwater pools may be used, especially if they include rubble or woody debris.

As stream temperatures decline in late fall and winter, steelhead parr may move downstream considerable distances, presumably to seek more suitable habitat for overwintering (Bjornn 1971). Population density can affect the numbers of downstream migrants in a particular year.

While smolt outmigration, as detected at Chandler, peaks from late March to late May, smolts are detected in significant numbers from March through early July (YSFWPB 2004, p 2-191; Frederiksen et al. 2014). Overwintering steelhead juveniles are also detected at Chandler between late November and March. The midpoint of outmigration at Wapatox is also generally around the first week in May. Given the distances involved and smolt migration rates observed, the midpoint of the outmigration of Naches steelhead would not occur at Prosser for at least another week. Thus, as many as half the smolts leaving the Naches pass the lower river in late May and early June (NPPC 2001).

Busack et al. (1991) analyzed scale samples from smolts and adult steelhead and found that most smolt outmigrants are age-2, with a few fish maturing after 3 years and an even smaller proportion as age-1 smolts. Very little data exist to estimate age at outmigration for specific populations. Based on scale samples from juvenile steelhead trapped by the Yakama Nation in Satus, Toppenish, and Ahtanum Creeks during the 2001 and 2005 outmigration seasons, age-1 smolts appeared to be more prevalent than age-2 in Satus and Toppenish Creeks, and age-3 smolts were uncommon in all three creeks. The average size by smolt age for outgoing smolts sampled at the Chandler Juvenile Facility at Prosser were found to be 145 mm for age-1 smolts, 184 mm for age-2 smolts, and 223 mm for age-3 smolts. No age-4 smolts had been captured at the Chandler Juvenile Facility.

5.2.4 Kelts

A proportion of a steelhead spawning population will return to the ocean after spawning and return to spawn again. Post-spawn steelhead heading back to the ocean are referred to as kelts. Kelts that successfully outmigrate to the ocean resume feeding, regain body mass, and increase gamete production. A subset of these fish make return attempts to their natal spawning areas to spawn again. In spawning areas near the ocean, rates of repeat spawning can be as high as 79 percent. Natural rates of repeat spawning for Interior Columbia steelhead populations are unknown. Documented kelt rates include 17 percent for the Kalama River, 4.6 percent for the Hood River, 2 to 9 percent in the Walla Walla, and 1.5 percent in the Upper Columbia River (Branstetter et al. 2006). Natural repeat spawning by Yakima basin steelhead is limited; scale analysis in 1990 to 1992 indicated that 1.6 percent of returning adults were repeat spawners in the 1990 to 1992 brood years (Hockersmith et al. 1995). Unpublished data from 2000 to 2005 indicates that the kelting rate is 3 percent (Frederiksen 2014). It is hypothesized that the development of the mainstem Columbia hydropower system and the associated passage impediments, reduced spring flows, and increased temperatures have reduced kelt survival rates.

Kelts typically migrate downstream from spawning areas in March through June. Kelts have been observed at the Chandler Juvenile Facility (RM 47.1) into the middle of July, but water temperature approaches lethal levels by that time even in normal water years. Temperatures do not return to safe levels until early autumn (NPPC 2001). Outmigration of kelts from the upper basin may be especially hazardous because later spawning dates combine with increased travel distance as the Yakima and Columbia Rivers warm and their flow declines (Bosch 2008).

Information on kelt emigration from the upper Yakima River was obtained during the 2002 to 2006 steelhead radio-tracking study by the Yakama Nation and Reclamation (Reclamation 2003, 2005). For the 2002 to 2003 tracking period, 50.5 percent (43 of 85) actively tracked fish were observed passing downstream from Roza Dam. Of these kelts, 28 were detected at the Chandler Juvenile Facility and subsequently included in the Yakama Nation's Kelt Reconditioning Program (see description below). Four additional fish were later detected

passing Bonneville Dam, and presumably made it to the Pacific Ocean (Reclamation 2003). Similarly, for the 2003 to 2004 tracking period, 60 percent (58 of 98) actively tracked fish were observed successfully passing Roza Dam. A total of 31 of these kelts were caught at Chandler and added to the reconditioning program, while 16 were detected at McNary Dam and 13 were detected passing Bonneville Dam later that year (Reclamation 2005). These data indicate that at least a portion of steelhead kelts are able to successfully migrate through the Yakima and Columbia Rivers to the Pacific Ocean. It is still unclear, however, what proportion of those fish that reach the ocean successfully migrate back to the Yakima basin to spawn again under current management scenarios in the Yakima and Columbia Rivers.

Since 2000, the YKFP has maintained a kelt reconditioning experiment. This program was designed to increase the contribution of repeat spawners to steelhead productivity in the basin. Post-spawning steelhead are captured as they pass through the Chandler Juvenile Facility at Prosser Dam on their downstream migration. The Yakama Nation subsequently holds them in rearing tanks, where they are fed and medicated to enhance survival.

5.2.5 Anadromy and Residency

The Yakima MPG steelhead co-occur with resident *O. mykiss*. Generally, anadromous steelhead dominate the Satus and Toppenish populations, while resident rainbow trout dominate the upper Yakima (YBFWRB 2009). In the Naches population, both anadromous and resident forms are widespread. The nature of the relationship between resident and anadromous life history forms in the Yakima basin, and particularly in the upper Yakima, has been identified as a key knowledge gap in the Yakima Steelhead Recovery Plan. The discussion of steelhead/resident pairings, factors influencing the upper Yakima and portions to Naches to support the anadromous form even under historic conditions, hypothesized mechanisms shifting production from anadromy to residency, and the potential resident rainbow trout to either facilitate or hinder steelhead recovery is included in this Recovery Plan and incorporated by reference (YBFWRB 2009). However, the Recovery Plan lacks discussion about 1) historic passage conditions into the upper Yakima River and 2) environmental conditions in freshwater rearing habitat, and the role these two factors may play in life-history expression.

In the late 19th and early 20th Centuries, splash dams constructed in the upper Yakima were used to move old-growth logs downriver to the City of Yakima (NPPC 2001). These dams were also situated near Pomona and hindered anadromous fish access into the upper Yakima (Haring 2001). By the time Roza Dam was completed, upper Yakima anadromous salmonid populations were severely depleted. While a fish ladder was incorporated at Roza Dam, forebay operations between 1941 and 1959 prevented fish access between mid-October to mid-March. The forebay was annually lowered during this period, precluding the use of the fish ladder at this time of year (Haring 2001). It is not clear what proportion of the steelhead population bound for the upper Yakima would have been excluded by these operations. While the majority of steelhead pass Prosser Dam from September through November,

significant passage is not observed at Roza Dam until March and April. Current passage timing at Roza Dam may reflect truncation of life history strategies due to the temporal passage barrier that was in place from 1941 to 1959, a natural migration behavior, or a combination of the two.

Freshwater rearing environmental factors in the upper Yakima may select for the resident versus anadromous *O. mykiss* life-history form. These environmental factors include a year-round dependable water supply from mountain runoff, and the cool water temperatures that seldom approach stressful levels, create a freshwater habitat in the upper basin that enables high growth and survival rates of rainbow trout that spend their entire life in freshwater. Average temperatures of the Yakima River from Sunnyside to Cle Elum are generally 14 to 18 ^{o}C (high 50s to low 60s ^{o}F) during July and August (Reclamation 2000). Because growth rates are relatively high, rainbow in the upper Yakima basin can achieve large body size, accompanied by moderate fecundity, without migrating to sea. In contrast, this may not be true of the lower elevation subbasins of Satus Creek, Toppenish Creek, and the lower Naches River mainstem. In those streams, summer temperatures are frequently stressful to resident trout, as are temperatures in the lower Yakima River where those streams enter.

Additionally, intermittent flow conditions in portions of the spawning and rearing area in the Satus basin favors anadromy over residency. Average temperatures in the Yakima River near Prosser typically exceed 21 ^{o}C (70 °F) from mid-July to mid-August. A survey of water temperatures throughout the Yakima basin in 1988 found that temperatures in all tributaries, except the lower portions of Satus Creek and Toppenish Creek, were well within the acceptable range for summer rearing of salmonids (YIN et al. 1990). Under the conditions in lower Satus and Toppenish Creeks, fish remaining through the summer would experience high mortality and low growth rate. The anadromous life history, however, enables rainbow trout to leave restricted rearing areas when they are still young, grow rapidly in the ocean, and return with a high fecundity that compensates for the added mortality that fish experience during the long migration.

5.2.6 Hatchery Influence

Hatchery releases of steelhead into the Yakima system ceased after 1993 (NPPC 2001); as a result, the proportion of returning spawners at Prosser Dam that are of natural origin has averaged 96 percent since 1994. The MCR Steelhead Recovery Plan noted that the Yakima populations have the lowest rates of hatchery strays in the DPS and concluded that hatchery effects are not a significant limiting factor (NOAA Fisheries 2009).

5.3 Yakima MPG Environmental Baseline

This section describes the environmental baseline conditions for the Yakima MPG and its critical habitat in the Yakima basin. The environmental baseline includes the past and present impact of all federal, state, or private actions and other human activities in an action area, the anticipated impacts of all proposed federal projects that have already undergone formal or early Section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR § 402.02). Consistent with this definition, this section describes impacts arising from the construction of Yakima Project facilities, and their historic operation. Chapter 2 provides specific descriptions of the federal, state, and private activities contributing to baseline conditions. This section begins with a discussion of the baseline population status of the Yakima MPG using VSP criteria. Next, this section continues with a description of the baseline function of each critical habitat primary constituent element in the Action Area.

5.3.1 Population Status

The ICTRT assessed the viability of Yakima basin steelhead stocks and concluded that none currently meet its standards for viability. The Satus population comes nearest to meeting the ICTRT's standard, while the upper Yakima population is farthest. The ICTRT analysis is based on NOAA Fisheries' VSP framework, which calls for managing salmon and steelhead populations based on an understanding of their abundance, productivity, spatial structure, and diversity. According to the ICTRT, one of the populations should be highly viable and one population should be viable to achieve the ICTRT's suggested MPG viability scenario (ICTRT 2007; YBFWRB 2009). The ICTRT guidelines specify that either the Naches River or the upper Yakima should be viable because these are the only two "large" populations in the basin.

The Yakima Steelhead Recovery Plan (YBFWRB 2009) analyzed the VSP characteristics of Yakima basin steelhead and determined that, based on abundance and productivity data, the Yakima population is not viable and was at "high" risk of extinction (greater than 25 percent chance of extinction in 100 years). The Naches, Toppenish, and Satus populations were found to be at "moderate" risk of extinction (between 5 percent and 25 percent chance of extinction in 100 years) for the abundance and productivity VSP parameters. The Yakima Steelhead Recovery Plan also determined that the upper Yakima population is at "high" risk of extinction for both diversity and spatial structure parameters, while the Naches, Toppenish, and Satus populations were at "moderate" risk. The recovery plan summarized the Yakima steelhead MPG as not currently viable and at a "high" risk of extinction (YBFWRB 2009).

At the time of the most recent 5-year status review in 2011, the integrated abundance and productivity risk assessments were moderate for all Yakima steelhead populations except for the upper Yakima population, which was rated as being at "high" risk (Ford 2011, Table 20). Similarly, combined spatial structure and diversity risk was "moderate" for all populations except the upper Yakima, which again was ranked at "high" risk. The latest overall viability ratings indicate that the Satus Creek population is "viable", the Toppenish Creek and Naches River populations are "maintained", and the upper Yakima population is at "highest risk" (Ford 2011, Table 20). These viability ratings are based on abundance and productivity data through 2009, and a spatial structure and diversity analysis conducted in 2008.

Abundance and Productivity

Natural origin steelhead returns to the Yakima basin indicate that abundance is generally increasing (Figure 5-3). Before 2000, basin-wide returns were low, less than 1,000 individuals. From 2000 to 2002, basin-wide returns increased dramatically. While returns then decreased between 2003 and 2009, abundance remained well above the low levels observed in the late 1990s. Most recently returns peaked at 2010, and then decreased in the last couple of years. Abundance measurement for individual populations should be interpreted cautiously given uncertainties associated with apportioning returns from Prosser Dam counts (Ford 2011). Individual spawning population abundance generally follows the same pattern observed for basin-wide counts. Abundance for all populations were very low in the late 1990s (Figure 5-4). The Naches and Satus populations have experienced the greatest increases. The 2003 to 2012 geomean estimates for the Satus and Toppenish populations meet the ICTRT minimum abundance threshold (Table 5-2). The 2003 to 2012 geomean estimate for the Naches River is approaching the ICTRT minimum abundance threshold. While the number of returning spawners have been steadily increasing for the upper Yakima population, its 2003 to 2012 geomean estimate is still significantly below the ICTRT minimum abundance threshold.

For the Yakima River MPG, to achieve viable status, two populations should be rated as viable, including at least one of the two classified as large (Naches River and upper Yakima River) (Ford 2011). The remaining two populations, should at a minimum, meet the maintained criteria. The management unit plan also calls for at least one population to be highly viable, consistent with ICTRT recommendations.

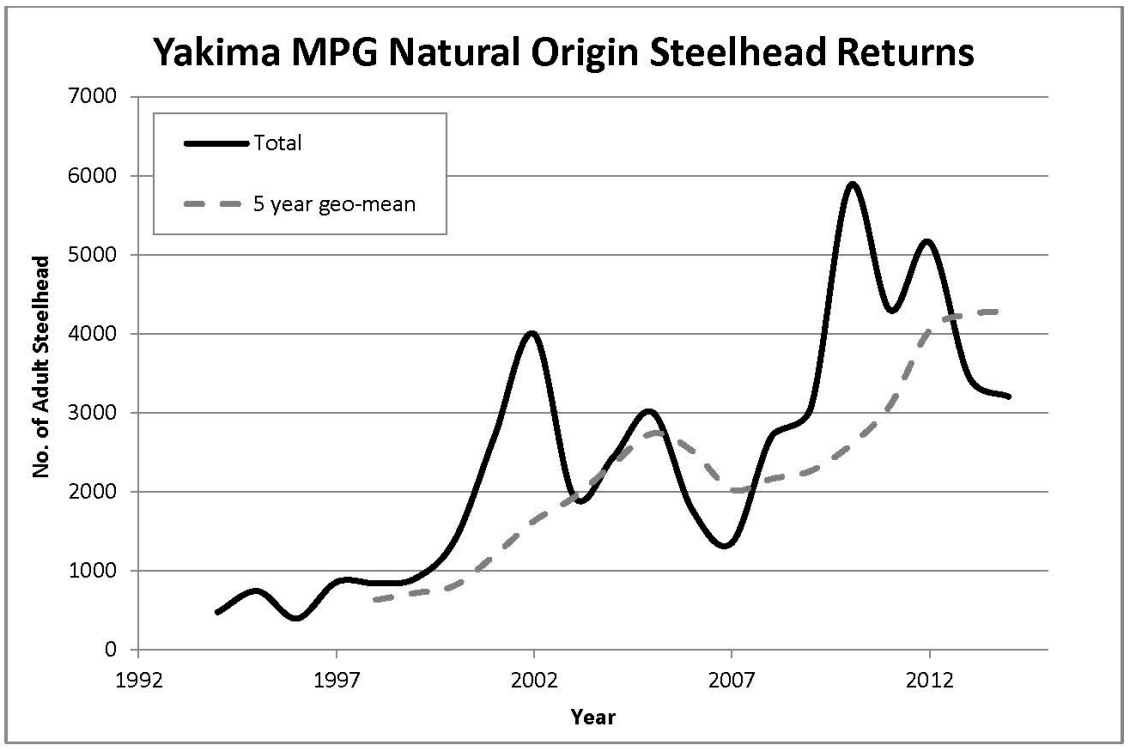

Figure 5-3. Yakima MPG natural origin steelhead returns from 1994 to 2014 and 5-year geometric mean plotted. Source: WDFW Salmon Conservation Reporting Engine (SCoRE 2015).

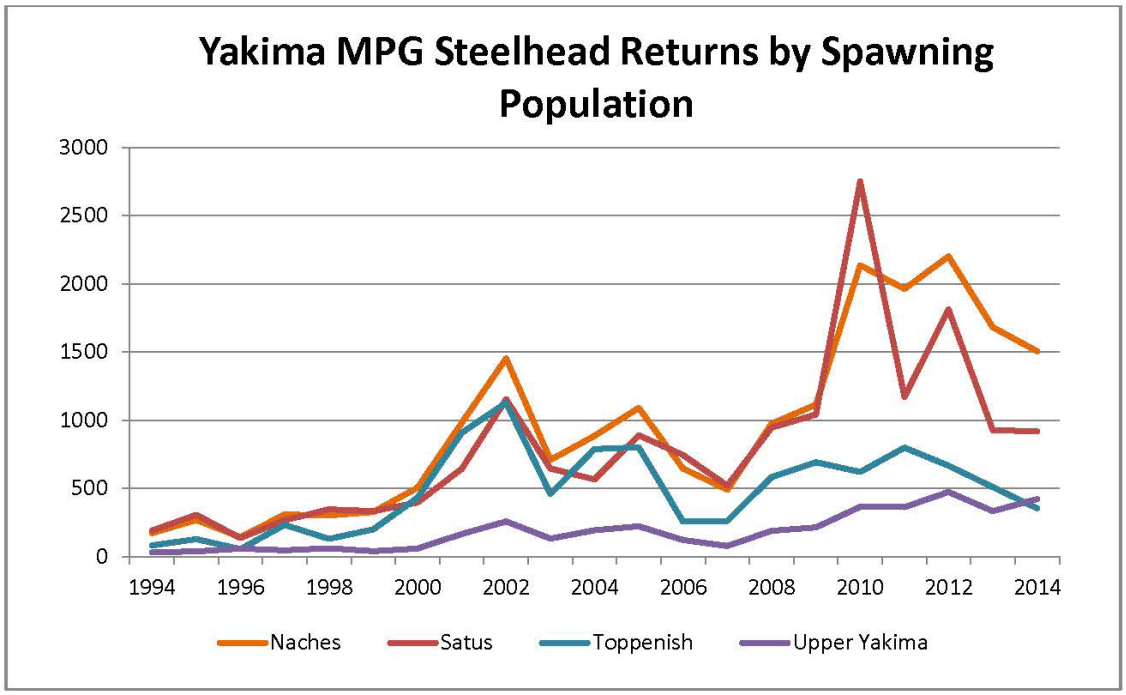

Figure 5-4. Yakima MPG natural origin steelhead returns by spawning populations from 1994 to 2014. Source: WDFW SCoRE (2015).

Table 5-2. Most recent 10-year geometric mean for steelhead returns by spawning population and ICTRT minimum abundance thresholds identified in the MCR Steelhead Recovery Plan (NOAA Fisheries 2009).

Population	10-Year Geometric Mean Abundance (2003-2014)	ICTRT minimum abundance threshold
Upper Yakima	426	1500
Naches River	1245	1500
Toppenish Creek	517	500
Satus Creek	1134	500

Recent analysis conducted by the Yakama Nation indicates the Yakima MPG adult productivity is generally increasing. A comparison of adult escapement to return rates indicates under current conditions, productivity peaks at about 1,000 to 1,500 spawners, and declines at higher spawner abundances (Frederiksen et al. 2014, p. 16). This pattern suggests that density-dependent limiting factors depress natural productivity at relatively low population abundance relative to historic abundance. Juvenile abundance and productivity metrics are not as reliable as adult metrics. While precise data is not available, juvenile abundance and productivity generally appear positive for Yakima River MPG steelhead as well (Frederiksen et al. 2014, p. 19).

A comparison of Yakima River MPG survival relative to other steelhead streams above Bonneville Dam helps differentiate improvements in Yakima basin conditions from survival increases in the Columbia River and ocean. From 1983 to 2013, the percent of the Bonneville Dam wild group A[9] steelhead that are composed of Yakima River MPG steelhead has increased from about 2 to 5 percent (Frederiksen et al. 2014, p. 16).

Spatial Structure

The historical distribution of Yakima steelhead is thought to have included all reaches of the Yakima River mainstem and its tributaries that supported spring Chinook salmon (*O. tshawytshca*), as well as many other tributaries (YIN et al. 1990). As steelhead spawners are capable of utilizing smaller streams with steeper gradients than spring Chinook, most accessible permanent streams and some intermittent streams may have once supported spawning steelhead. Currently, Yakima River steelhead are found in nearly all mainstem and tributary reaches; however, access to portions of the headwaters of the Yakima River and some tributaries are blocked by dams and other passage barriers. As a result, anadromous steelhead cannot access the entire Yakima River watershed.

[9] A size-based categorization used from fisheries management purposes, refers to fish less than 78cm fork length.

Steelhead spawning varies across temporal and spatial scales in the Yakima basin, although the current spatial distribution is significantly decreased from presumed historic conditions. Steelhead are currently the most widespread anadromous fish in the Yakima basin. Yakima basin steelhead currently spawn in intermittent streams in semiarid watersheds, mainstem reaches and side-channel areas of larger rivers, and in perennial streams up to relatively steep gradients in headwaters high in the Cascades (Hockersmith et al. 1995; Pearsons et al. 1996). Steelhead spawning is widely distributed throughout the areas accessible to them, except in the lower Yakima River and its tributaries below the Satus Creek confluence.

The ICTRT examined all accessible habitat areas and information on steelhead spawning distributions within the Yakima basin and designated both Major (MSAs) and Minor (MiSAs) Spawning Areas for the four Yakima basin steelhead populations (ICTRT 2007). The Yakima Steelhead Recovery Plan (YBFWRB 2009) and the NOAA Fisheries Middle Columbia Steelhead Recovery Plan (NOAA Fisheries 2008) propose to use these spawning areas for monitoring steelhead spatial distribution within the Yakima MPG. Figure 5-5 shows the ICTRT's MSAs and MiSAs overlaid with the WDFW's current steelhead distribution map.

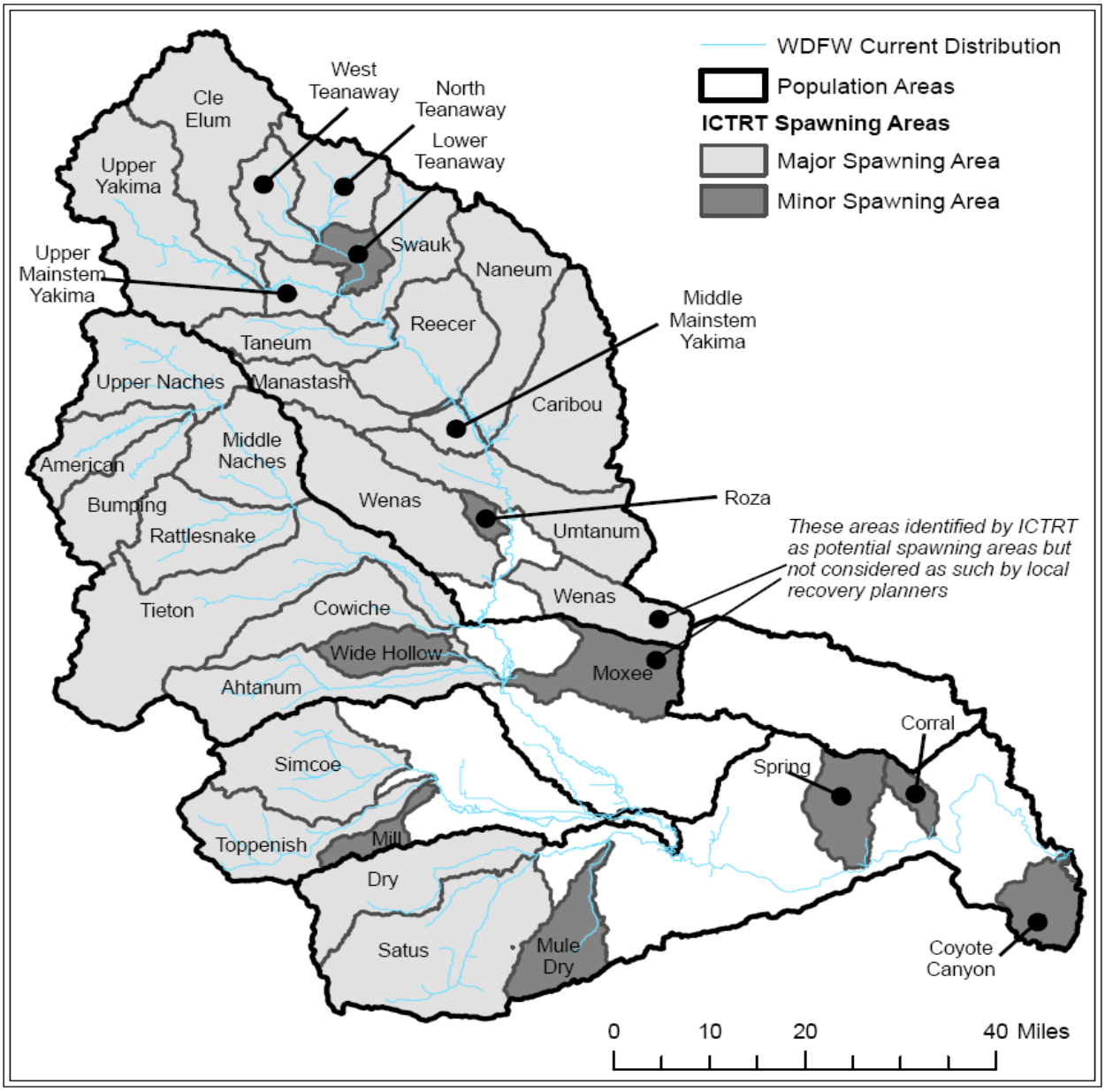

Figure 5-5. MSAs and MiSAs delineated by the ICTRT for the four Yakima River steelhead populations.

Upper Yakima

The upper Yakima population consists of all steelhead that spawn in the Yakima River and its tributaries upstream of the Naches confluence. The ICTRT has identified 14 major historical MSAs and two MiSAs associated with the upper Yakima River steelhead population (Figure 5-5). Of these, the 2014 assessment identifies nine as currently occupied (in both upper and lower portions) and another six as occupied in their lower extent only (Frederiksen 2014). Impassable storage dams block the Cle Elum and Kachess Rivers and the uppermost reach of the Yakima River, though permanent fish passage facilities are being advanced for the Cle Elum Dam.

The early radio tracking work of Hockersmith et al. (1995) indicated that 3 percent of steelhead radio-tagged at Prosser Dam spawned in the mainstem Yakima River above Roza Dam. The more recent 2002 to 2006 steelhead radio-tracking study in the upper Yakima basin (above Roza Dam) conducted by Reclamation and Yakama Nation provided greater detailed information on the distribution patterns of adult steelhead. Of the 351 wild adult steelhead tagged at Roza Dam, most (98.3 percent) moved upstream following release, and 62 percent moved into tributaries to spawn (Table 5-3). Upper Yakima River steelhead primarily migrated into the Teanaway River, Swauk 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 (Table 5-3). Radio and pit-tagging investigations conducted in 2013 show a similar distribution (Temple et al. 2013).

Table 5-3. Summary of wild steelhead movements for 351 steelhead tagged at Roza Dam and tracked to upstream locations between 2002 and 2006 (Reclamation 2009) and 2013 (Temple et al. 2013).

Presumed Spawning Location	Upper Yakima Run (2002 – 2006)	Upper Yakima Run (2013)
Mainstem Yakima River	**38%**	**39%**
Tributary Spawning	**62%**	**61%**
Teanaway River	39%	27.6%
Swauk Creek	13%	20.6%
Taneum Creek	5%	12.9%
Cle Elum River	3%	
Lower Naches River, Umtanum Creek, Cherry/Wilson/Naneum Creeks	2%	

The percentage of fish that used mainstem reaches varied from 34 to 45 percent of fish tagged in any specific year. Although steelhead use of the mainstem Yakima River was concentrated between Umtanum Creek (RM 139.8) and the confluence with the Cle Elum River (RM 186.5), steelhead were observed using all mainstem areas from Roza Dam to approximately Easton Dam (RM 202.5). The upper extent of steelhead migration in the Yakima River was observed to be as far upstream as the base of Easton Dam where, at least three steelhead were tracked during 3 years of the study. However, it was uncertain if these fish ascended the ladder and moved farther upstream to spawn or reached the fish ladder and moved downstream shortly thereafter. It appears from both radio-tracking information as well as Easton Fish Ladder video and acoustic counts (VAKI Counter) that steelhead do not routinely migrate to habitat areas above Easton Dam (Reclamation 2009; Mays 2015).

Presumed and observed tributary spawning areas in the upper Yakima basin included the Teanaway drainage (mainstem and all three forks), Swauk Creek, Taneum Creek, lower Cle Elum River, Umtanum Creek, and the Wilson Creek, Cherry Creek, and Naneum Creek systems near Ellensburg. The Teanaway River system and Swauk Creek were the most consistently used tributary spawning areas as indicated by the radio-tracking study (Reclamation 2009). For example, the Teanaway River drainage was the most heavily used tributary during the spawning season and was the destination of 39 percent of all fish radio-tagged at Roza Dam over the entire 4-year steelhead tracking study. Tagged fish were found as far as 20 miles upstream in the North Fork Teanaway River, including 1 mile up Stafford, Standup, and Jack Creeks; and at least 5 miles upstream in both the middle and west forks of the Teanaway River. At least 20 radio-tagged male-female pairs were located throughout the system including one pair in the west fork Teanaway River.

From 2002 to 2006, 46 steelhead (13 percent of all tagged fish) used the Swauk Creek system, moving upstream at least 20 miles to the Swauk Creek campground. Steelhead were observed using both First and Williams Creeks in the Swauk Creek drainage; migrating at least 1 mile up each tributary. A total of 17 adult steelhead used Taneum Creek, some moving upstream at least to the Taneum Creek campground at RM 9.0. Most (82.4 percent) ascended the Bruton Diversion Dam fish ladder (about 1.6 miles) and more than half of these moved above the Taneum (RM 2.4) and Knudsen (RM 3.0) diversions. Three male-female pairings of steelhead were observed together in the middle and upper reaches as a result of the radio-tracking study.

Additionally, two fish moved at least 4 miles into Umtanum Creek, and three steelhead moved about 2 miles into the Wilson Creek drainage (including Naneum and Cherry Creeks). Four fish radio-tagged at Roza Dam moved downstream following release and were tracked to a location about 5 miles into the lower Naches River and into Cowiche Creek, a Naches River tributary.

Radio-tagged steelhead have only been detected in the lower few miles of the Cle Elum River (Reclamation 2009; Mays 2014). However, during a 2014 spawning survey in the Cle Elum River, 12 *O. mykiss* of sufficient size to be made by steelhead were observed. Nine of these redds were located just downstream of Cle Elum Dam.

Naches

The Naches population includes steelhead spawning in the Naches River and its tributaries (including the Tieton, Little Naches, American, and Bumping Rivers and Cowiche, Rattlesnake, and Nile Creeks), the mainstem Yakima from the Naches confluence to the Toppenish Creek confluence and the tributaries to that reach of the Yakima, including Ahtanum Creek.

The ICTRT has identified eight major historical MSAs and two MiSAs associated with the Naches River steelhead population (Figure 5-5). Seven of the MSAs are in the Naches River drainage. The remaining MSA, Ahtanum Creek, is a major tributary to the Yakima River mainstem, entering just downstream from the Naches River confluence. Impassable storage dams block the upper portions of the Tieton and Bumping watersheds. The two MiSAs are small tributaries to the Yakima River between the Naches River and Ahtanum Creek. Based on the most recent assessment, steelhead spawning is known to occur in all seven MSAs (Frederiksen 2014). Spawning in the remaining MSA, the American River, and the two MiSAs are currently unknown.

Radio-telemetry research underway by the Yakama Nation and WDFW has yielded additional insight into Naches steelhead spawning distribution. This telemetry investigation underway has shown spawning in tributary locations previously documented by Hockersmith et al. (1995) and regular redd surveys. Tributaries with past documented spawning activity include Ahtanum Creek, Oak Creek, Rattlesnake Creek, Nile Creek, Bumping River, and various parts of the Naches River (Table 5-4) have been consistent with historic telemetry studies. The most recent radio telemetry study has identified significant spawning in some areas not previously known to support significant steelhead spawning. These areas include the Yakima River from Toppenish Creek to the Naches River Confluence, the Naches River floodplain reach (RM 3.3 to 17.1), Cowiche Creek, Tieton River, Rock Creek, numerous Naches mainstem reaches upstream of the Tieton River confluence, and other smaller tributaries in the Naches (Frederiksen et al. 2014, p. 22). The Tieton River was previously believed to be unsuitable for steelhead spawning, yet this area had the highest number of steelhead spawners observed among Naches River tributaries. Spawning in the Naches River mainstem was also high, both above and below Wapatox Dam (RM 17.1). Telemetry investigations conducted in 2012 were consistent with Hockersmith et al. (1995) observations showing steelhead spawning in the mainstem Yakima River between Wapato Dam and the Naches confluence. However, this latest telemetry study suggests that mainstem Yakima River steelhead spawning is occurring further downstream than previously documented, in the floodplain below Sunnyside Dam. Frederiksen et al. (2014) observed that the detection histories for the three fish observed in this area was consistent with kelt-like behavior.

Table 5-4. Spawning distribution of Naches steelhead radio tracked in 2012, based on preliminary data (Frederiksen et al. 2014).

Presumed Spawning Location	Percent of Radio-tagged Steelhead
Mainstem Yakima RM 101-106.6	2%
Ahtanum	7%
Mainstem Yakima RMR 106.6-116.3	6%
Cowiche	9%
Naches River RM 3.3-17.1	18%
Tieton River	19%
Rattlesnake	7%
Nile	2%
Rock	1%
Upper Naches RM 17.1-44.6	21%
Bumping	6%
Little Naches	3%

Toppenish

The Toppenish population, which is located exclusively on the Yakama Reservation, consists of steelhead that spawn in Toppenish Creek, its tributaries, and the short stretch of the mainstem between Toppenish and Satus Creeks. The ICTRT assigned two MSAs and one MiSA to the Toppenish Creek steelhead population, based on historical intrinsic potential analysis. All are within the Toppenish Creek drainage itself. Spawning is known to occur throughout the Simcoe and Toppenish Creek MSAs. Steelhead spawning has also been documented in Marion and Harrah drains, which join near the confluence of Toppenish and Simcoe Creeks. Marion drain then flows east and enters the Yakima River 3 km upstream of Toppenish Creek (Rogers 2007). Both drains were excavated in the 1920s to carry return flows from the Wapato Irrigation Project to the Yakima River.

Satus

The Satus Creek population consists of steelhead that spawn in the Satus Creek drainage on the Yakama Reservation, the mainstem Yakima River below Satus Creek, and tributaries to the lower mainstem. The ICTRT assigned two MSAs and four MiSAs to the Satus Creek steelhead population, based on habitat potential and an analysis of steelhead presence/absence data (Figure 5-5). Both MSAs and one of the MiSAs are within the Satus Creek drainage itself. Spawning is known to occur throughout the Satus and Dry Creek MSAs, as well as in Mule-Dry Creek MiSA. The remaining three minor spawning concentrations are associated with small irrigation drains on the left bank of the mainstem Yakima River. The mainstem Yakima River, as well as tributaries to the lower mainstem, were included in the Satus population.

5.3.2 Critical Habitat

Analytical Approach

In assessing whether the Proposed Action may directly or indirectly affect PCEs related to steelhead critical habitat, Reclamation first conducts a baseline analysis. In this baseline analysis, Reclamation identified whether a PCE is present or not in an area and how it contributes to the habitat use for which an area was designated. In areas where a PCE is present and associated influencing factions were sufficient to support its intended use at the time of designation, Reclamation described the PCE as "Functioning". Where baseline influencing factors might limit the performance of a PCE, Reclamation described the PCE as "Not Fully Functioning." Finally, where a PCE is not supported within an area or is so degraded to make no meaningful contribution to a designated use, Reclamation described a PCE as "Not Present." For the three freshwater PCEs examined, Reclamation evaluated the primary habitat factors influencing the PCE. PCE baseline and effects evaluations are organized first by PCE, and then by the three major subbasins in the watershed included in the action area: upper Yakima, Naches, and lower Yakima. While the subbasin unit is used to generally describe a geographic unit, the PCE analysis is focused on stream reaches included as part of the Action Area. Information about conditions on the reach-level is provided when information is available and discussions on this spatial scale are informative. Reach delineations are specified in Appendix I. Table 5-5 provides a summary of Reclamation's baseline determinations.

Table 5-5. Summary of Reclamation critical habitat baseline determinations.

	Upper Yakima	Naches	Lower Yakima
PCE 1 Spawning			
Spawning Flow	Functioning	Functioning	Functioning (Union Gap Reach) Not Present (Downstream of Sunnyside Dam)
Spawning Substrate	Functioning (Upstream of Roza Dam) Not Fully Functioning (Downstream of Roza Dam)	Functioning (Naches and Bumping Rivers) Not fully functioning (Tieton River)	Not Fully Functioning (Union Gap Reach) Not Present (Downstream of Sunnyside Dam)
Spawning Temperature	Functioning	Functioning	Functioning (Union Gap Reach) Not Present (Downstream of Sunnyside Dam)

	Upper Yakima	Naches	Lower Yakima
PCE 2 Rearing			
Rearing Flow	Not Fully Functioning	Not fully functioning (Tieton River) Functioning (Bumping River & Naches River)	Not Fully Functioning
Rearing Complexity		Not fully functioning	
Rearing Food	Functioning	Functioning	Functioning
Rearing Competition			Not Fully Functioning
Rearing Water Quality & Temperature			
PCE 3a Adult Migration			
Adult Migration Barriers	Functioning	Functioning	Functioning
Adult Migration Flow			
Adult Migration Temperature			Not Fully Functioning
PCE 3a Juvenile Migration			
Juv. Migration Barriers	Not Fully Functioning	Functioning	Not Fully Functioning
Juv. Migration Flow		Functioning (Upper Naches and Bumping Rivers) Not fully functioning (Tieton and lower Naches Rivers)	
Juv. Migration Temperature	Functioning	Functioning	

Freshwater Spawning (spawning, incubation, and larval development)

Historically, summer steelhead likely spawned throughout all accessible portions of the basin (YSFWPB 2004). Reductions in distribution have been most pronounced in the lower Yakima River and tributary systems, particularly those areas blocked by storage dams and irrigation infrastructure. In the lower Yakima River, sections of many streams thought to formerly support spawning and rearing are now utilized only as migration corridors due to habitat degradation (YSFWPB 2004). When Yakima basin steelhead spawning distribution is compared to other river systems with similar elevations, the proportion of the *O. mykiss* population that exhibits anadromy is significantly reduced (YSFWPB 2004).

Upper Yakima

Reclamation has determined that the baseline status of the Freshwater Spawning PCE in the upper Yakima subbasin is Functioning. While PCE factors influencing spawning, incubation, and larval development have been affected by anthropogenic influences, indicators are within criteria to support the designated use of the critical habitat.

Field evaluations of spawning habitat in the mainstem Yakima river between the Keechelus Dam and the Teanaway confluence (including some tributary habitat) characterized the majority of the area surveyed as good spawning habitat (USFWS, as cited in Haring 2001). Evaluation of gravel characteristics within spring Chinook redds in the upper Yakima River found 11 to 16 percent fines and egg-to-fry survival rates of 59.6 percent (Fast et al. 1991). These results were within the values reported by other researchers, indicating generally good substrate condition.

Biologists have identified general mechanisms that may degrade spawning habitat. For example, reaches exposed to regulated, high summer flow conditions may show scouring and loss of spawning gravels (YBFWRB 2009, p. 97). The effect of high summer flows on potential spawning substrate degradation is expected to be highest in channels subject to channel morphology simplification and shoreline armoring, as these areas have reduced sediment inputs and little instream structure to help dissipate energy. The reduction in gravel and wood inputs from upstream sources, as is associated with shoreline protection, gravel mining, levee construction, and dam construction, increases the potential for unnaturally high flows to degrade spawning habitat. While the scale and scope of these habitat changes may be sufficient to limit the degree to which this PCE supports freshwater spawning, these changes are largely characterized as permanent alterations that existed at the time of critical habitat designation. Additionally, current gravel assessments indicate that available substrates are adequate to support spawning.

The maximum temperature standard for Class AA streams is 16 °C (61 ^{o}F) (WAC 1997). The general statewide standard for Class A streams is 18 °C (64 ^{o}F); however, the mainstem of the Yakima River (from the confluence with the Cle Elum River to the mouth) has a

special standard of 21 °C (70 °F). While there is a temperature TMDL for portions of the upper Yakima River, Cle Elum River, and tributaries, the state is only in the initial stages of developing a study. However, temperatures during the steelhead spawning period are presumed low enough to support steelhead incubation. In the Yakima River, daily maximum temperatures recorded at the gage near Cle Elum, Washington generally begin to warm above 16°C by the middle of June. Temperature ranges from 16 to 18 °C through July, and by August through early October temperatures can reach 21 to 24 °C. By the middle of October, temperatures fall rapidly and remain below 16°C for the remainder of the year.

Naches

Spawning factors within the Tieton River are sufficiently outside of criteria to limit the frequency or degree to which spawning, incubation, and larval development can be supported. Minimum flows out of Rimrock Reservoir were historically sufficiently low to limit the amount of spawning habitat. High September flows for flip-flop implementation and low channel complexity may result in scouring and loss of spawning gravels.

The effect of the Rimrock storage dam and YTID diversion dam on Tieton River spawning substrate recruitment was in effect at the time critical habitat was designated. In addition to this reduction in coarse gravel recruitment, two Tieton River tributaries contribute excessive fine sediments to the Tieton River (USFS 2004, p. 15). The lower Tieton River itself is characterized by the USFS as functioning at unacceptable risk due to a loss of gravel and sediment recruitment due to the dam and loss of channel complexity.

It was previously believed that the Tieton River did not support significant steelhead spawning due to the altered streamflow regime and unavailability of appropriately sized streambed gravels. The most recent radio telemetry indicates high steelhead spawning use in this tributary (Frederiksen et al. 2014; Frederiksen 2014). In the absence of a longer time series of spawning data, and in light of the degree of alteration to the flow and sediment factors, Reclamation concludes that the Not Fully Functioning designation is warranted.

Reclamation has determined that spawning factors within the Bumping and Naches Rivers are sufficient to support the designated use of the critical habitat, and is Fully Functioning. Potential hydrologic effects in the Bumping River are expected to be relatively modest due to the small size of this reservoir. Similarly, downstream from the Bumping-American confluence and the Naches–Tieton confluence, unregulated flow components are more substantial, reducing the potential for summer flows to result in scouring.

Water temperatures in the Bumping River are within the ranges to allow for successful spawning and egg incubation. In the lower Naches reach, seasonal water temperatures exceed 20ºC (68ºF) for very short periods during the summer, but seasonally high temperatures do not affect spawning and incubation.

The USFS has characterized the Naches as functioning at risk due to concerns about status of other watershed conditions that can increase delivery of fine sediment: high road density, high levels of past timber harvest, and natural potential for fine sediment (USFS 2004, p. 39).

Lower Yakima

Reclamation has determined that the Freshwater Spawning PCE is Functioning for the Union Gap reach and not present downstream of Sunnyside Dam, though there are suitable gravels in this area. While the most recent radio-telemetry investigation found evidence of limited spawning below Wapato Dam and into the floodplain below Sunnyside Dam (Frederiksen et al. 2014), PCEs to support successful spawning in these areas have not been confirmed and are presumed to not be present.

While PCE factors influencing spawning, incubation, and larval development have been affected by anthropogenic influences in the Union Gap reach, indicators are within criteria to support the designated use of the critical habitat. Temperatures are adequate for incubation and larval development, appropriately sized gravels are recruited and retained, and the hydrologic regime does not cause appreciable scour. In the Yakima River, daily maximum temperatures recorded at the most downstream gage near Prosser, Washington generally begin to warm above 16°C by early May and by late May through late September remain above 21 °C. Temperatures in June, July, and August range from 22 to 31°C. By late October temperatures fall rapidly and remain below 16°C for the remainder of the year.

Freshwater Rearing (juvenile growth, development, mobility, and survival)

Upper Yakima

Hydrology

The hydrology factor within the upper Yakima basin is sufficiently outside of criteria to limit the frequency or degree to which juvenile growth, development, mobility, and survival can be supported. The profound hydrologic changes in the upper Yakima watershed associated with both storage and delivery operations affect year-round rearing conditions. The general ways in which altered flow affect juvenile rearing include potential mortality or displacement of emerging fry exposed to high irrigation flows, increased energetic demands of high summer flow, potential for stranding during implementation of the flip-flop operation, increased energetic demands due to winter flow regime, and lack of access to temperature and flow refugia in the winter. Since these are all ongoing effects of Project Operations, they are described in detail in the effects section.

Floodplain Connectivity and Channel Complexity

Reclamation determines that the baseline channel complexity in the upper Yakima subbasin is Not Fully Functioning. Even at the time Critical Habitat was designated for MCR steelhead, channel complexity in the upper Yakima had already been significantly diminished by the construction of roads, dikes, and gravel mining ponds in the Easton, Cle Elum, and Kittitas floodplains. In 2002, Snyder et al. (2002) used aerial photography and estimated that the percent of floodplain disconnection was 59 percent in the Cle Elum River and 69 percent in the Kittitas reach (p.138).

While sections of the Yakima River possess adequate amounts of structural material (LWD and boulders) and inherent channel morphology and geologic characteristics (connected side channels and access to alluvial floodplains) to maintain complex stream channels in most reaches (USFS 1996a), these areas are generally limited to the most upstream reaches, particularly the Keechelus to Easton reach and the upper half of the Easton reach. Further downstream natural canyon constrictions, past development, and continued bank armoring results in less complex habitat. Where sections of less confined floodplain exist, continued wood and gravel recruitment and geomorphically active flows are necessary to create complex habitat features. The present river channels for the Kittitas and Cle Elum reaches occupy much of the same historical channel positions. Lorang et al. (2002) thought that this observation may suggest that these reaches have become incised, or had relatively less upstream sediment supply compared to the Naches and Union gap reaches, which were more fluvially active (p. 37).

Food base

Reclamation has determined that the baseline condition for Freshwater Rearing food base factor in the upper Yakima subbasin is Functioning. Cuffney et al. (1997) sampled water quality, algae, invertebrates, and fish species community indices at sites in the Yakima basin, including the Yakima River, and concluded that upper basin areas tended to have lower levels of biological impairment than comparative sites in the lower basin. For the Yakima River, two sites were located in stream segments designated as steelhead critical habitat areas (the Yakima River at Cle Elum and the Yakima River at Umptanum in the Yakima Canyon). Site condition ratings based on fish, invertebrate, and algal community condition indices showed no impairment to fish, invertebrates, and algae communities at the upper site, and no impairment to invertebrates and algae, but moderate impairment to fish communities at the Umptanum site in the mainstem Yakima River reach (Cuffney et al. 1997). Aquatic habitat with sufficient quality to support steelhead rearing within the upper Yakima subbasin can be considered to exist in these reaches in the environmental baseline based on results from this study.

Competition

Reclamation has determined that the baseline condition for Freshwater Rearing competition factor in the upper Yakima subbasin is Functioning. In the Yakima basin, steelhead occur with resident *O. mykiss*, native cutthroat trout, Chinook, coho, mountain whitefish, bull trout and various sculpin, sucker, and minnow species. While nonnative salmonids and other species have been widely introduced and have become established in numerous areas throughout the range of steelhead, none (with the possible exception of resident brook trout [*Salvelinus fontinalis*]) are thought to be abundant enough to pose a significant predatory, interbreeding, or competitive threat to steelhead in the upper Yakima subbasin. Cold water salmonid species, particularly brook trout and cutthroat trout (*O. clarki*) were introduced into the upper Yakima basin in the mid-1900s. While nonnative species are no longer stocked in mainstem river areas where there is potential to interact with native species, they have become established in many areas of the basin with self-sustaining, naturally reproducing populations. Currently, there are naturally reproducing populations of brook trout and cutthroat trout throughout the upper Yakima basin (WDFW 1998). Notable populations exist in upper Yakima River tributaries; however, smaller populations are likely to exist in stream segments designated as critical habitat throughout the mainstem Yakima river reach as well.

Naches

Hydrology

The hydrology factor within the Tieton River is sufficiently outside of criteria to limit the frequency or degree to which freshwater rearing is supported. Therefore, Reclamation characterizes its baseline as Not Fully Functioning. The Tieton River is influenced by only a minor unregulated flow component (Section 2.2.2). Its hydrology is therefore largely governed by dam operations, particularly the implementation of flip-flop and winter storage operations. Since these are ongoing project effects, they are discussed in more detail in the effects section.

Reclamation has characterized Bumping and Naches Rivers' baseline condition as Functioning for the hydrology factor of the freshwater rearing PCE. Due to the relatively modest size of Bumping Reservoir and the number of unregulated tributaries in the upper Naches basin, the Naches River and its tributaries upstream of the Tieton confluence still exhibit a largely normative flow regime (YBFWRP 2009, p. 113). The upper and lower Naches reaches currently have significant streamflow amounts year-round that not only provide habitat in mainstem reaches, but also connected side channels in these reaches. A study of side channel connectivity in the Naches River by the USFWS in 2002, indicated that at streamflows of 311 cfs, more than 84 percent of side channels remained connected to the mainstem river channel (USFWS 2002). With further flow reductions to 240 cfs, the proportion of side channels that remained connected to the mainstem Naches River fell to 68 percent. As currently operated, minimum streamflows in the lower Naches reach are held in

the 300 to 400 cfs range for most of the year. As a result, most of the side channels in the upper and lower Naches reaches will remain connected to the main flow of the river for most of the year and will provide permanent water sources for steelhead, other fish species, and other aquatic biological communities.

Floodplain Connectivity and Channel Complexity

Reclamation determines that the baseline channel complexity in the Naches subbasin is Not Fully Functioning. As in the upper Yakima, at the time Critical Habitat was designated for MCR steelhead, channel complexity in the Naches had already been significantly diminished by road and dike construction and gravel mining. Snyder et al. (2002) characterized the Naches reach as being disconnected from 44 percent of its historic floodplain (p. 138). Upstream of the Tieton River confluence, the Naches River is naturally confined by basalt canyon walls, but has been further constricted by revetments (YBFWRB et al. 2009, p. 111). In particular, right-bank revetments protecting homes have cut off historic side channels and spring brooks. This impact, combined with constrictions caused on the left-bank by Hwy 410, resulted in the near-entire loss of the Nile Valley floodplain.

Downstream from the Tieton confluence, the floodplain widens but Highway 12, gravel pits, local roads, and revetments have isolated the river from part of its active floodplain and degraded conditions (YBFWRB et al. 2009, p. 111). While the upper Bumping River generally had good floodplain connectivity, the lower Bumping River is confined by FR 1800 and Hwy 410 (USFS 2004, p. 15). The USFS (2004) considers off-channel habitat along the mainstem Tieton to be functioning at unacceptable risk due to channel confinement and side channel disconnection caused by HWY 12 (p. 15).

Even those PCE factors subject to changing conditions in the baseline, such as woody debris and gravel recruitment, and geomorphically active flows are sufficiently outside of criteria to limit juvenile growth, development, mobility, and survival. Recruitment of LWD in the Naches basin has been affected by many human activities. First, headwater source areas were removed from the river continuum by construction of the storage dam embankments on the Tieton and Bumping Rivers. The natural lake at Bumping may have acted to some extent as LWD "traps" before the dam was built. Further down the system, diversion structures may impede the transport of LWD though, to large extent, LWD is simply passed over these structures as part of operations.

Impacts to riparian conditions associated with flow regulation also affect LWD recruitment. Flow regulation and water diversion has contributed to impaired floodplain function along alluvial reaches of the river (Snyder and Stanford 2001). Cottonwoods (*Populus spp*.) are a primary species along these alluvial floodplain reaches of the Yakima basin. Braatne and Jamieson (2001) found that very little recruitment to cottonwood stands in the alluvial floodplain reaches of the Yakima and Naches Rivers is occurring. They felt this was primarily as a result of the highly modified flow regime of the Yakima and Naches Rivers.

This lack of cottonwood stand development, coupled with floodplain disconnection and development, associated largely with flood control dike and levy construction, highway construction, railroad construction, and land use changes, has decreased LWD supply and recruitment.

No comprehensive assessment of pool frequency and quality exists for the streams in the Naches watershed. McIntosh et al. (1994) compared pool frequency in 80 km of tributaries in the Naches basin (Little Naches River, Rattlesnake Creek, and American River) from data collected in the 1930s and 1940s, with that collected in 1990 to 1992. He found that pool frequency had increased in both managed and unmanaged areas. However, none of the surveyed areas were affected by flow regulation and the increases were attributed to a recovery from intensive sheep and cattle grazing that had occurred in the 1880s and early 1900s. The Naches and Tieton Watershed Analyses (USFS 1996b) both reported that none of the streams they surveyed for frequency of pools per mile met expected levels of pool frequencies.

Food Base

Reclamation has determined that the baseline condition for Freshwater Rearing food base factor in the Naches subbasin is Functioning. Natural streamflow variability and diverse stream channel conditions and complexity have controlling effects on the biology of native aquatic species assemblages, and the physical and chemical ecosystem attributes upon which they depend for survival. It is assumed that adequate amounts of aquatic and terrestrial food sources are present in designated stream reaches in this basin. From existing information sources, it appears that both the upper and lower Naches reaches have adequate channel connectivity, habitat complexity, and streamflow regimes to support a diverse array of aquatic and terrestrial invertebrates and forage fish species. Cuffney et al. (1997) sampled water quality, algae, invertebrates, and fish species community indices at sites in the Yakima basin, including the Naches subbasin, and concluded that upper basin areas tended to have lower levels of biological impairment than comparative sites in the lower basin. For the Naches subbasin, three sites were located in stream segments designated as steelhead critical habitat within the federal Action Area (American River near Hells Crossing, upper Naches River near Cliffdell, and the lower Naches River near Yakima). Site condition ratings based on fish, invertebrate, and algal community condition indices showed either moderate or no impairment at these sites (Cuffney et al. 1997).

Unfortunately, no data on biological impairment or condition ratings for fish, algae, and invertebrate populations has been collected for the Bumping or Tieton Rivers. It is assumed that invertebrate and fish communities in the Tieton River are at least moderately impaired due to the seasonal variation is streamflows and degraded habitat complexity conditions that exist in this reach in the environmental baseline. However, invertebrate and forage fish populations are still likely to be sufficient in the Tieton River to support steelhead food requirements, despite the highly regulated flow regime in this reach.

Competition

Reclamation has determined that the baseline condition for Freshwater Rearing competition factor in the Naches subbasin is Functioning. Cold water salmonid species, particularly brook trout and cutthroat trout, were introduced into the upper Naches basin in the mid-1900s. While nonnative species are no longer stocked in mainstem rivers where there is potential to interact with native species, they have become established in many areas of the basin with self-sustaining, naturally reproducing populations.

Currently, there are naturally reproducing populations of brook trout and cutthroat trout throughout the upper Naches River basin (WDFW 1998). Notable populations exist in upper Naches River tributaries; however, smaller populations are likely to exist in stream segments designated as critical habitat in the upper and possibly lower Naches reaches, as well as the Tieton and Bumping Rivers. Although, a variety of nonnative fish species are found within stream segments designated as critical habitat in the Naches subbasin, none (with the possible exception of rainbow trout) are thought to be abundant enough to pose a significant predatory, interbreeding, or competitive threat to steelhead in this subbasin. Populations of nonnative predatory species may be significant enough in the lower Naches reach to put juvenile steelhead at a competitive disadvantage in this reach. Although adult steelhead have few predators due to their relatively large size which allows them to avoid predation in the Naches subbasin, juvenile steelhead may not be able to compete with the abundance and diversity of nonnative fish that are present in the lower Naches reach.

Lower Yakima

Hydrology

Reclamation has characterized lower Yakima subbasin baseline condition as Not Fully Functioning for the hydrology factor of the freshwater rearing PCE. Low streamflows from April through October have been identified as reducing the availability of summer and early fall rearing habitat in the mainstem Yakima River downstream from Sunnyside Dam (YBFWRB 2009, p. 94).

Floodplain Connectivity and Channel Complexity

Reclamation determines that the baseline channel complexity factor in the lower Yakima subbasin is Not Fully Functioning. As in the rest of the basin, at the time Critical Habitat was designated for MCR steelhead, channel complexity in the lower Yakima had already been significantly diminished by road and dike construction and gravel mining. Snyder et al. (2002) characterized the Union Gap reach as being disconnected from 61 percent of its historic floodplain (p. 138). The Wapato reach has the broadest floodplain within the entire Yakima subbasin as a whole. However, the current extent of the floodplain is just a fraction of the historic area (Snyder and Stanford 2001).

Even those PCE factors subject to changing conditions in the baseline, such as woody debris and gravel recruitment, and geomorphically active flows are sufficiently outside of criteria to limit juvenile growth, development, mobility, and survival. The Union Gap reach has been identified as being relatively fluvial active, but depended on sediment supply from the Naches River (Lorang et al. 2002, p. 38). Large woody debris is still present in this reach; however, at reduced levels from the historic condition. Wood recruitment has been reduced by alteration of the upstream riparian zone as well as development and channelization of the stream channel through urban areas. Wood retention is also inhibited by the modified channel geometry that concentrates flow into a narrow cross section. Stream velocities in this reach during the spring and summer are much higher than desired for steelhead rearing (WDFW 1998), especially during the emergence period of June and July.

Additionally, the Wapato reach may be incising due to depleted sediment supply behind Sunnyside Dam, and reduced stream power from hydrologic alteration may reduce bank erosion and sediment supply (Lorang et al. 2002, p. 38). Despite contraction of much of the floodplain area and reduced sediment supply, much of this reach is still characterized by intact floodplains, cottonwood gallery forests, and extensive riparian wetlands (YSFWPB 2004).

Riparian vegetation along the Yakima River from Union Gap to Prosser Dam is relatively healthy with mature cottonwoods and an understory of willows and other brushy plants forming an almost unbroken corridor from Sunnyside to Prosser. This corridor is interrupted infrequently by a small number of highway revetments or levees. This reach is characterized by a single meandering channel with few mid-channel islands that has downcut over time (Snyder and Stanford, as cited by Haring 2001). During the summer months, a massive growth of aquatic vegetation occurs over a broad longitudinal extent of the mainstem Yakima River from Prosser Dam to the confluence with the Columbia River, primarily in shallow water areas. This vegetation spans from bank to bank of the river and may inhibit migration, but certainly dramatically alters habitat conditions such as dissolved oxygen, pH, temperature, substrate, and macroinvertebrate communities in this reach.

Food Base

Reclamation has determined that the baseline condition for Freshwater Rearing food base factor in the lower Yakima subbasin is Functioning.

Little information exists to document the amount or quality of steelhead food sources in the lower Yakima subbasin. However, from existing information sources, it appears that all three lower Yakima stream reaches have adequate channel connectivity, habitat complexity, and streamflow regimes to support a diverse array of aquatic and terrestrial invertebrates and forage fish species. Cuffney et al. (1997) sampled water quality, algae, invertebrates, and fish species community indices at sites in the Yakima basin, including the lower Yakima subbasin, and concluded that upper basin areas tended to have lower levels of biological impairment than comparative sites in the lower basin. For the lower Yakima subbasin, four

sites were located in stream segments designated as steelhead critical habitat within the federal Action Area (Yakima River at Parker, Yakima River near Toppenish Creek, Yakima River at Kiona, and in the Spring Creek Wasteway). Site condition ratings based on fish, invertebrate, and algal community condition indices indicated severe impairment levels at all sites for fish and algae in the lower Yakima River, and moderate impairment for invertebrate communities at all sites in the lower Yakima River (Cuffney et al. 1997). Conversely, in their review of the literature for the Yakima basin, Snyder and Stanford (2001) concluded that based strictly on biomass estimates from the mainstem, that salmonids are likely not food limited by the macroinvertebrate community.

Competition and Predation

Reclamation determines that the baseline condition for the competition and predation factors in the lower Yakima subbasin is Not Fully Functioning. Nonnative salmonids and other species have been widely introduced and have become established in numerous areas in the lower Yakima subbasin.

Populations of nonnative predatory species may be significant enough in the lower Yakima reaches to put juvenile steelhead at a competitive disadvantage. Piscivorous animals (California gulls, great blue herons, American white pelicans, Northern pikeminnow, and smallmouth bass) consume smolts and parr as they negotiate past Sunnyside and Prosser Diversion Dams, the Chandler power canal fish bypass, as well as Wanawish Diversion Dam in the lower Yakima reach. High concentrations of predatory fish have been observed below Sunnyside and Wapato Dams during smolt outmigration periods (McMichael et al. 1998). Studies on the impacts of piscivorous fish on the survival of outmigrating smolts in the lower Yakima River (McMichael et al. 1998) indicated that predation rates were high and were caused mainly by three predators; the indigenous northern pikeminnow (*Ptychocheilus oregonensis*), found primarily above Prosser Dam, and two exotic piscivorous species, the smallmouth bass (*Micropterous dolomieui*), found primarily above Prosser Dam, and perhaps the channel catfish (*Ictalurus punctatus*), found primarily in and just above the Yakima River delta (YSFWPB 2004).

The abundance and spatial and temporal distributions of piscivorous birds can have significant impacts to the survival of steelhead in the Yakima River. The abundance, distribution, and the estimated maximum consumption (kg biomass) of fish eating birds along the length of the Yakima River was studied during 1999 to 2002 by Major (2003). A greater diversity of avian piscivores occurred in the lower river and potential impacts to fish populations was more evenly distributed among the species. In 1999 to 2000, great blue herons potentially accounted for 29 and 36 percent of the fish consumed, whereas in 2001 to 2002 American white pelicans accounted for 53 and 55 percent. It is estimated that approximately 75,878 ± 6,616 kg of fish were consumed by piscivorous birds in the lower sections of the Yakima River during the study. Bird assemblages differed spatially along the river with a greater abundance of colonial nesting species within the lower sections of the river, especially during spring and the nesting season (Major 2003).

Water Quality and Temperature

Reclamation determines that the baseline condition for the water quality and temperature factors in the lower Yakima subbasin is Not Fully Functioning. High summer temperatures of the lower Yakima River can exceed levels suitable for juvenile steelhead and other salmonids (Vaccaro 1986; Rinella et al. 1992). Water temperature is likely the controlling factor in availability of salmonid rearing habitat downstream from the Sunnyside Diversion in the summer and early fall. However, groundwater inflows do provide some cool water refuges that may provide limited rearing habitat for juvenile steelhead. High nutrient loading along with warmer water temperatures create habitat conditions more favorable to non-native species, some of which are predators upon juvenile steelhead.

Freshwater Migration (juvenile and adult mobility and survival)

The five upper basin storage reservoirs existed at the time of critical habitat designation. While the storage dams do pose a migration barrier, they are excluded from Reclamation's baseline evaluation.

Adult Migration

Upper Yakima

Reclamation has determined that the baseline condition for adult migration in the upper Yakima subbasin is Functioning. Flow and temperature is sufficient during the steelhead adult migration period to enable steelhead to move throughout the Action Area unimpeded. There are also three diversion dams in this area: Easton, Town, and Roza Diversion Dams. Each of these dams has fish ladders. As an ongoing effect of Project operations, ladder function is described in more detail in the effects section. Historically, Easton Dam ladder operation precluded passage in water-short years. When Reclamation did not have sufficient water supply to implement the mini flip-flop operation, the fish ladder was shut down in the fall and winter to prevent spring Chinook from spawning in the Keechelus reach, since there was concern about dewatering redds. An Easton ladder shut down has not occurred since Reclamation modified the outlet works at Kachess Dam in 1996. In 2010, Reclamation modified the Roza roller gates, enabling Reclamation to provide surface spill at this facility at flows less than 1,000 cfs. This modification benefits outmigrating kelts by providing them with a surface spill option for outmigration.

Within the upper Yakima subbasin, the lower reaches of Taneum, Manastash, Wilson/Cherry, Reecer, Big, and Little Creeks are within the Action Area, since they receive operational spill. These areas are also Designated Critical Habitat. Activities that have occurred under the baseline have restored complete access to Taneum Creek and will restore access to Manastash Creek. Access into Wilson/Cherry, Reecer, Big, and Little Creeks is currently impeded by private irrigation infrastructure.

Naches

Reclamation has determined that the baseline condition for adult migration in the Naches subbasin is Functioning. A largely unregulated flow regime combined with diverse habitat characteristics have created a river corridor that is relatively complex and free of migration blockages in the upper Naches and Bumping River reaches. Adult migration through these reaches is expected to be unimpeded by conditions that currently exist in these areas. Adult steelhead are also expected to have unimpeded passage into tributary channels due to the flow regimes currently existing in the mainstem Naches River. Flow levels and water temperatures throughout the year, even during the summer low flow period, are within ranges that do not block or impede steelhead migration. In addition, no physical structures, such as diversion dams, exist in this reach to limit or delay migration into the upper Naches and Bumping River reaches.

Flows in the lower Naches reach below the confluence are thought to be suitable for steelhead migration when flows meet or exceed 300 cfs (Reclamation 2000). Between 1982 and 1999, this flow was met or exceeded 80 percent of the time. With the acquisition of the Wapatox water right in 2003, minimum flows below the Wapatox Diversion Dam have increased substantially in the lower Naches River. Flows in this reach have increased by 200 to 275 cfs and minimum flows are now about 300 to 325 cfs or the natural runoff, whichever is less (Reclamation 2002). Prior to this instream flow water acquisition, there were times when streamflow dropped below these amounts. Additionally, passage into Cowiche Creek has occurred under baseline conditions (see section 2.4.2 for more details).

Three diversion dams, Tieton Canal, Wapatox, and Nelson Dam all have fish ladders. While short-term delays in migration are possible in association with flood events, the ladders are operated and maintained year-round and passage conditions are not significantly limited. Significant improvements to adult migration under baseline conditions include the 2007 Yakima-Tieton Diversion Dam ladder rebuild in 2007 (poor passage conditions at this facility were highlighted in the Yakima Basin Steelhead Recovery Plan), and improvements to the Wapatox fish ladder completed in 2009.

Lower Yakima

Reclamation has determined that while the flow and barrier factors are generally adequate to promote adult migration, the overall baseline PCE condition is Not fully functional due to the temperature factor. Elevated water temperatures in the lower Yakima River during the end of the irrigation season (beginning of the steelhead upstream migration) may constitute a thermal barrier to adult steelhead and likely delays their entry into the Yakima River until water temperatures drop to more suitable or preferable ranges, typically at temperatures below 19˚C (66 ^{o}F) (Spence et al. 1996; McCullough et al. 2001). Impaired passage may not be directly lethal, but it may delay and exhaust adult salmonids, possibly increasing pre-spawning mortality (Haring 2001). Elevated temperatures at the mouth of the Yakima River are also believed to contribute to known incidences of early arriving (July – August)

steelhead adult migrants overshooting the Yakima River and continuing up the Columbia River. PIT-tag data between 2007 and 2014 indicates that on average, 17 percent of returning adult steelhead overshot the Yakima River (Frederiksen 2014). Of these fish, about 67 percent eventually returned to the Yakima River, and 33 percent were not subsequently detected. Given the extensive network of PIT-tag arrays within the Upper Columbia, it is not likely that undetected fish successfully spawn in the Upper Columbia. From these numbers, the cumulative effect of overshoot on steelhead prespawn mortality is estimated to be 5 to 6 percent of Yakima basin steelhead.

Wapato, Sunnyside, Prosser, and Wanawish Dams are the major impoundments located within this subbasin. Despite periods when passage may be temporarily restricted, these diversion dams do not constitute significant migration barriers for steelhead at the present time. There is potential for delay at these facilities associated with either short-term closures or debris removal associated with flood events. However, these facilities are maintained and kept open year-round. Since facility maintenance is an ongoing operation, more detailed analysis of the effects of flow and ladder operations is presented in the effects analysis.

Historically, return flows in the lower river could falsely attract returning adults to these drains and wasteways. Improved system efficiency has led to reduced amounts of irrigation return flows in such return flow canals as the Sulphur Wasteway, Spring/Snipes Creek, and the Kiona Wasteways between Sunnyside and Benton City. For example, it has been estimated that the total system improvements made to the Sunnyside Main Canal since various components of the Sunnyside Division's Water Conservation Plan was initiated in 2005, have resulted in average return flow reductions of 13 percent in Sulphur Wasteway and a 71 percent return flow reduction in the Spring/Snipes Creek return flow channel. At complete project implementation, further reductions in return flow volume will decrease the overall flow into Sulphur and Spring/Snipes Creek Wasteways by 10 to 25 percent, respectively, from existing levels. Additionally, the Sulphur Creek wasteway barrier was constructed in 2008 to exclude adult salmon for being falsely attracted to this area that was unsuitable for spawning.

Juvenile Migration

Upper Yakima

Reclamation has determined that based on the condition of the barrier and flow factors, baseline condition for juvenile migration in the upper Yakima subbasin is Not Fully Functioning. As an ongoing effect of Project operations, flow and barrier effects will be described in more detail in the effects section. The general mechanisms of impact are increased mortality due to travel time and predation. Temperature in the Action Area is suitable for outmigrating smolts.

Naches

Reclamation has determined that based on the condition of the barrier and flow factors, baseline condition for juvenile migration in the upper Yakima subbasin is Not Fully Functioning. As an ongoing effect of Project operations, flow and barrier effects will be described in more detail in the effects section. The general mechanisms of impact are increased mortality due to travel time and predation. Temperature in the Action Area is suitable for outmigrating smolts.

Improvements to smolt outmigration factors that have occurred as part of the baseline include the upgrades of a number of unscreened and poorly screened diversions historically located on the middle and lower Naches (CBSP 1990, as cited in Haring 2001, p. 185). These were replaced with louvered screens in the early 1990s. Until 2002, the City of Yakima Water Treatment Plant, which at approximately 39 cfs was a significant diversion on the Naches River, was poorly screened.

Lower Yakima

Reclamation has determined flow, barrier, temperature, and predation factors within the lower Yakima subbasin are sufficiently outside of criteria to limit juvenile outmigration. As an ongoing effect of Project operations, flow and barrier effects will be described in more detail in the effects section.

Elevated stream temperatures in the lower Yakima reach during late spring and early summer can adversely affect steelhead smolts by creating stressful or lethal thermal barriers that increase mortality and limit the number of smolts that successfully emigrate from the basin (Spence et al. 1996). Predation factors also affect the juvenile migration PCE. Piscivorous animals (California gulls, great blue herons, American white pelicans, Northern pikeminnow, and smallmouth bass) consume smolts and parr as they negotiate past Sunnyside and Prosser Diversion Dams, the Chandler power canal fish bypass, as well as Wanawish Diversion Dam in the lower Yakima reach. The presence and abundance of exotic species declines upstream of the Yakima River delta. High concentrations of predatory fish have been observed below Sunnyside and Wapato Dams during smolt outmigration periods (McMichael et al. 1998). Studies on the impacts of piscivorous fish on the survival of outmigrating smolts in the lower Yakima River (McMichael et al. 1998) indicated that predation rates were high and were caused mainly by three predators; the indigenous northern pikeminnow (*Ptychocheilus oregonensis*), found primarily above Prosser Dam, and two exotic piscivorous species, the smallmouth bass (*Micropterous dolomieui*), found primarily below Prosser Dam, and perhaps the channel catfish (*Ictalurus punctatus*), found primarily in and just above the Yakima River delta (YSFWPB 2004).

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Data collected to date suggest that steelhead smolts may not be as vulnerable to predation by northern pikeminnow, smallmouth bass, or channel catfish as fall Chinook parr (McMichael et al. 1998a). This is because steelhead smolts are relatively large compared to fall Chinook parr. McMichael et al. (1998a) found that northern pikeminnow were a relatively abundant piscivorus fish between the city of Yakima and Prosser Dam, smallmouth bass were relatively abundant from Prosser Dam to West Richland, and channel catfish were relatively abundant from West Richland to the mouth of the Yakima River. About 25 percent of the stomach contents of smallmouth bass and northern pikeminnow contained salmon, mostly fall Chinook parr. Studies conducted in 1998 found similar results.

5.4 Effects of the Proposed Action

5.4.1 Analytical Approach

Since all steelhead habitat in the Action Area is designated as Critical Habitat, and direct and indirect project effects to the species are largely associated with habitat impacts, the effects analysis largely discusses species and habitat effects together. The effects analysis for maintenance is discussed in a Section 5.4.4. Maintenance activities can affect individual steelhead in proximity to the activity, directly or indirectly, for short periods of time. Short-term habitat effects are confined to small areas while long-term habitat effects can affect critical habitat PCEs.

In the effect analysis for each PCE, Reclamation described how our proposed actions influences each PCE and determines how and to what extent the proposed actions affect each PCE. Where a proposed action degrades a PCE to such a degree to affect a change in the function and use of a designated critical habitat area for the use it was designated, Reclamation described the effect as “adverse.” Where a proposed action influences, but does not alter the function of a PCE, Reclamation described the effect as “insignificant.” Where a proposed action may influence, but the effects are so small that they are not detectable, Reclamation described the effect as "discountable;" meaning those effects that are extremely unlikely to occur (USFWS and NOAA Fisheries 1998).

In the maintenance effect analysis, each major type of maintenance activity is analyzed for effects directly and indirectly to steelhead, as well as for the overall effect to critical habitat. The effects determination is not broken out by major subbasins because the actions occur throughout the Yakima Project, with many sites involved.

5.4.2 Summary

A summary of critical habitat effect determination calls are provided in Table 5-6. A more detailed explanation is provided in Section 5.4.3.

Table 5-6. Summary of critical habitat effects determination. For "may adversely affect" determinations, expected conditions relatively to the baseline (maintain or improve) are indicated.

<table>
<tr><th></th><th>Upper Yakima</th><th>Naches</th><th>Lower Yakima</th></tr>
<tr><td colspan="4">PCE 1 Spawning</td></tr>
<tr><td>Spawning Flow</td><td rowspan="3">NLAA</td><td>NLAA</td><td rowspan="3">NLAA
(Union Gap Reach)

N/A
(Downstream of Sunnyside Dam)</td></tr>
<tr><td>Spawning Substrate</td><td>NLAA
(Naches and Bumping Rivers)

LAA | Maintain
(Tieton River)</td></tr>
<tr><td>Spawning Temperature</td><td>NLAA</td></tr>
<tr><td>PCE 2 Rearing</td><td></td><td></td><td></td></tr>
<tr><td>Rearing Flow</td><td>LAA | Improve</td><td>LAA | Improve
(Tieton River)

NLAA
(Bumping River & Naches River)</td><td>LAA | Maintain</td></tr>
<tr><td>Rearing Complexity</td><td rowspan="4">NLAA</td><td rowspan="4">NLAA</td><td rowspan="4">NLAA</td></tr>
<tr><td>Rearing Food</td></tr>
<tr><td>Rearing Competition</td></tr>
<tr><td>Rearing Water Quality & Temperature</td></tr>
<tr><td colspan="2">PCE 3a Adult Migration</td><td></td><td></td></tr>
<tr><td>Adult Migration Barriers</td><td>LAA | Improve</td><td>LAA | Improve</td><td>LAA | Improve</td></tr>
<tr><td>Adult Migration Flow</td><td rowspan="2">NLAA</td><td rowspan="2">NLAA</td><td rowspan="2">NLAA</td></tr>
<tr><td>Adult Migration Temperature</td></tr>
</table>

	Upper Yakima	Naches	Lower Yakima
PCE 3a Juvenile Migration			
Juv. Migration Barriers	LAA | Improve	LAA | Improve	LAA | Improve
Juv. Migration Flow		NLAA (Upper Naches and Bumping Rivers) LAA | Improve (Tieton and lower Naches Rivers)	
Juv. Migration Temperature	NLAA	NLAA	NLAA

5.4.3 Operations

Spawning and Incubation

Direct and Indirect Effects

Reclamation has determined that the Proposed Action is not likely to adversely affect spawning and incubating steelhead. The primary effect mechanism for spawning and incubation associated with the Proposed Action is streamflow regulation. While there are elevation-related differences in steelhead spawning and incubation throughout the basin, the February through July period encompasses these life stages within the Action Area. Flow conditions at these times of year are supportive of steelhead spawning and incubation. For the Naches River above the Tieton River confluence, flows are influenced more by natural spring runoff than Project operations. In areas under more storage dam regulation, such as the Tieton, Bumping, and Cle Elum Rivers, Naches River below the Tieton confluence, upper Yakima River, and Union Gap reach of the lower Yakima River, winter minimum flows are maintained or exceeded during the spawning and incubation period. Since steelhead spawning occurs in the late winter period when water supply is more certain, flow-adjustments tend not to be recommended by the analytical tool (in the modeled period, flow-adjustments were not recommended by the tool after January 1 during the period of record examined). In the case that adjustments were recommended, potential impacts to redds would be considered (Section 3.1.4, "Spawning Flows"). While flows may increase and fluctuate during this period for flood control, outmigration pulses, or irrigation delivery, they remain above the winter minimum flow targets, making the chance of redd stranding highly unlikely. From Parker (Sunnyside Dam) downstream, streamflows decrease as irrigation withdrawals begin. This flow decrease occurs sometime between mid-March and mid-July, depending on the storage control date, but occurs in lower basin areas where steelhead spawning is not supported.

High flows and flashy flows (characterized by rapid increases and decreases) can scour redds and harm incubating eggs. While harm to incubating eggs could possibly be associated with flood control releases, it would be impossible to meaningfully disaggregate these effects from impacts associated with unregulated flood flows. In general, risk to incubating eggs from flood flows is likely reduced from storage dam regulation.

Critical Habitat Effects

Reclamation concludes the Proposed Action is not likely to adversely affect the Spawning PCE, with the exception of Tieton River. Increased winter and spring flows in some years may improve conditions for incubating redds. The temperature factor will not significantly change. Sediment transport will continue to be affected by the presence of storage and diversion dams. However, the scale spawning effects tied to sediment recruitment is expected to be modest in relation to the scale of change already experienced under the baseline from other, non-Project factors influencing sediment nourishment (such as levee development). In the Tieton River, spawning substrate may become coarsened through project operations.

Juvenile Rearing

As a result of the Yakima Project irrigation deliveries and reservoir filling, flows are higher than natural flows in the summer and early fall and lower than natural flows in the fall and winter below the storage reservoirs. Rearing in the lower Yakima River (downstream from Marion Drain) is most affected in the summer months when low flows in some reaches and high water temperatures may make most of the reach unsuitable for rearing. Fluctuations in some portions of the reach may also impact rearing habitat. Project operations have been adjusted in response to information about fishery needs. Changes that were established as part of the project baseline include establishing minimum flows during winter reservoir filling, following ramping rates for reservoir releases, and establishing a more gradual implementation of flip-flop when conditions allow. As part of the Proposed Action, Reclamation will continue to follow established reservoir ramping rates and implement flip-flop gradually, as conditions allow. Further refinements to the winter flow setting process are also proposed.

There have been a series of efforts to identify instream flow needs for the Yakima basin, targeting salmon and trout habitat conditions. In the early 1980s, the USFWS utilized physical habitat modeling to identify reach-specific flow recommendations, though the USFWS never officially endorsed the recommended flows (for full discussion, see Haring 2001, p. 94). Subsequently, an interagency technical advisory group (the Instream Flow Technical Advisory Group, or IFTAG) was convened as part of an YRBWEP investigation to evaluate the USFWS study results. A series of reach-specific flow recommendations came out of this effort. The instream flow recommendations were based on the amount of suitable habitat available at different flows, and so other hydrologically-mediated factors affecting

rearing habitat, such as food availability, access to instream cover, and energetic demands were not considered. One key assumption associated with the IFTAG effort, which is not supported by more current knowledge, was that the spawning habitat was given preference over rearing habitat (Parametrix 1984, p. 2). Additionally, it was recognized that data deficiencies could compromise the accuracy of the recommendations (TRPA 1995b, as cited in Haring 2001). Still, the USFWS study and accompanying IFTAG review is the only comprehensive instream flow study in the basin (Haring 2001, p. 95). SOAC's 2001 Report on Biologically Based Flows for the Yakima basin did not utilize the USFWS/IFTAG analysis and did not identify specific flow recommendations. Physical Habitat Simulation modeling (PHABSIM) was developed for the Yakima basin in the mid-1990s and was used to evaluate fisheries effects from various water storage options and associated operational changes over the years, but no specific instream flow recommendations were made based on that effort. A summary of Yakima specific instream flow recommendations made through various efforts is provided in Appendix J.

The most recent effort to identify instream flow needs was conducted in 2011 as part of the YRBWEP Integrated Plan effort. As part of this process, the USFWS and IFTAG recommendations were reviewed, in addition to operational flows identified by the IOP, and flow recommendations identified as part of the Water Storage Feasibility Study (Reclamation 2008b) and Yakima River Basin Study (Hubble 2010). Professional knowledge and field observations regarding habitat conditions, particularly associated with side-channel activation, were also used to prioritize and recommend instream flows. The most recent effort cumulated with a series of instream flow recommendations and associated priority rankings (Anchor QEA and HDR Engineering 2011). These instream flow recommendations were used to establish priorities and evaluate the effectiveness of the Integrated Plan in achieving instream flow needs. Within the effects analysis, instream flows expected under the Proposed Action will be discussed in the context of these flow recommendations.

Temperature is another important physical factor influencing rearing conditions. Yakima River temperatures are influenced by solar radiation, elevation, air temperature, flow volumes, tributary and irrigation return flow volumes and temperatures, riparian and topographic shading, surface and groundwater interactions, reservoir operations, and other factors (Bartholow 1989; Lilga 1998). Summer temperatures of the lower Yakima River can exceed levels suitable for juvenile steelhead and other salmonids (Vaccaro 1986; Rinella et al. 1992). Water temperature is likely the controlling factor in availability of salmonid rearing habitat downstream from Sunnyside in the summer. The temperature gage near Sunnyside is located directly below the diversion dam and as such only represents the temperature at the top of the reach. The temperature increases as you go down the river, partly due to low flows and returning irrigation water, but mostly due to thermal warming from ambient air temperature. Water temperature is also likely the controlling factor in availability of rearing habitat during the summer in the reaches above and below Prosser Dam (see Section 4.2.3 for additional detail). In most years, the water temperatures get too

warm below Prosser Diversion Dam to allow rearing in this reach of the river during the summer months. There are cool water refuges from groundwater inflow in this reach, which may allow some rearing to be supported in this area.

The USGS, in cooperation with the Yakama Nation, developed a water temperature model to estimate the effects of regulated flows from headwater reservoirs, flow diversions, irrigation return flows, and meteorological parameters (air temperature and wind speed) on Yakima River temperatures, and to examine the effects of alternative water management scenarios (Vaccaro 1986). That study concluded that even with radical changes in Project operations, lower river water temperatures in July, August, and September might only be lowered slightly.

The relationship between steelhead rearing, habitat quality and quantity, and steelhead productivity is complicated by complex and poorly understood factors that influence the ratio between resident and anadromous *O. mykiss* where both life-history forms co-occur. Additionally, factors influencing life history trajectories of individual fish have not been established. These dynamics are of particular importance in the upper Yakima basin, which supports relatively abundant resident rainbow trout, but where steelhead trout production is still well under abundance criteria identified in the MCR Steelhead Recovery Plan (NOAA Fisheries 2009). Life history is genetically influenced to some degree (Thrower et al. 2004; Hayes et al. 2012). Environmental factors are known to be significant factors. Yakima basin *O. mykiss* life-cycle modeling conducted in the last 6 years indicates that smolt production is particularly sensitive to survival rates associated with smolt outmigration, ocean residence, and returning adult migration (Courter et al. 2013, p.12). Survival associated with these life-stages can be influenced by both natural factors (such as increased mortality associated with long migratory distances or poor ocean feeding) and human related factors (such as increased smolt mortality at irrigation diversions or increased predation due to flow conditions). While the cost of migration and ocean residence can be strong determinants in the proportion of an *O. mykiss* population expressing anadromy, freshwater rearing conditions are also key factors. Freshwater rearing that provides for year-round suitable adult rearing habitat can increase the resident proportion of the population (Courter et al. 2009). Additionally, when steelhead production rates increase, smolt production can become limited by freshwater carrying capacity (Courter et al. 2013, p.12). While Yakima-specific life-cycle modeling investigating the relationship between freshwater rearing conditions and individual life history trajectory is lacking, life-cycle modeling and associated field observation for *O. mykiss* in coastal and central California streams indicate that body length and growth early in life affect whether an individual fish will adopt a resident or anadromous life history strategy (Courter et al. 2013, p. 17). Body length and growth are influenced by both genetic and environmental factors.

Direct and Indirect Effects

Summer Rearing

Summer rearing flows are significantly higher than under an unregulated flow regime. In mainstem reaches of the upper Yakima River, effects begin immediately as steelhead fry emerge from their gravels from mid-June through the end of July. Under unregulated conditions, natural flows would be dropping during this time period. Under current conditions, steelhead fry are exposed to sustained high flows associated with irrigation water deliveries which are hypothesized to reduce growth and potentially survival (YBFWRB 2009, p. 96). Yakima basin *O. mykiss* growth rates were slower than trout in other regional rivers. These slow growth rates may be attributed to a more energetically demanding flow regime and colder summer temperatures, associated with releasing water from the storage reservoir's hypolimnion. While early summer flow conditions are believed to negatively affect emerging fry, summer flow conditions, particularly in the late summer when flows would recede and warm under unregulated conditions, may be beneficial for continued residence by *O. mykiss*. The maintained summer flows and cool water temperatures associated with the upper Yakima flow regime is believed to be favorable for resident rainbow trout and be a significant factor in observed patterns of life history type distribution in the Yakima basin (Courter et al. 2009, p. 28).

The high September water deliveries originating from Rimrock at part of the flip-flop causes a rapid increase in flow in the Tieton and lower Naches Rivers during a time of year when natural flow fluctuations would be uncommon. This flow increase is likely sufficient to displace and may even injure or kill juvenile steelhead, which are not large enough to maintain position in high river flow (YBFWRP 2009, p. 113). Although flip-flop flows in the lower Naches may open access to side- and off-channel areas that could be used by juvenile steelhead, the rapid increase and decrease in flow can cause displacement and stranding.

Flows anticipated as part of the Proposed Action are not expected to significantly differ from baseline conditions, with the limited exception of very high flows that historically were occasionally released out of Keechelus in the summer but are not included as part of proposed operations (Section 4.2.2, "Summer and Fall Flows"). High summer flows can potentially result in the direct mortality of steelhead fry emerging from redds located in mainstem areas and, by increasing energetic demands, can reduce growth and potentially indirectly reduce survival. There are no direct investigations of the effect of high irrigation flows on emerging *O. mykiss*, let alone attempts to quantify the impact or determine a flow to survival relationship. Potential for flow-related harm for emerging fry is expected in the mainstem of the upper Yakima River. Injury or harm to fry in the Tieton River from high summer flows after the flip-flop operation is also possible. It is anticipated that while fish may be displaced downstream, direct effects may be relatively less than effects to young-of-

the-year steelhead from high flows in the upper Yakima River. Tieton River flow increases occur later in the summer, when young-of-the-year steelhead have had an opportunity to grow and develop stronger swimming abilities.

The relatively rapid flow changes associated with the flip-flop operation causes dewatering, particularly of side channels, stranding fish and benthic invertebrates. In 1996, an investigation of side channel habitat in the Cle Elum and upper Yakima Rivers determined that 3 of the 21 side channels had completely dewatered, and an additional 1 was disconnected (Pearsons et al. 1996). Dewatering can directly result in juvenile mortality, and side channel disconnection can make juveniles more vulnerable to predation and elevated temperature. It is anticipated that a more gradual implementation of flip-flop (Appendix K) and side channel work that has already occurred along the Cle Elum River will reduce potential effects from flip-flop, relative to conditions experienced as part of the baseline.

Winter Rearing

There are no direct studies about winter rearing conditions in the Yakima River. Based on available information about winter rearing needs and studies from other basins, it is reasonable to expect that winter flow regulation may negatively impact rearing steelhead if flows are not sufficient to provide these fish with adequate habitat. As temperatures decline, a fish's ability to swim, feed, avoid predators, and defend their locations declines with a slowing of metabolism (Brown et al. 2011, p.8). In fall or early winter, the emphasis in fish behavior switches from defending feeding positions to searching for suitable winter habitat (Cunjak and Power 1986; Cunjak 1996; Lindstrom and Hubert 2004a, as cited by Brown et al. 2011). For salmonids, a diversity of habitat types, including deep pools with lower water velocities, coarse rock substrate, and abundant cover, side channels and backwaters, and groundwater inflow to help moderate temperatures provides good quality habitat (Brown et al. 2011, p. 8).

The ability of a winter rearing fish to occupy good quality habitat throughout the winter affects survival. At low temperatures (1°C [34 ^{o}F]), most freshwater fish have little ability to respond to changes in their environment (Brown et al. 2011, p. 12). Swimming to a winter refuge when a fish's current habitat becomes unsuitable comes at a high energetic cost during a time of year when food resources are scarce. Simkines et al. (2003a, 2003b, 2003c, 2004a, as cited in Brown et al. 2011) found that forced winter swimming increase lipid depletion, resulting in size-selective mortality (Brown et al. 2011). Therefore, the ability to access to good quality habitat in the fall and maintain that position throughout the winter may be critical for survival.

A field study in another regulated river, Henry's Fork of the Snake River, indicates that reduced winter flows can reduce juvenile salmonid abundance. Mitro et al. (2003) found that higher streamflow during the second half of the winter resulted in more rainbow trout occupying the river in the spring. The effect of winter streamflow was more important than

autumn abundance in predicting spring abundance. The authors concluded that higher discharge in the second half of winter may have provided more bank habitat at a critical time for survival.

In addition to this information about the importance of high quality winter habitat and related factors influencing survival, available information from the Yakima basin indicates that winter subyearling habitat may be relatively limited. Physical habitat modeling by species lifestage indicates that the least amount of habitat is available for winter subyearlings relative to other lifestages in the Easton, Kittitas, and Naches reaches, particularly at the low-end of the flow curve (Bovee et al. 2008, p. 140, 145, 150).

While winter reservoir operations may adversely affect rearing steelhead, Reclamation has proposed winter minimum flows intended to minimize harm. These winter minimum flows were informed by previous instream flow recommendations (Table 5-7). Of particular note are the Integrated Plan flow recommendations, which were informed by on-the-ground knowledge about side channel activation. The one exception is the minimum flows identified at Cle Elum. Recent instream restoration enables an extensive side-channel complex to be activated at much lower flows, about 220 cfs. Additionally, Tieton River flow recommendations are not tied to side channel activation flows as much as a general increase in habitat area as flows increase. While Reclamation is not able to provide these flows in all years and provide irrigation water as proposed, and required by our contracts, Reclamation has specified minimum instream flows that are rooted in biological principles.

Modeling indicates that anticipated flows capable of activating key side channels will be provided in 55 percent of the years examined for the Easton reach and Cle Elum River. The Keechelus reach, which currently has the lowest level in presumed steelhead rearing is expected to have minimum flows sufficient to active side-channel habitat in approximately 21 percent of the years studied. While the flows identified for the Tieton River do not meet current winter minimum flow recommendations, they are still significantly higher than winter flows provided under baseline conditions, or if current operations were to be carried forward into the future (Figures 4-18, 4-19, 4-22, 4-23).

Table 5-7. Summary of past winter minimum flow recommendations and Proposed Action flows.

Reach	Proposed - Low	Proposed - Average	Proposed - High	Range of Yakima Basin Flow Recommendations	IP Flow Recommendation
KEE	80	100	120	100-175	120
EASW	190	250	300	250 - 375	250
CLE	180	220	250	150 - 425	500
TICW	75	100	120	125 - 275	125

Critical Habitat Effects

Reclamation concludes the Proposed Action is likely to adversely affect the Rearing PCE, though improvement in winter flows are expected to improve rearing conditions relative to baseline condition. The primary effect mechanism is through flow regulation, and the effect on habitat rearing quality described in the direct and indirect effects section. The effect of project operations on geomorphically active flows is unclear at this time (see Section 4.4.1 for additional detail). Geomorphic analysis, based on comparing modeled output from the Status Quo and Proposed Action alternatives, indicates that flow changes that have evolved over time may have inadvertently resulted in fewer days with geomorphically active flows when compared to historic conditions. In 2002, Stanford et al. concluded that the current flood flows are needed to maintain the existing shifting habitat mosaic (p.3).

Juvenile Migration

Direct and Indirect Effects

Project operations could continue to affect smolt mortality through alteration of streamflow quantity and timing. While stream temperatures may also affect smolt survival, this effect is largely unaffected by project operations. While diversion structures have fish screens, harm to outmigrating smolts can still potentially occur at these sites. In addition to potential physical injury from interactions at the screens and bypasses, diversion structures and changes in streamflow could affect predator distributions, which could in turn affect smolt predation rates. These factors are discussed below.

Streamflow Quantity and Timing

Streamflow quantity and timing aids outmigration as was discussed by the ISG (1996, p 220-221); it was suggested that yearling spring Chinook emigration from the Yakima River was likely to be associated with rising flows. For this analysis, it is assumed that steelhead outmigration follows the same general cues and patterns as spring Chinook outmigration.

The Yakima Basin Steelhead Recovery Plan identified that low spring flows could affect juvenile outmigration by increasing travel times and exposing smolts to increased predation (YBFWRB 2009, p. 95). Streamflow is affected both by storage dam operations and diversions. On average, the system does not go onto storage control until June or July; this means that agricultural diversions during the main downstream migration period are met through natural streamflows below the reservoirs, not storage.

One location in Yakima basin where the relationship between instream flow and juvenile survival has been intensively studied utilizing actively tagged fish is in the 11.6-mile reach downstream from Roza Dam. The relationship between instream flows and spring Chinook smolt survival was studied between 2012 and 2014. While final results from this investigation are not currently available, preliminary data indicates that there is a significant

flow to survival relationship, and that a substantial component of this relationship is mortality that occurs at Roza Dam, rather than in the Roza reach. When the effect of downstream flow condition in the Roza reach was examined (excluding the effect of the dam), smolt survival was estimated to be 94 percent when Roza reach flows were 860 cfs and subsequent increases in survival were not observed when reach flows were increased through about 1,900 cfs. However, survival estimates for juvenile Chinook salmon increased to 98 percent and 100 percent when reach flows were tested at 2,081 cfs, and 2,275 cfs, respectively (Kock et al. 2014).

When combining effects of dam passage and downstream migration conditions, flows below approximately 1,900 to 2,000 cfs appear to reduce smolt survival. When survival at Roza Dam was partitioned, survival was estimated to range 67 percent at 697 cfs to 100 percent at 2,081 cfs. It appears that the amount of water passing through different passage route options at the dam, and associated differential survival associated with each passage route, is responsible for this flow to survival relationship at Roza Dam (Kock et al. 2014).

Under baseline conditions, the power subordination flow was 400 cfs. At this flow, the smolt survival estimates incorporating both reach and dam mortality was less than 60 percent. Under the Proposed Action, 1,300 cfs is proposed as the power subordination flow. At 1,300 cfs, estimated survival improves to 80 percent. Flows at Roza Dam are influenced by natural flow availability, storage operations, and diversions. During the primary outmigration period, April and May, flows below Roza Dam are expected to exceed 1,300 cfs 82 percent of the time over the 29-year period studied (Figure 4-35). Under baseline conditions, flows only exceeded 1300 cfs over Roza Dam about 42 percent of the time.

While the primary objective of the Roza reach study was to develop a flow to survival relationship in the Roza reach, smolt survival information was also collected in downstream reaches. Data collected indicates survival estimates in the Roza reach did not appear to be much different from survival experienced in other parts of the basin when standardized for migration distance (Courter et al. 2013, Table 6). A formal analysis of survival data collected between the Naches River confluence and the mouth of the Yakima River is in development.

The most commonly stated hypothesis for a relationship between flow and survival in the Roza reach is that the risk of predation is higher at lower flows, due to shallow water depths, exposing rocks for avian predators to perch on, combined with increased travel times for outmigrating fish. It is possible that the factors mediating a flow to survival relationship at the low end of the flow range, which was observed in the Roza reach, are also factors in other parts of the basin. However, these mechanisms would be expected to differ downstream of the Naches River confluence due to differences in stream temperature conditions, fish species assemblages, and a variety of other abiotic and biotic factors. The range of flows governing smolt survival below the Naches River confluence would be different due to larger channel size, irrigation diversions, and accretion from tributaries and irrigation return flows. Data

from PIT–tagged fish detected at Prosser Dam and McNary Dam between 1998 and 2004 was analyzed to examine the flow to survival relationship in the lower Yakima River. This analysis indicated that increased flow generally resulted in increased survival, but that the effect differed between species studied (Pyper and Smith 2005, p. 73). The greatest effect was detected in fall Chinook, an intermediate effect was detected in coho, and the least effect was detected in spring Chinook (and presumably steelhead). Even for spring Chinook, with the exception of 1999, survival rates tended to increase and flows increased and travel times decreased (Pyper and Smith 2005, p. 22).

There was considerable unexplained variation in observed survival, indicating that key variables affecting smolt survival were not examined (Pyper and Smith 2005, p. 73). The variables that were analyzed were flow, temperature, Julian day, and travel. Additionally, significant differences in survival were observed between years studied. The researchers hypothesized that year-to-year differences in the abundance and distribution of predators might be an important factor in survival, a factor not included in the analysis.

As described in Section 4.2.3, the lowest flows experienced during the outmigration period are determined by winter minimum flows. Thus, winter minimum flow improvements included in the Proposed Action are also expected to improve smolts survival by increasing the minimum flow experienced during the outmigration period. Except for the highest flows, those exceeded about 25 percent of the time, Proposed Action flows are higher than both the Status Quo and Historic flows. This result is reflective of the dedicated water provided for outmigration flows. Smolt survival is also anticipated to be increased by the application of these flows during the outmigration period. While the application of the freshet guidance was not included in the RiverWare model, this operational protocol helps improve outmigration conditions by ensuring that freshets, which are associated with stimulating outmigration, are allowed to pass through the watershed. Smolts benefit from increased survival associated with both increased flow and increased turbidity, which helps guard against predation.

While much of the Naches basin is minimally affected by storage regulation, the Tieton River is a key exception. Dedicated outmigration releases out of Rimrock Reservoir will help restore this flow component to a tributary which is characterized by relatively little unregulated inputs.

The lower Yakima reach is an important migration corridor. Outmigrating smolts from the four spawning populations must all travel through the reach downstream from Prosser Diversion Dam. Power subordination at Chandler Powerplant helps provide for flows during a critical time period. The Chandler Smolt survival study will also help identify key steps that can be taken to improve smolt survival in this area.

Flow and outmigration conditions in the lower Yakima are not expected to affect the basin's four steelhead populations equally. Naches and upper Yakima steelhead smolts are affected to a much greater degree than smolts from Satus Creek, as Naches system smolts must negotiate up to four dams and all 57 miles of the Sunnyside to Prosser reach. Satus smolts have only one dam and the lower 12.5 miles of the reach, which benefits from discharge from Toppenish and Satus Creeks and from several irrigation return drains (Haring 2001).

Stream Temperature

As discussed, water temperature cannot be easily altered by changes in Project operation; temperature is, however, an important determinant of smolt survival during migration. Relatively high river temperatures of 16 ^{o}C (60 °F) or more can be stressful for steelhead smolt migrants (Barnhart 1986). Temperatures above 11 ^{o}C (70 °F) can cause extreme stress or mortality. On average, 90 percent of Yakima steelhead smolts migrate past Prosser Dam by May 20 when mean daily water temperatures do not exceed 15 ^{o}C (59 °F). In the warmest years, however, mean daily temperatures above 15 ^{o}C (59 °F) can occur by about May 10. Given a smolt migration that is early to average in timing, approximately 12 to 30 percent of the seasonal movement at Prosser would take place at or above optimal temperatures (Reclamation 2000). Steelhead smolt migrants from the Naches River have been considered to be especially disadvantaged because they migrate later than smolts from lower river areas, such as Satus and Toppenish Creeks (Fast et al. 1986).

Diversion Structures

An additional concern relating to steelhead smolt migration is possible mortality associated with entrainment at diversions. All major diversions on the Yakima and Naches mainstems have modern, operational, fish screen structures. Concerns have been raised about downstream migrant mortality in the Chandler Canal and in the Chandler Juvenile Facility. Data provided by the NOAA Fisheries PIT-tag study of spring Chinook smolts in 1992 indicated that in the latter half of May, at relatively high river temperatures (16 to 22 °C [61 to 72 ^{o}F]), smolt mortality in the upper canal (between the head gates and the fish diversion screens) could be in the order of 40 percent (Sanford and Ruehle 1996, Table 12). Since steelhead tend to migrate later in the spring than spring Chinook, the proportion of the run affected by these late spring conditions could be higher. However, since there is no detailed investigation which quantifies this mortality and can be used to inform diversion operations at this site, the Proposed Action includes the Chandler fish bypass steelhead smolt survival study as a conservation measure (Section 3.3.2).

Direct evaluations of mortality and injury associated with the Phase 1 and Phase 2 fish screen facilities were conducted between 1985 and 1994. Eleven Phase 1 fish screen facilities were included in these investigations: Sunnyside, Richland, Toppenish/Satus, Wapato, Columbia, Toppenish Creek, Chandler, Westside Ditch, Roza, Easton, and Town Canal. The primary conclusion of this investigation was that as long as facilities were operated as designed,

maintained a sweep-to-approach ratio was 2:1, and approach velocities were less than or equal to 5 cfs, these facilities were protective of juvenile salmonids (Chamness 2007). While researchers reported that the fish screens caused injury or death to less than 2 percent of juveniles studied, caution is required when examining the measures of injury and death associated with this investigation. Survival and mortality estimates were only generated for fish that were recaptured and examined, and 24-hour monitoring did not occur as part of the study design (Fast 2013).

More recently, paired releases of fish released just inside headgates and just below the outfall mixing zones have been used to generate screen site and bypass survival estimates. This study released PIT-tagged Chinook and coho salmon smolts at Roza, Sunnyside, and Prosser during the outmigration season from 2003 to 2011. Survival estimates varied based on the methodology used for the data analysis, month examined (April and May), and smolt age. The range of survival estimates ranged from 64 to 82.8 percent at Prosser, 78 to 97.2 percent at Sunnyside, and 80 to 84.1 percent at Roza (Watson 2011). Survival estimates for individual releases did exceed 100 percent at times, at all of these facilities. The researcher attributed this finding to both relatively low sample sizes, and that at sufficient flows, survival through the fish bypass may not be distinguishable from survival of fish travelling over the dam (Watson 2011).

In order to gage the importance of bypass mortality at the three dams included in this study, plus Wapato Dam (Sunnyside data was used as a surrogate), two EDT scenarios were run: 1) revised mortality doubled, 2) revised mortality at all four dams bypass set to zero. When all bypass mortality at all dams assumed to be zero, abundance of summer and spring Chinook increased by 164 and 39 percent, respectively. A similar EDT exercise conducted for steelhead salmon showed similar increases in steelhead equilibrium abundances for Naches and upper Yakima steelhead (Frederiksen 2005).

Summary

While impacts to outmigrating smolts are expected due to water storage and diversion during the outmigration period, Reclamation has worked to minimize harm by providing dedicated outmigration flows and increasing the power subordination flow at Roza Dam to 1300 cfs (Sections 3.1.4 and 3.1.5). These operational revisions for outmigration benefit are proposed in addition to improvements already achieved under the baseline conditions from fish screen upgrades that occurred under YRBWEP authority, implementation of freshet guidelines so that natural flow events can pass through the system without Reclamation increasing its diversions, and improvements to the Roza roller gate. Increases in winter minimum flows will also benefit outmigrating smolts, as these minimum flows are still in effect during the outmigration period. Flow analysis for the April and May period indicates that except for the highest flows that occur during this 2-month period, those exceeded about 25 percent of the time. Proposed Action flows are higher than those experienced historically (Figures 4-4, 4-14, 4-21, 4-31, 4-35). The flow to survival relationship observed in the Roza reach study

indicates that flow increases in the lower range of flows tested resulted in higher survival benefits than flow increases in the higher range. Therefore, while the Proposed Action is expected to adversely affect steelhead, Reclamation anticipates significant improvements to smolt survival rates relative to baseline conditions.

Critical Habitat Effects

Reclamation concludes that the Proposed Action may adversely affect the juvenile migration PCE, but that conditions will be improved relative to baseline conditions. As described in the baseline section, factors influencing juvenile outmigration are Not Fully Functioning under baseline conditions. The effect of the Proposed Action on flow and diversion structures is discussed as a direct effect to steelhead. Project flow operations and the presences of diversion structures will continue to affect the juvenile migration PCE, though continued improvements over baseline function are expected due to the dedicated outmigration flows, revised power subordination target at Roza Dam, and Roza screen upgrades described in the Proposed Action.

Adult Migration

Direct and Indirect Effects

Active and successful migration of adult steelhead requires adequate streamflows for transportation and protection, a proper range of water temperatures, and sufficient holding habitat for protection while returning fish mature for spawning. The reported minimum depth for successful passage is about 7 inches (Thompson 1979, as cited in Reisner and Bjornn 1979). The optimal temperature range during migration for adult steelhead is 8 to 11 ^{o}C (46 to 52°F) (Bovee 1987; Reisner and Bjornn 1979; Bell 1986, all as cited in McEwan and Jackson 1996). The range of acceptable temperatures for adult salmon migration is 8 to 13 ^{o}C (46 to 55°F) and migration probably becomes stressful at temperatures above 16 ^{o}C (60°F) (ISG 1996, p. 171).

Passage conditions are affected by the hydrologic conditions at the time steelhead are migrating. Based on counts at Prosser Dam, most adult steelhead enter the Yakima River during September to April, with peak movement occurring in the fall from mid-September to November (Figure 5-1). Little upstream migration occurs in the lower Yakima River from May through August. Therefore, the majority of steelhead move upstream outside the period when individual ladders are closed during the low flow irrigation period. For the minor proportion of the steelhead population which migrates upstream during this low flow summer period, implementation of the Title XII flows and additional water provided through water conservation provide sufficient flow for proper operation of at least one ladder per diversion dam (see Section 4.2.2, “Summer Flows”). Due to operational constraints, the flows may temporarily fall below the Title XII instream flow levels. However, the impacts to passage conditions associated with these fluctuations are expected to affect passage for a relatively short duration, on the order of hours rather than days.

Under the YRWEP program, Reclamation installed fish passage structures that met NOAA Fisheries' criteria at the time of construction in order to address barriers created by diversion dams (Table 5-8). While the Wapatox ladder does not meet NOAA Fisheries' criteria, is has been updated and subsequently maintained to meet its original design criteria, and no passage delays or other issues have been observed following the 2007 repair. Even when designed to NOAA Fisheries' passage criteria, it is recognized that upstream migration delays or stress can still occur under some circumstances. One stated goal of the Hockersmith et al. (1995) study was to evaluate fish passage conditions. More recent radio-telemetry and PIT-tag investigations have not been designed to test for successful passage, but do provide additional observations at these facilities.

Hockersmith et al. (1995) observed delays at each of the five fish ladders they studied. It is difficult to draw conclusions about the exact role the diversion dam and ladder facilities played in this delay, as behavioral factors associated with decreasing temperatures and normal overwintering holding behavior was reflected in the passage timing observations. Some of the time a steelhead spent downstream from a particular dam can be attributed to cold temperatures, rather than passage difficulties. Radio-tagged steelhead moved most quickly over Sunnyside Dam, where approximately 70 percent of the fish passed the dam in less than one day and the median passage time was 0.4 days. Passage took the longest and Prosser and Wapato Dams, where only about 37 and 43 percent of fish passed the dams in less than a day, and median times were 5.9 and 6.9 days, respectively.

At Wapatox and Roza Dams, few fish passed the dam within 1 day (0 and 33 percent, respectively), but a large proportion passed within 2 days and the median passage time was less than 2 days at each of these locations (Hockersmith et al. 1995). Observations from the Hockersmith study indicated that all steelhead ascending the left bank ladder moved upstream of the dam. More recent PIT tag data from 2012 and 2013 indicate that 91 to 92 percent of steelhead that are detected at the left bank ladder pass upstream of the dam (Frederiksen 2015). A portion of the steelhead that did not pass upstream of the ladder are out-of basin hatchery strays or from populations other than the upper Yakima. Consequently, there is uncertainty about whether these fish that did not move upstream of Roza Dam were unable to pass or unwilling (Frederiksen 2015). Hockersmith's research indicated that 2 of the 3 steelhead that enter the Roza Dam right bank ladder (requiring the fish to then traverse a galley at the base of the dam to then reach the left bank ladder) ended up moving downstream at the left bank ladder and did not pass upstream of Roza Dam (Hockersmith et al. 1995).

There is not much documented use of the Easton Ladder by steelhead. No steelhead were documented entering the Easton ladder in the Hockersmith study (Hockersmith et al. 1995). From fall 2002 to spring 2006, two female steelhead were detected at the base of Easton Dam, but no fish were detected upstream of the dam (Reclamation 2009). During the last 3 years, one radio-tagged fish entered the Easton ladder on six different occasions, before ultimately spawning approximately 400 meters below the dam (Mays 2015).

Routine visits to check facilities for debris clogging help minimize the amount of time that a ladder may not provide adequate passage. Additionally, short-term closures at some ladder facilities during flood flows help prevent sediment deposition that can result in longer term passage problems. Overall, while the fish passage program provides for passage at diversion dams and Reclamation works to operate and maintain ladders to design criteria, there is still potential for steelhead delay which could be sufficient to cause harm to individual steelhead.

Historically, false attraction flows, particularly at Spring, Snipes, and Sulphur Creeks were a concern as they could poise either a delay, or attract steelhead spawning in areas that did not support successful incubation. As reflected in the baseline, Reclamation, SVID, and RID have taken steps to reduce the harm caused by false attraction flows through the installation of the Sulphur Creek wasteway barrier, and through water conservation projects that reduce operational spill and return flows.

High summer temperatures at the mouth of the Yakima cause steelhead to delay entry into the Yakima River or overshoot the Yakima and continue up the Columbia River. These high temperatures are not believed to be directly lethal, but may delay and exhaust adult salmonids and increase the possibility of pre-spawn mortality (Haring 2001, p. 101). Whether, and under what circumstances, changes in Project operations could reduce temperatures in the lower river in September and early October is a complex question. Air temperatures, riparian cover, basin-wide floodplain function, groundwater and return flow contributions, sediment load, and precipitation are all important factors. Vaccarro (1986) found in his modeling study that even radical changes in Project operations would result in only slight changes in temperatures in September at Prosser. Ring and Waston (1999) theorized that hydrologic regulation, particularly of spring freshets, has dramatically decreased the frequency with which the alluvial floodplain aquifer is recharged, reducing the amount of shallow aquifer water that would help provide for cool water temperatures and thermal refugia (p. 2). The degree to which shallow groundwater movement associated with canal seepage and irrigation application can replicate this shallow aquifer recharge process is unclear, though it does appear to occur to some extent.

Adult steelhead tend to move from winter holding areas to spawning areas from January through May (Hockersmith et. al. 1995). Physical barriers on tributaries, rather than flow conditions, are most likely to affect adult passage. While the north branch KRD canal creates passage barriers along tributaries to the upper Yakima River, particularly within the Reecer/Caribou, and Naneum MSAs, these barriers are located upstream of non-Project barriers and are; therefore, not affecting steelhead passage at these locations. Under the Proposed Action, project water is delivered to Tanum and Cowiche water users, eliminating their need to divert tributary water, and enabling the removal of physical passage barriers. The delivery of project water to these users improves steelhead passage into these tributaries.

Critical Habitat Effects

Reclamation concludes the Proposed Action is not likely to adversely affect the adult migration component of the freshwater migration PCE. Streamflow, water temperature, and barrier factors affecting adult migration are not expected to significantly change as a result of the Proposed Action. Woody debris recruitment will continue to be affected by the presence of storage and diversion dams and hydrological alteration affecting riparian development. However, the scale of fish passage effects tied to wood recruitment is expected to be modest in relation to the scale of change already experienced under the baseline from other, non-Project factors influencing wood recruitment (such as forestry practices and levee development) and large wood's relative impact on adult migration.

Table 5-8. Adult fish passage conditions in mainstem reaches of the Yakima basin.

Reach	Potential Project-Related Barriers	RM	Criteria for effective adult passage	Comments
Lower Yakima				
Yakima River to Marion Drain		0-82.6	Adequate passage = 400 cfs Minimum depth = 7 inches Optimal Temp = 46-52 °F	Low flow at times but improved by conservation water, too high temperatures until early to mid-October
	Wanawish Diversion Dam	18	Designed and operated to NOAA Fisheries passage criteria	No identified passage problems
	Prosser Diversion Dam	47	Designed and operated to NOAA Fisheries passage criteria	No identified passage problems
Marion Drain to Ahtanum Creek		83-107	Adequate passage = 300-400 cfs Minimum depth = 7 inches Optimal Temp = 46-52 °F	Low flow at times but improved by conservation water, too high temperatures until early to mid-October
	Sunnyside Diversion Dam	104	Designed and operated to NOAA Fisheries passage criteria	No identified passage problems
	Wapato Diversion Dam	106	Designed and operated to NOAA Fisheries passage criteria	No identified passage problems
Ahtanum Creek to Naches River	None identified	107-116	Minimum depth = 7 inches Optimal Temp = 46-52 °F	No identified passage problems
Upper Yakima				
Wenas Creek to Wilson Creek		122-147	Adequate passage = 400 cfs Minimum depth = 7 inches Optimal Temp = 46-52 °F	See text
	Roza Diversion Dam	128	Designed and operated to NOAA Fisheries passage criteria	No identified passage problems. Recent radio-telemetry information indicates that a small proportion of population (3-8%) entered but did not ascend the ladder).
Wilson Creek to Taneum Creek		147-166	Minimum depth = 7 inches Optimal Temp = 46-52 °F	No identified passage problems

Reach	Potential Project-Related Barriers	RM	Criteria for effective adult passage	Comments
	Ellensburg Town Dam		Designed and operated to NOAA Fisheries passage criteria	No identified passage problems
Taneum Creek to Easton Dam		166-203	Adequate passage = 100 cfs Minimum depth = 7 inches Optimal Temp = 46-52 °F	No identified passage problems
	Easton Diversion Dam	203	Designed and operated to NOAA Fisheries passage criteria	No identified passage problems
Easton Dam to Keechelus Dam		215	Minimum depth = 7 inches Optimal Temp = 46-52 °F	The number of steelhead documented in the vicinity of Easton dam are limited, but of these fish, no successful passage observed.
Naches				
Naches River mouth to Cowiche Creek		0-2.7	Minimum depth = 7 inches Optimal Temp = 46-52 °F	No identified passage problems
Naches River from Cowiche Creek to and including Tieton River		2.7-17.5	Adequate passage = 125 cfs (Naches River) Minimum depth = 7 inches Optimal Temp = 46-52 °F	Wapatox acquisition addressed historic flow-related passage problems
	Wapatox Diversion Dam	17.1	Was not designed to meet NOAA Fisheries passage criteria	
	Yakima - Tieton Diversion Dam	14.2	Designed and operated to NOAA Fisheries passage criteria	Did not meet NOAA Fisheries passage criteria until 2010
Naches River from Tieton River to Nile River			Minimum depth = 7 inches Optimal Temp = 46-52 °F	No identified passage problems
			Minimum depth = 7 inches Optimal Temp = 46-52 °F	No identified passage problems

5.4.4 Maintenance

A summary of maintenance habitat effect determination calls for activities described in Section 3.2 are provided in Table 5-9. A more detailed explanation is in the following paragraphs.

Table 5-9. Summary of maintenance effects.

Activity	Effect Determination
General Activities	
Activity 1a – Site access	NLAA
Activity 1b – Worksite isolation	LAA
Activity 1c – Fish salvage	LAA
Activity 2a – Herbicide application	LAA
Storage Dam	
Activity 3a – Inspections	NLAA
Activity 3b – Debris and vegetation clearing	NLAA
Activity 3c – Repairs to existing rock armoring	
Upstream of dams	NE
Downstream of dams	NLAA
Activity 3d - Concrete repair	NLAA
Gaging Station	
Activity 4a –Routine inlet clearing	NLAA
Activity 4b i –Gaging house repair - minimal inwater work	NLAA
Activity 4b ii – Gaging house repair - inwater work / worksite isolation	LAA
Activity 4c – Staff gage replacement	LAA
Irrigation Division	
Activity 5a - Inspections	NLAA
Activity 5b - Diversion debris removal	LAA
Activity 5c - Canal maintenance	NE
Activity 5d -Drain maintenance	NLAA
Fish Passage Program	
Activity 6a - Inspections	NLAA
Activity 6b - Operations	See Section 5.4.3
Activity 6c – Gravel and debris removal	LAA
Activity 6d - Routine repairs and maintenance	LAA

General Activities

Activity 1a – Site Access

When heavy machinery is used in the riparian area to maintain site access, a temporary increase in sediment mobilization is possible. BMPs to address any erosion or sediment concerns will be implemented. Increases in sediment mobilization are expected to be low intensity (barely detected above baseline conditions), short-term, and localized.

Clearing and grading in the riparian zone can also have an adverse effect on fish species by reducing shade, cover, and allochthonous inputs such as leaf litter and LWD. This impact expected to be insignificant, since site access is intended to maintain existing paths or temporary access to existing infrastructure.

Therefore, Reclamation concludes that site access activities may affect, but are not likely to adversely affect, steelhead and steelhead critical habitat.

Activity 1b– Worksite Isolation

While WDFW in-water work windows will be used to avoid conducting worksite isolation when salmonids are present, steelhead (adult, juvenile, or incubating eggs) could potentially occur at site where more extensive repairs requiring excavation would be required. The worksite will be isolated and fish exclusion techniques used unless a variance is requested and granted by the Services. Fish salvage efforts associated with worksite exclusion efforts therefore have the potential to directly affect any present steelhead individuals.

The placement of the cofferdam will cause some temporary disturbance in the immediate area which will cause juvenile fish to move away from the project site. Cofferdam installation and removal may cause some increased levels of turbidity and physical disturbance of the river bed which may harm juvenile steelhead. Although unlikely, placement of rock material in the river during cofferdam construction could also result in the inadvertent crushing of a juvenile fish holding or rearing in the area. Downstream effects caused by construction related turbidity from cofferdam installation will be localized. It is expected that fine sediments in the water column will settle out to the streambed in a distance less than 300 feet downstream of the project area.

Installation and removal of the cofferdam around the work area may affect juvenile steelhead due to the size of the cofferdam footprint, fine sediments released into the water column during cofferdam construction, and the duration of the project. The greatest disturbance will occur during the process of installing and removing the cofferdam, and removal of juvenile fish within the isolated area prior to dewatering of the work area. Reclamation concludes that worksite isolation and accompanying fish salvage activities may affect, are likely to adversely affect, steelhead.

Activity 1c – Fish Salvage

When diversions are shut down for routine maintenance or because the irrigation season is over, fish can become stranded at some locations where the water pools in depressions rather than draining directly to the river and thereby carrying the fish to the river. Sites where water can pool during the dewatering process include the Chandler, Sunnyside, Wapato, Roza, and Easton screen sites. Sites where fish can be stranded include Chandler, Sunnyside, Wapatox, and Roza. Fish are annually salvaged in the fish screen forebay at these sites. Annual *O. mykiss* records from annual dewatering operations are presented in Table 5-10.

Table 5-10. Number of *O.mykiss* salvaged as part of annual salvage operations at major diversions.

		O. mykiss		
Location	year	Juvenile	Year 1+	Adults
Chandler	2004	2		
	2005			
	2006	2		
	2007			
	2008			
	2011			
Chandler Total		4		
Roza Ladder	2002	52		1
	2003	1	7	3
	2004	3	2	
	2005		9	8
	2006	1	8	24
	2007	1	5	
	2008	3	2	2
	2009	3	2	2
	2010	1	2	
Roza Ladder Total		65	37	40
Roza Screens	2002	92		
	2003	4		2
	2004	76	1	1
	2005	41	17	13
	2006	131		
	2007	90	1	1
	2008	75	6	14
	2009	290		1
	2010	32	5	6
Roza Screens Total		831	30	38
Sunnyside Screens	2002	250		
	2003	205		
	2004	20	12	6
	2005	9	0	7

		O. mykiss		
Location	year	Juvenile	Year 1+	Adults
	2006			5
	2007	87	1	6
	2008	22	11	5
	2009	21		15
	2010	40		4
	2011	20		1
Sunnyside Screens Total		674	24	49
Wapatox Screens	2006			
	2007	8	4	
	2008	8	1	10
	2009	16		3
	2010	41	5	1
	2011	39	4	2
Wapatox Screens Total		112	14	16

Fish recovery measures are implemented to reduce fish loss as a result of dewatering actions. These include relocating adult fish recovered from ladder facilities to the Yakima River. Live-boxes located on two Roza Canal drains collect fish which are then transported by aerated tank and truck to the river. USFWS (2012) and NOAA Fisheries (2000) standards for fish exclusion, capture, handling, and electroshocking are implemented to reduce fish mortality and injury. Gradual dewatering and upstream block net placement is the preferred method to prevent fish stranding during dewatering. The area will be seined before electrofishing is utilized. Electrofishing will not be employed until steelhead fish have been removed using less injurious methods. Electrofishing will not be conducted when turbidity reduces visibility to less than 0.5 meter, when water conductivity exceeds 350 µS/cm, or when water temperature is above 18°C (64°F) or below 4°C (39°F). If bull trout may be present, fish salvage will not occur when temperature is above 15°C (59°F), if possible. An onsite fish biologist will confirm success of fish capture and removal before completely dewatering the facility.

Due to the necessity of handling fish, potential stress to fish associated with capture, and the exposure of fish to electrical currents associated with electroshocking, Reclamation concludes that fish salvage activities may affect, and are likely to adversely affect steelhead.

Activity 1d – Herbicide Application

The Services suggested that Reclamation's proposed herbicide actions match proposals already consulted on programmatically by other action agencies (BPA, ACOE), and Reclamation has incorporated these protocols in our Proposed Action. The herbicide effects

analysis conducted by NOAA Fisheries in the Habitat Improvement Program III Biological Opinion issued to BPA in 2013 is incorporated by reference (NOAA Fisheries 2013).

Individual steelhead are likely to be negatively impacted by herbicide exposure. The proposed minimization measures are intended to minimize risk to steelhead. Reclamation concludes that herbicide application may affect, and is likely to adversely affect, steelhead.

Storage Dam

Activity 3a - Inspections

Annual storage dam inspections are coordinated with staff hydrologists and biologists as well as SOAC to confirm that appropriate reservoir elevations and downstream target flows can be met from fish bypass pipes or outlet conduit at Keechelus, Kachess, and Cle Elum. At Tieton Dam, penstocks are alternated so that one can be inspected while the other ensures uninterrupted releases downstream. The spillway at Bumping Dam is used to provide target flows downstream to allow inspection of the outlet works and stilling basin. Most of the spillway gate inspection and maintenance is done when no water is present, but some of the gate tests must be done when water is present. This can result in short-term flow fluctuations, but target flows are required to be met.

Annual spillway gates at Kachess, Cle Elum, and Tieton Dams are required to be load tested during maximum reservoir levels or maximum runoff (May to June). Spillway releases are dampened to reduce flow fluctuations below each reservoir by decreasing outlet releases at commensurate levels as spillway releases.

Reclamation anticipates that some minor flow fluctuations may affect, but are not likely to adversely affect MCR steelhead.

Activity 3b - Debris and Vegetation Clearing

Large wood and debris are annually removed from the upstream face of storage dams as well as intake towers and spillway channel crests at Keechelus, Cle Elum, Bumping, and Tieton Dams. Up to 20 cubic yards of woody debris is relocated downstream to predetermined downstream locations recommended by basin biologists, with suitable access and located below gaging stations. When possible, spillway flows are used to move woody debris downstream. Kachess and Clear Creek Dams do not collect enough material to meet this commitment.

Minor short term increases would occur as woody debris is placed in the stream channel. Over the long term, the salvaging and placement of large wood in stream channels will improve channel complexity and rearing habitat for MCR steelhead. This commitment will help to rectify the loss of woody debris that in the past was removed and burned.

Reclamation anticipates that potential direct and indirect impacts associated with physical injury to rearing steelhead are unlikely. Passing LWD that collects on dam faces will result in a beneficial improvement to MCR rearing habitat.

Activity 3c/3d - Repairs

Flow Adjustments. Repairs to storage dam facilities are conducted when flow criteria can be maintained. Flows are maintained by using fish bypass pipes (Keechelus, Kachess, and Cle Elum Dams), or release from the outlet conduit to the outlet channel or by using one of two penstocks while the other is repaired (Tieton Dam). No adverse impact to downstream flows would occur. Reclamation concludes this activity may affect but is not likely to adversely affect MCR steelhead.

Rock Placement. A tracked excavator is used to individually place large rocks to fill voids in bank armoring. Work is done outside of the water when possible or by the individual placement of rock when it is not possible to work in dry conditions. There is the potential for physical injury to steelhead, should they be present. This potential effect is minimized by working within WDFW approved work windows and employing worksite isolation (unless a variance is requested and approved). Due to the potential for physical injury to steelhead, Reclamation concludes this activity may adversely affect MCR steelhead.

Concrete Repair. Repairs to storage dam outlet works and spillway channels consist of using concrete to patch small areas (less than 10 percent of the spillway face), and spot repairs to the outlet conduit or outlet tunnels, seams, joints, cracks and spalling. All concrete patches are isolated from wetted areas to prevent concrete contamination and allowed to completely cure before being exposed to water. There would be minimal risk of contamination and subsequent injury to steelhead, eggs, fry, juveniles, or adults. There would be no interruption to streamflow through storage dams for work that requires dewatering outlet conduits or tunnels. Water is routed through the spillway or fish bypass pipe if present to meet target flows.

Reclamation concludes that routine storage dam repairs may affect but are not likely to adversely affect MCR steelhead.

Gaging Station

Reclamation operates and maintains about 90 HydroMet gages. Maintenance involves tasks that can be conducted without entering the stream channel, as well as larger tasks that involve working in the stream channel.

Activity 4a – Inlet Flushing

Gage station inlets are flushed with compressed air to remove sediment and debris. This is conducted usually during the spring during high flows when background turbidity is high. A subset of gage station sites requires more frequent flushing. Generally, one to two sites a week are flushed during the irrigation season. Flushing gage station inlets with compressed air will result in short-term, minor, and localized increases in turbidity. This impact is offset when done during high flows; however, stations requiring more frequent flushing will be done at lower flow levels resulting in slightly more turbidity. Given the small area of the inlet, and the short-term duration of increased turbidity, it is unlikely that long-term adverse impact would affect steelhead individuals or degrade spawning or rearing habitat. Reclamation concludes that this maintenance activity may affect but is not likely to adversely affect MCR steelhead.

Activity 4b i – Repair or replace gage station components – minor excavation

Minor excavation of gaging station intakes orifices using hand tools may temporarily displace steelhead, should they be present. This activity may also result in a short-term, minor, and localized increase in turbidity. It is unlikely that long-term adverse impact would affect steelhead individuals or degrade spawning or rearing habitat. Reclamation concludes that this maintenance activity may affect but is not likely to adversely affect MCR steelhead spawning or rearing habitat.

Activity 4b ii – Repair or replace gage station components – excavation with heavy equipment

While WDFW in-water work windows will be used to avoid conducting this activity when salmonids are present, steelhead (adult, juvenile, or incubating eggs) could potentially occur at sites where more extensive repairs requiring excavation would be required. The worksite will be isolated and fish exclusion techniques used unless a variance is requested and granted by the Services. Fish salvage efforts associated with worksite exclusion efforts therefore have the potential to directly affect any present steelhead individuals.

The placement of the cofferdam will cause some temporary disturbance in the immediate area which will cause juvenile fish to move away from the project site. Cofferdam installation and removal may cause some increased levels of turbidity and physical disturbance of the river bed which may harm juvenile steelhead. Although unlikely, placement of rock material in the river during cofferdam construction could also result in the inadvertent crushing of a juvenile fish holding or rearing in the area. Downstream effects caused by construction related turbidity from both cofferdam installation and rock placement along the left bank will be localized and in compliance with Washington State water quality standards for turbidity. In this instance, fine sediments in the water column will settle out to the streambed in a distance less than 300 feet downstream of the project area.

Installation and removal of the cofferdam around the work area may affect juvenile steelhead due to the size of the cofferdam footprint, fine sediments released into the water column during cofferdam construction, and the duration of the project. The greatest disturbance will occur during the process of installing and removing the cofferdam, and removal of juvenile fish within the isolated area prior to dewatering of the work area. Every attempt will be made to remove all fish captured from within the dewatered area by first seining and then electrofishing within the area to be dewatered. Some damage may occur to juvenile salmonids during fish removal activities.

Once the cofferdam is in place and fish removal activities have been completed, juvenile fish should not be impacted from the actual channel excavation and installation of the new staff gage other than physical displacement from the immediate area taken up by the cofferdams. Rock placement and concrete pouring along the left bank should not affect fish life or the aquatic environment since these activities will be performed in the dry and in areas isolated from fish and flowing water. Reclamation does not expect this activity to significantly impair water quality, result in permanent loss of adult or juvenile steelhead habitat, or significantly disrupt migratory behavior.

Due to the need for worksite isolation and fish salvage to conduct this activity in a manner protective of steelhead, Reclamation determines that the activity may affect and is likely to adversely affect steelhead.

Activity 4c – Staff Gage Replacement

The majority of staff gage replacements only require that a new gage be mounted to an existing pole. These activities have little potential to affect steelhead in the vicinity. Steelhead could be temporarily displaced due to increased disturbance or noise in the area. If a new mounting pole must be installed, there is greater potential to adversely affect steelhead, should they be present. The vibratory tamper is usually used for compacting gravel and backfill to increase densities, using more of a vibratory motion than an impact motion. Vibratory pile driving methods result in substantially less peak sound levels than does impact pile driving (less than 180 dB for vibratory pile driving in comparison to 190 to 210 dB for impact pile driving). The underwater noise generated by vibratory hammers is typically 10 to 20 dB lower than for impact hammers, and has a lower rise time (time for the noise wave form to rise from 10 to 90 percent of its highest peak). As a result, the pile driving energy is spread out over a longer time period, thereby minimizing the potential to harm aquatic organisms.

Most relevantly, impacts on fisheries or other aquatic organisms have not been observed with vibratory hammers. For example, vibratory installation of steel piles in a river in California resulted in sound pressure levels that were not measurable above the background noise created by the current (Reyff 2006). Carlson et al. (2001) studied acoustic data and salmonid response during construction of a new pier on the Oregon Coast, and found that the use of

vibratory hammers for pile installation are not likely to have a significant impact on migrating salmon behavior, because infrasound produced by vibratory pile driving is short in duration and because the relatively short range of the component of the total sound field to which salmon show an avoidance response.

For these reasons, installation of the pipe using this technique will not cause barotraumas or other negative physiological effects on fish in the vicinity. Additionally, any behavioral effects are expected to be insignificant, and would not rise to the level of take (NOAA Fisheries 2013).

Irrigation Division

Activity 5a - Inspections

For routine annual diversion dam inspections, inspection crews will consult and coordinate with hydrology and environmental programs staff prior to implementing required activities in order to minimize adverse impacts to storage, flood control, irrigation diversion, fishery, and natural resources. When determining the most suitable time of year for the work, the instream flow requirements are considered along with maximum flows that can safely allow the inspection activities to occur. Inspections consist of visual evaluation of the structures. Reclamation concludes that this activity may affect but is not likely to adversely affect MCR steelhead.

Activity 5b - Debris Removal

Heavy machinery must enter the stream channel to move large debris that collects on diversion dams. The work area cannot be safely and effectively isolated for this activity.

Equipment operation in the water has the potential to impact any fish that may be occupying the affected area. Adult fish could be disturbed and temporarily displaced. Juveniles could also be disturbed or displaced, or may experience direct mortality from the heavy equipment. Effects will be reduced by following WDFW in-water work windows, ensuring that only clean and well maintained equipment is used during the operation, and limiting the travel pathways to the minimum amount necessary to access the work area. Reclamation concludes that debris removal at diversion dams requiring the use of heavy machinery in-water may affect, and is likely to adversely affect, steelhead.

Activity 5c - Canal Maintenance

Routine in-canal maintenance activities are performed after the irrigation season, after the canals are dewatered, thus there is little to no risk of impacts to aquatic habitats. Access is typically through adjacent canal access roads. BMPs that limit area disturbed, revegetation, and work area isolation are anticipated to limit disturbance to surrounding aquatic areas. Canals are usually located away from the Yakima and Naches Rivers and associated

tributaries so repair activities are expected to have minor impacts to downstream water bodies. No significant increases in turbidity in areas with steelhead presence is anticipated from maintenance activity

Reclamation concludes that these activities may affect but are not likely to adversely affect MCR steelhead.

Activity 5e - Drain Maintenance

Less than 4 miles of drain tile is repaired annually. Vegetation is mechanically removed and accumulated sediment and aquatic vegetation mats are removed. Since these facilities do not directly discharge into salmonid-bearing water, potential impacts to steelhead from increased turbidity are highly unlikely. Reclamation concludes that the limited scope of this activity and location away from major streams and rivers in the Yakima Basin will result in a may affect, but not likely to adversely affect MCR steelhead finding.

Fish Screening and Passage Facilities

Activity 6a - Inspections

There are two levels of fish screening facility inspections. The first type consists of regular inspections which are done daily, except that during periods when debris loads are low the inspections occur at least 1 or 2 times weekly. The primary task is to monitor bypass systems for debris which accumulates on the upstream face of screens. Most debris will flow through the bypass without problem, but larger woody debris and other debris sometimes gets stuck in the down well and is removed by personnel on site. This prevents damage to the screens/bypass facilities and reduces risk of harm to fish using the bypass. Outfall pipes of the bypass system are also inspected daily and all debris is removed with hand tools.

The second level of inspection occurs annually at irrigation diversions outside the irrigation season or at hydroelectric diversions during a regularly scheduled shut-down period. The most significant effect to fish is associated with annual dewatering when diversions are shut down either for the winter (irrigation diversions) or for a 3-week maintenance period (Roza and Chandler power diversions). The effects to steelhead associated with dewatering and associated with diversion shut down activities are discussed under the fish salvage activity.

Routine inspections of fish passage facilities are necessary to ensure that these facilities are operated as designed and to prevent and address problems that could impact the facilities ability to provide safe and effective passage. Reclamation concludes that fish passage facility inspections are beneficial and not likely to adversely affect steelhead.

Activity 6b - Operations

The potential effect to adult and juvenile migrating steelhead is discussed in section 5.4.3, "Adult Migration" and "Juvenile Migration."

Activity 6c - Sediment, Gravel and Debris Removal

Completion of sediment, gravel, and debris removal at fish screening and passage facilities will improve upstream migration conditions for adult steelhead as well as outmigration conditions for steelhead smolts. This excavation is required to maintain effective fish passage at fish ladders and fish screens and to keep facilities in criteria. Steelhead presence is presumed at these facilities, but timing work during WDFW in-water work windows reduces the number of fish and lifestages present. Potential effects from this activity includes disturbance and displacement, exposure to turbidity, fish handling when worksite isolate and salvage is employed, and potential physical harm from heavy machinery.

Due to the number of sites and the complex and diverse life history characteristics exhibited by steelhead trout, steelhead presence is presumed during gravel removal activities. At Roza Dam, the proposed project timing of November 1st to December 15th was chosen to correspond with the fall and winter low flow period and to coincide with the typical winter maintenance period at Roza Dam when the Roza Pool is normally drawn down to accommodate fish screen and canal maintenance activities. This time period corresponds with a time when the fewest steelhead life-history stages are present in this vicinity of the Yakima River. Furthermore, conducting the proposed work at a coordinated time with the typical fall maintenance period avoids the necessity to lower the Roza Pool a second time during the year and allows the dredging to occur in the dry for the vast majority of the work. Gravel removal at other locations is determined by low flow conditions and WDFW in-water work windows. At the Bachelor-Hatton diversion, gravel removal occurs between August 15th and October 31st.

Sediment dredging work will occur within the streambed but is not directed at thalweg areas, which are naturally kept clear of sediment. Only the minimum amount of gravel is removed to ensure effective passage conditions. Sediment removal activities could disturb steelhead that are in the vicinity of the work area. This disturbance would only occur due to the generation of suspended sediments during brief periods of time when dredging occurs along the channel margin. At dredging upstream of fish, the most turbid water is likely to flow into and through the fish ladder which could prevent or delay adult fish from entering the ladder while dredging activities are occurring. However, only a few clamshell dredging scoops will be made in the river itself or along the channel margin to generate such turbidity events, so adverse effects are not expected to be severe from in-water dredging activities upstream of the fish ladder. The vast majority of the dredging activity will occur on exposed and dry sediment areas that are not likely to contribute turbidity to the river.

Newly emerged fry, as well as juvenile steelhead (i.e. mixture of 1+ and 2+ fish), are presumed to be present within and in the vicinity of the proposed project area. Steelhead fry and juveniles will be in the Yakima River for rearing and cover habitat. These fish are likely to be the most vulnerable life history forms affected by the Proposed Action due to their small size and distribution within the Yakima River basin relative to the project area. Work will not occur during spring outmigration periods.

It is expected that juvenile steelhead present in the vicinity of construction equipment will move away from the work area to nearby habitat areas that are not affected by the Proposed Action. Effects to juveniles from operation of the dredging equipment near the river are thought to be minor due to the limited amount of in-water work and the brief periods of elevated turbidity that this work may generate.

The removal of accumulated sediment may result in some short-term sedimentation effects downstream of the project. Fine sediment inputs into the Yakima River or other associated river (Ahtanum Creek for the Bachelor Hatton Diversion) from the Proposed Action should be limited due to the small streambed area that the dredging equipment will need to operate in within the wetted margin of the Yakima River. The amount of turbidity will also be minimized by operating all equipment from existing access roads, and transporting all removed sediments to upland disposal areas, unless the deposition of clean river cobbles is permitted through the WDFW HPA process.

At Roza Dam, the vast majority of sediments removed by dredging operations will occur in the dry exposed substrate areas away from the Yakima River that are not likely to contribute suspended sediments to flowing waters of the Yakima River. Sedimentation effects should not impact adult steelhead migration, spawning, or egg incubation since these activities either don't occur in this reach of the Yakima River, or these activities occur prior to or after the proposed work windows for the project. Sedimentation effects from the Proposed Action may also impact any steelhead fry and juveniles rearing in the project area. Project related activities may result in the short-term disturbance of rearing habitat used by juvenile steelhead and may result in some fry displacement to downstream areas. However, this disturbance or displacement will be very localized and will occur over a very short time period (i.e. a few hours during one or two days of the Proposed Action).

Other fish screening and passage facilities will require less volume of sediment and gravel removal, but overall impacts will be similar.

Reclamation concludes that the Proposed Action may affect and is likely to adversely affect MCR steelhead in the Yakima River basin.

Activity 6d- Routine Repairs and Structural Upgrades

Routine repairs at screen sites occur during normal shut-down operations; therefore, do not result in impacts beyond those already described for diversion shut-down and salvage efforts. There is no regularly scheduled shut-down period of fish ladders, and so repairs at these facilities necessitate the temporary closure of these facilities. These activities therefore have the potential to delay fish movement. If a ladder deficiency is negatively impacting fish movement, it will be shut-down and immediately repaired. If ladder deficiencies do not pose an immediate risk to ladder function, the repair will be scheduled for periods with low fish utilization of these structures. For those mainstem dams that have multiple fish ladders, Reclamation will only shut down one ladder at a time to decrease the impact on listed fish species that could be migrating through the facilities concurrent with maintenance activities.

The preference is to conduct screen mesh refurbishment activities outside the irrigation season when the fish screen structure is not being used. In some instances, this activity may occur during the irrigation season, as long as the fish screen structure can be operated to NOAA Fisheries criteria. This is achieved by installing a temporary screen. Since the temporary screen is not a rotating drum, more frequent site monitoring and debris cleaning is required.

Due to potential delay associated with fish ladder repairs, Reclamation concludes that routine repairs may affect, and are likely to adversely affect steelhead.

5.5 Interrelated and Interdependent Effects

5.5.1 Operation of Privately-Owned Facilities

Project water is occasionally directly spilled into tributary streams that traverse KRD lands, or travel to the systems as return flows. When this occurs, tributary water and project water becomes co-mingled and cannot be separated. In these instances, water users that divert along this tributary system end up diverting a mixture of tributary and project water. Diversions at this location would occur in the absence of the federal irrigation project, though it is possible that diversions may increase, due to the increase in available water. The potential effect to steelhead from this diversion of intermingled water is expected to be small when compared to the effect of diverting water originating from the tributary (an action entirely independent from the Federal Project and Proposed Action) and potential effects to tributary systems from operational spill.

The Taneum Canal Company has a tributary water right on Taneum Creek. Most of the lands which receive water from the Taneum Canal Company also lie within the KRD service area and have a KRD water allotment. By agreement between KRD and the Taneum Canal Company, KRD operates and maintains the ditch that delivers both the KRD and Taneum

Canal Company water during the irrigation season. This agreement does not affect the amount of water that either KRD diverts from the Yakima River at Easton or the amount of water that the Taneum Canal Company diverts from Taneum Creek under its own water right. In the event that KRD terminated its deliveries to its water users, the Taneum Canal Company would continue to divert all of their water from Taneum Creek and deliver through the facility that is now jointly used with KRD. As such, impacts associated with the diversion of Taneum Creek flows by the Taneum Canal Company would occur with or without its O&M agreement with KRD.

Currently, KRD supplements flows in lower Taneum Creek by making releases down the Taneum Chute, but this activity is separate from their contract with the Taneum Canal Company. Steelhead are able to access the reach where the creek is used to convey KRD water. The diversion used to remove the water from the creek is screened and false attraction has not been identified as an issue at the site under current operations. KRD water is not released into the stream until flows in Taneum Creek drop to the point where users who have both Taneum Creek and KRD water make a call on their KRD water. This normally happens in June. As a result, flows in Taneum Creek are not augmented with KRD releases during the high runoff period, but they are augmented during the summer low flow period. As such there are no adverse flow related impacts to steelhead in Taneum Creek from KRD's delivery of water to Taneun Canal Company water users.

The operation of the Cowiche and Orchard Avenue hydroelectric plants and Leishman Powerplant occur within the irrigation distribution system. Additional diversions are not made for power generation, and water used is screened. No effects to steelhead are expected from these power operations. Similarly, since steelhead cannot access areas upstream of Tieton Dam, hydropower generation at this facility, which occurs incidentally and does not affect dam releases, no effects to steelhead are anticipated due to hydroelectric generation at this facility.

5.5.2 Recreation

Recreation use along the Tieton River increases in September in response to unique rafting opportunities created by high flow releases under the flip-flop operations. The recreation can potentially degrade riparian habitat. As dispersed camp sites have already been established through use, this effect has been captured through existing habitat conditions in the baseline.

5.5.3 Upper Yakima Check Dams

As discussed in Chapter 3, due to low flows in the upper Yakima from late-August through October associated with the flip-flop operation, some irrigators must install check or wing dams to have sufficient head to divert water. This practice is known to occur at the Westside diversion. This structure is constructed in the late summer when rearing *O. mykiss* juveniles and adult resident rainbow trout could be present. These rearing fish may be displaced by in-

water construction, directly harmed from heavy machinery entering the water and the placement of rock, or exposed to elevated turbidity levels. Due to the timing of this activity, returning adult spawners and incubating eggs are not directly affected by this activity. Any increases in turbidity are expected to be short-term and localized and not affect the overall quality of gravels in the area. This structure does not span the entire channel width of the channel and do not create a passage barrier for migrating fish.

5.6 Cumulative Effects

Cumulative effects are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the Action Area of the federal action subject to consultation.

5.6.1 Yakama Nation Kelt Program

The Yakama Nation's continued implementation of the reconditioning and transport of steelhead kelts potentially represents a much greater improvement in both outmigration survival and return rates. Reconditioning programs capture kelts and hold them in tanks where they are fed and medicated to enhance survival. Current programs either hold kelts for 3 to 5 weeks and release them below Bonneville, or hold kelts until they are ready to spawn and release them below Prosser Dam. Short-term reconditioning efforts have produced average survival rates of 82 percent and kelt returns of 4 percent to the Yakima River (Hatch et al. 2006). Long-term reconditioning has produced average survival rates of 35.6 percent, all of which are returned to their natal stream for spawning (Hatch et al. 2006). Taken together, the short-term and long-term kelt reconditioning groups are estimated to have increased the number of spawning steelhead in the Yakima basin by 6.6 percent overall (Bosch 2008).

5.6.2 In-Basin Habitat and Flow Improvements

Private and state actions described in Section 2.4 of this BA that benefit Yakima basin fisheries are expected to continue in the future. The actions include state and non-profit water conservation efforts expected to result in tributary instream flow improvements and continued habitat restoration efforts. Significant improvements in tributary habitat access and habitat quality are anticipated to result from water conservation efforts that benefit tributary systems. Levee setback efforts intended to reduce flood risk and improve instream habitat in key alluvial reaches are expected to be implemented. This includes floodplain restoration projects in the lower Naches River and Gap to Gap reach of the Yakima River identified in Yakima County's Comprehensive Flood Hazard Management Plan, and floodplain improvements in Kittitas County likely to occur as a result of the formation of the Kittitas County Flood Control Zone District.

5.6.3 Water Quality Improvements

Water quality improvements are anticipated in areas where TMDLs are developed and implemented. In particular, suspended sediment and turbidity and organochlorine pesticide TMDLs are in place for the upper Yakima River. A detailed implementation plan was developed in 2003 and TMDL targets anticipated to be met by October 2016 (Ecology 2013). An assessment of TMDL implementation was completed in 2006 for both the upper and lower Yakima River TMDLS (Ecology 2006, 2008). At that time, Ecology determined that significant sediment reductions had been made and that interim targets established in the TMDLs were being met. New target goals for 2006 to 2016 were also established for BMP implementation for the next review period. Also in the upper Yakima, a draft temperature TMDL report has been developed. Implementation of the TMDL is expected to improve temperature conditions within several tributary streams (Ecology 2014b, p. xvii). A suspended sediment and DDT TMDL was developed for the lower Yakima River in 1998. This TMDL remains in place, and new DDT-reduction work will be covered by a new water quality improvement plan (Ecology 2012). A Pesticides and PCBs TMDL water quality study finding for the entire Yakima basin was developed in 2010.

5.6.4 Climate Change

The Climate Impacts Group at the University of Washington analyzed the effects of global climate change on the Pacific Northwest and on Washington in particular (Littell et al. 2009). That evaluation used up to 20 different General Climate Models and two different emission scenarios to explore potential impacts at three different time periods extending out to near the end of the century. The global climate models generally agree that future conditions in the Pacific Northwest will be warmer. While the effect of climate change on regional precipitation is variable among climate change models, a loss of snowpack is consistently projected (Salathé et al. 2009).

Climate change models indicate significant changes in runoff in the Yakima River basin. Generally, the projected increased air temperatures would cause some precipitation to fall as rain instead of snow, which would increase winter and early spring runoff and reduce the volume of runoff from snowpack that occurs in the late spring and early summer. The net effect is anticipated to be a shift in the peak runoff period to earlier in the season, with a corresponding decrease in spring and summer (projected at 12 to 71 percent of existing runoff) and increase in fall and winter runoff (projected at an increase of 4 to 74 percent of existing runoff). Fall and winter inflow to reservoirs would increase, and the reservoir system may not be able to capture and hold the increased flow for release during the high-demand period (spring and summer). Additionally, a decrease in spring and summer supply would cause water stored in reservoirs to be depleted at a faster rate to meet demand. The combined effects would likely cause a decrease in overall supply during the high-demand period (Reclamation 2012, p. 1/12).

Climate change is expected to result in a decline in the quantity of freshwater habitat for salmonid populations across Washington State (Manuta, Tohver, and Hamlet 2010, p. 187). The Yakima River basin is a transient watershed, one that is dominated by a mix of direct runoff from fall rain and spring snowmelt. Simulations predict that this type of watershed would be most affected by climate change, with accompanying impacts to fisheries. Specific impacts to fish are expected to include:

- Increased air temperature would increase water temperature, negatively impacting fish habitat.
- Elevated stream temperatures would increase thermal barriers to migration.
- Increased winter flood frequency and intensity would cause a negative effect on juvenile coho, Chinook, steelhead, and bull trout survival and reduction of survival rates for incubating eggs and rearing parr.
- Reduced spring snowmelt and summer and fall streamflows would impact summer-run steelhead, sockeye, and summer Chinook migrations.
- Diminished flows, in combination with increased water temperatures, would increase pre-spawn mortality for summer-run and stream-type salmonids.

The hydrologic effects analysis presented in Chapter 4 is based on an assumption that historic conditions are an appropriate representation of future conditions. Expectations associated with climate change challenge this assumption. Brekke et al. (2009) suggest that long-range planning and decision-making efforts consider a range of climatic variability wider than the historic record. In the Yakima basin, the one purpose of the Integrated Plan is to provide increased flexibility in water supply to adapt to potential climate change conditions (Reclamation and Ecology 2012). Potential effects from climate change are; therefore, best considered alongside changes to operations associated with implementation with the Integrated Plan. As stated in Chapter 3, future implementation of Integrated Plan activities fall outside the scope of this current consultation.

5.7 Effects from FCRPS Consultation

Federal agencies are implementing numerous projects associated with the FCRPS hydro-system to address impacts to outmigrating steelhead. Restoration actions included as part of the FCRPS proposed action will benefit MCR steelhead broadly and are aimed at improving access to blocked habitat, riparian condition, channel complexity, and instream flows. These projects will benefit the viability of the affected populations by improving abundance, productivity, and spatial structure. Future federal restoration projects will improve the functioning of the PCEs safe passage, spawning gravel, substrate, water quantity, water quality, cover/shelter, food, and riparian vegetation. Projects implemented for other purposes will be neutral or have short- or even long-term adverse effects on some of these same PCEs.

Taken together, the combination of all the quantitative and qualitative survival-related factors indicates that all populations and MPGs of the MCR DPS as a whole are likely to have a low risk of short-term extinction when the environmental baseline, including implementation of the suite of actions outlined in the recently completed FCRPS consultation on the Columbia and Snake Rivers (FCRPS BA 2007, NOAA Fisheries 2008), cumulative effects, and the proposed action for this consultation are considered. The status of the species has been improving in recent years and abundance is expected to increase in the future as a result of additional improvements in the baseline and FCRPS proposed action. Therefore, the status of the DPS as a whole is expected to improve compared to its current condition, and to move closer to a recovered condition. These improvements result in lower short-term extinction risk than in recent years. The survival changes described in the FCRPS consultation are expected to ensure a level of improvement that results in the MCR steelhead DPS trending toward recovery (NOAA Fisheries 2008).

The future status of all 17 populations in the 4 MPGs of MCR steelhead will be improved compared to their current status. Status will be improved through a reduction of adverse effects associated with FCRPS and upper Snake projects and the implementation of actions with beneficial effects. These actions include reduction of avian and fish predation, estuary habitat improvements, kelt reconditioning, and tributary habitat improvements for each population. Beneficial actions included in the FCRPS proposed action, now part of the environmental baseline, will also offset the slightly decreased survival associated with the continued harvest of Columbia River steelhead stocks. Therefore, the status of the DPS as a whole is expected to improve compared to its current condition, and move closer toward a recovered condition (NOAA Fisheries 2008).

The juvenile in-river survival rate under the fully implemented FCRPS consultation is expected to be 0.3 percent, 5.1 percent, 8.2 percent, and 10.2 percent higher than the current survival rate for those populations migrating through the one to four dams, respectively, in the lower Columbia River. In-river survival will increase to 52.4 percent for MCR fish passing four dams and to 90.3 percent for fish passing one dam. Finally, implementing tributary habitat projects across the DPS will result in a 1 to 4 percent increase in survival, by improving habitat function through addressing significant limiting factors. Tributary projects have the capacity to also improve spatial structure and diversity parameters by improving habitat quality and access. Tributary habitat projects described in the FCRPS consultation include restoration and protection of areas that function as thermal refugia. Implementation of FCRPS proposed actions are expected to increase total system survival by 15 to 37 percent, depending on the population, compared to the baseline condition. However, actions included in the FCRPS consultation represent significant improvements to address these factors if they can be reasonably implemented within the next 10 years.

The existence, operation, and maintenance of the FCRPS dams, the mainstem effects of Reclamation's projects in the Columbia River Basin, and other mainstem actions have adversely affected some aspects of critical habitat of MCR steelhead in the mainstem

migration corridor. Although some current and historical effects of the existence and operation of the hydrosystem, tributary, and estuary land use will continue into the future, critical habitat will retain at least its current ability for PCEs to become functionally established to serve the intended conservation role for the species in the near and long term. The functioning of many of the PCEs will improve substantially under the proposed actions included in the FCRPS consultation for the MCR steelhead DPS. Implementation is expected to maintain the current high rate of survival for adults and will substantially improve safe passage for juveniles. Implementation of habitat restoration actions that address limiting factors will improve the functioning of many PCEs such as water quality, water quantity, cover/shelter, food, riparian vegetation, and space in spawning and juvenile rearing areas. The positive effects on the functioning of PCEs within the MCR DPS and the conservation value of critical habitat are expected to be long-term.

In sum, these quantitative and qualitative considerations suggest that the MCR steelhead DPS will be trending toward recovery when aggregate factors are considered. In addition, critical habitat conditions currently supporting UCR steelhead will be maintained or improved compared to the current condition and are expected to function sufficiently to serve the intended conservation role for the species. Effects resulting from the future operation of the Yakima Project will not cause the MCR steelhead DPS to deviate from this trend toward recovery, nor will it adversely affect the ability of critical habitat to support the habitat requirements of the species.

5.8 Recovery Context

The status of steelhead recovery strategies that are highlighted in the Yakima Basin Recovery Plan and pertinent to the Action Area are provided in Table 5-11. Recent improvements in baseline condition, specific activities proposed as part of the Proposed Action, activities that are anticipated as part of cumulative effects, and potential implementation of the Integrated Plan substantially addresses the strategy identified in this local recovery plan.

Table 5-11. Identified recovery strategies (source, YBFWRB et al. 2009, p. vi) pertinent to the Action Area, organized by spawning population and status given baseline, Proposed Action effects, and cumulative effects.

Identified Recovery Strategies Pertinent to the Action Area	Status
Common to all four populations	
Improve migration conditions in the mainstem Yakima River	Significant improvements in baseline associated with implementation of the YRBWEP fish screening program and subsequent facility upgrades (Section 2.3.5). Further improvements under the Proposed Action associated with dedicated outmigration flows, continuing attention to fish passage facilities, and Chandler Steelhead Smolt Survival Study.
Naches Population	
Significantly protect and improve passage, flows, and instream and riparian conditions in tributaries (Ahtanum, Bumping, Cowiche, Rattlesnake, Nile, and Little Naches watersheds)	Contract to supply Cowiche Water users with Yakima Project water and associated passage restores access to over 20 miles of habitat in Cowiche Creek under baseline conditions (Section 4.2.1).
Address effects on steelhead from reservoir operations and irrigation withdrawals in the Tieton, lower Bumping, and lower Naches Rivers.	In the baseline Wapatox water right acquisition significantly improves Naches streamflows in majority of years. Improved winter rearing and outmigration flows over baseline conditions in the Tieton and lower Naches Rivers associated with Proposed Action.
Improve floodplain function and conditions in the mainstem Naches River	Improvements expected under cumulative effects associated with Yakima County flood management program.
Upper Yakima Population	
Continue efforts to protect existing functional habitat	Improvements under baseline conditions (Sections 2.4.1, 2.4.5, and 2.4.6).
Provide unimpeded passage for steelhead in key tributaries (Manastash, Taneum and, if feasible, Naneum and Cle Elum)	Improvements to Manastash and Taneum have occurred in the baseline. Further improvements to Manastash passage are anticipated with cumulative effects associated with planned water efficiency upgrades (Section 2.4.4). The construction of Cle Elum fish passage facilities has been authorized and is reasonably foreseeable.
Improve outmigration conditions at Roza Dam	Under baseline conditions, Roza rollergate modification results in initial improvements by providing surface passage over a range of flows. Further improvements are expected with the Proposed Action due to change in power subordination target.

Identified Recovery Strategies Pertinent to the Action Area	Status
Address the effects of reservoir and irrigation system operations on winter/spring/fall low flows and summer high flows in the lower Cle Elum and mainstem Yakima Rivers	Improvements occurred under baseline conditions for winter rearing and outmigration flows associated with the use of analytical tools to set winter flows. Refinements to these flows are included as part of the Proposed Action. Reclamation's ability to further enhance flows will be associated with the development of additional infrastructure, as identified as part of the Integrated Plan.
Protecting and enhancing floodplain conditions along the mainstem Yakima	Improvements under baseline conditions through YRBWEP and basin partners (Sections 2.4.1, 2.4.5, and 2.4.6).
Improve flows and instream and riparian conditions in tributaries and side channels.	Water conservation and water rights acquisition under baseline conditions improve tributary flows under baseline conditions. Restoration projects aimed at improving side-channel conditions completed under the baseline, with additional projects reasonably foreseeable (Section 2.4.4).

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Chapter 6 Bull Trout

6.1 Bull Trout Overview

6.1.1 Status

All populations of bull trout within the coterminous U.S. were listed as a threatened species pursuant to the ESA of 1973, as amended (64 FR 58910; November 1, 1999). The 1999 final listing created one DPS of bull trout within the coterminous U.S. by adding bull trout in the Coastal-Puget Sound populations (Olympic Peninsula and Puget Sound regions) and Saint Mary-Belly River populations (east of the Continental divide in Montana) to the previous listings of three separate DPS of bull trout in the Columbia River, Klamath River, and Jarbidge River basins (63 FR 31647, June 10, 1998; 64 FR 17110, April 8, 1999).

Critical habitat for the Klamath River and Columbia River bull trout populations was initially designated on October 6, 2004 (69 FR 59995). This designation was subsequently revised with the final rule effective on November 17, 2010. The revised rule added critical habitat acreage to the Yakima basin. The Yakima River Critical Habitat Unit 11 is encompassed within the Mid-Columbia Recovery Unit with a total of 557.3 miles of stream habitat and 15,530.9 acre-feet of lake and reservoir surface area and supports one core area.

The Draft Bull Trout Recovery Plan was released September 2014 (USFWS 2014a). This Draft Recovery Plan delineates the single bull trout DPS into six biologically-based recovery units. These recovery units are then broken down further into 110 core areas. Core areas are expected to function similar to bull trout metapopulations, in that spatial and temporal interactions between bull trout within a core area are more likely than between bull trout from separate core areas. All bull trout within the Yakima basin are within the Yakima Core Area, which is within the Mid-Columbia Recovery Unit. The Yakima River Core Area consists of 15 local bull trout populations. Major threats include 1) Connectivity impairment (lack of passage at storage dams and other instream barriers); 2) instream impacts (entrainment, low instream flows); 3) Upland/riparian land management (legacy timber harvest and roads; recreation; grazing impacts; water temperature); and 4) nonnative fishes (brook trout hybridization, especially in Waptus, North Fork Tieton, upper Yakima; brown trout in Cle Elum).

In their most recent 5-year status review for bull trout, completed in 2008, the USFWS (2014) concluded that listing the species as "threatened" remained warranted range-wide in the coterminous U.S. Since listing bull trout, there have been numerous conservation measures that have been and continue to be implemented across its coterminous range.

6.1.2 Life History and Ecology

When compared to other native trout and salmon species, bull trout have some of the most demanding habitat requirements (Rieman and McIntyre 1993). Habitat components that effect bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Pratt 1992; Rieman and McIntyre 1993, 1995; Watson and Hillman 1997). To successfully spawn and rear, bull trout need specific physical characteristics within watersheds, but those characteristics are not necessarily present throughout watersheds even in pristine habitats (Watson and Hillman 1997; Rieman and McIntyre 1993) resulting in patchy distribution for bull trout (Rieman et al. 1997).

Seasonal habitats for all bull trout life histories are linked through migratory corridors. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993; Rieman et al.1997). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed, stray, or return to non-natal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants.

Bull trout spawn, incubate, and rear in colder water than other salmonids. This unique adaptation allows bull trout to survive in habitat that may be unsuitable for most other species of fish. Ratliff and Howell (1992) note that bull trout may be the only fish present in many of the cold streams. Bull trout are found primarily in colder streams, although individual fish are found in larger, warmer river systems throughout the Columbia River Basin (Fraley and Shepard 1989; Rieman and McIntyre 1993, 1995; Buchanan and Gregory 1997; Rieman et al. 1997). Water temperature above 15 ^{o}C (59 ^{o}F) is believed to limit bull trout distribution, which may partially explain the patchy distribution within a watershed (Fraley and Shepard 1989; Rieman and McIntyre 1995).

Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992; Rieman and McIntyre 1993; Rieman et al.1997b; Baxter et al.1999). Goetz (1989) suggested optimum water temperatures for rearing of about 7 to 8 ^{o}C (44 to 46 ^{o}F) and optimum water temperatures for egg incubation of 2 to 4 ^{o}C (35 to 39 ^{o}F). McPhail and Murray (1979) demonstrated that survival of bull trout eggs was 80 to 95 percent to hatching at temperatures of 2 to 4 ^{o}C (36 to 39 ^{o}F) and dropped to 0 to 20 percent at temperatures of 8 to 10 ^{o}C (46 to 50 ^{o}F). Buchanan et al. (1997) report observations from throughout Oregon and the published literature, and concluded that,

while optimum temperatures for juvenile growth are between 4 to 10 ºC (39 to 50 ºF), the optimum for adult bull trout is near 12 to 15 ºC (54 to 59 ºF).

All life history stages of bull trout are associated with complex forms of cover, including LWD, undercut banks, boulders, and pools (Fraley and Shepard 1989; Goetz 1989; Hoelscher and Bjornn 1989; Sedell and Everest 1991; Pratt 1992; Sexauer and James 1997; Watson and Hillman 1997). Maintaining bull trout habitat requires stream channel and flow stability (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered streamflow in the fall may disrupt bull trout during the spawning period and channel instability and may decrease survival of eggs and young juveniles in the gravel during winter through spring (Fraley and Shepard 1989; Pratt 1992).

Bull trout reach sexual maturity after 4 of more years and live up to 10 to 12 years. Bull trout typically spawn from August to November during periods of decreasing water temperatures. Temperatures during spawning generally range from 4 to 10 ºC (39 to 51 ºF), with redds often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989; Pratt 1992; Rieman and McIntyre 1996). Preferred spawning habitat consists of low gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989) and water temperatures of 5 to 9 ºC (41 to 48 ºF) in late summer to early fall (Goetz 1989).

The incubation period for bull trout is extremely long, often exceeding 145 days (Pratt 1992), and young fry may take up to a total of 225 days to emerge from the gravel (Craig 1997, 63 FR 31647). Fry normally emerge from early April through May depending on water temperatures and increasing streamflows (Pratt 1992, Ratliff and Howell 1992). Because of this long incubation period, eggs are particularly vulnerable to siltation problems and bed load movement in rivers and streams where spawning occurs. Any activity that causes erosion, increased siltation, removal of stream cover, or changes in water flow or temperature affects the number of bull trout that hatch and their ability to survive to maturity (Knowles and Gumtow 1996).

Bull trout show both migrant and resident life history strategies. After rearing as juveniles for 2 to 4 years in their natal streams (Meehan and Bjornn 1991), migrant bull trout emigrate to larger rivers or lakes, whereas resident fish complete their entire life cycle within their natal stream. Migrant forms, including both fluvial (downstream migration to larger rivers) and adfluvial (downstream migration to lakes) grow rapidly, often reaching over 500 mm (20 inches) in length and 2 pounds by the time they are 5 to 6 years old. Migratory bull trout live several years in larger rivers or lakes, where they grow to a much larger size than resident forms before returning to tributaries to spawn. Growth differs little between forms during their first years of life in headwater streams, but diverges as migratory fish move into larger and more productive waters (Rieman and McIntyre 1993).

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro-zooplankton, and small fish (Boag 1987; Goetz 1989; Donald and Alger 1993). Adult migratory bull trout feed on various fish species (Fraley and Shepard 1989; Donald and Alger 1993; Brown 1992).

6.1.3 Factors Contributing to Species Decline

Historically, bull trout were more widely distributed in the Yakima basin than is currently observed (WDFW 1998). Bull trout naturally occur in a patchy fashion on the landscape. Furthermore, their distribution was (and is) naturally variable by core area, depending on the presence of geologic features, slope, elevation, aspect, water temperatures, etc. (Rieman et al. 1997). Although historic population numbers are unavailable, it is assumed they were more abundant (WDFW 1998).

The Middle Columbia Recovery Unit chapter for the draft Recovery Plan identifies general factors that have contributed to decline across this recovery unit. These factors include isolation by dams, agricultural practices and associated water withdrawal, forestry practices, grazing, roads, mining, harvest, nonnative species, and residential development. A threats analysis was conducted in 2012 for Yakima basin local bull trout populations (Reiss et al. 2012). This document characterized threats as significant, moderately significant, or unknown but believed to be significant for each local population. The significant and moderately significant threats included forest management, passage barriers, dewatering, introduced species, altered flows, and low abundance. Additional threats that were captured under unknown but believed significant included angling, prey base, entrainment, limited extent of spawning/rearing habitat, recreation, and development.

6.2 Yakima Core Area Population Characteristics

The number of recognized local populations in the Yakima basin has shifted throughout the last decade, changing from 13 local bull trout populations in the 2002 Draft Recovery Plan for the Yakima Core Area (USFWS 2002), to 16 described in the Bull Trout Action Plan of 2012 (Reiss et al. 2012). These include four fluvial populations (mainstem Yakima River, American River, Crow Creek, and Rattlesnake Creek), two resident populations (North Fork Teanaway River and Ahtanum Creek), and ten adfluvial populations (Gold Creek, Box Canyon Creek, Kachess River, Cle Elum River, Deep Creek, Indian Creek, South Fork Tieton River, North Fork Tieton River, Bumping River, and Waptus Lake) (Table 6-1).

At the time of listing, the USFWS found no evidence that a local population of bull trout remained in the mainstem Yakima River (63 FR 31647). This is the reason the Draft 2014 Bull Trout Recovery Plan lists 15 populations. However, WDFW did recognize a mainstem

Yakima stock (WDFW 2004) based on catch records, anecdotal accounts, and bull trout captures in the 1990s. More recently, bull trout have been captured at various locations in the mainstem Yakima River and redds have been observed in the upper Yakima River between Keechelus Dam and Lake Easton. Consequently, this BA will analyze 16 local populations.

The term local population is defined as "a group of bull trout that spawn within a particular stream or portion of a stream system;" a local population is considered to be the smallest group of fish that is known to represent an interacting reproductive unit. This document considers the 15 local populations identified by Reiss et al. (2012). The 2012 Draft Bull Trout Recovery Plan also identifies 15 local populations in the Yakima Basin (USFWS 2014a).

Table 6-1. Local populations of bull trout in the Yakima basin (Reiss et al. 2012).

Geographic Area	Population	Life History Type	Status*	Year Spawning First Observed
Keechelus Reservoir	Gold Cr.	Adfluvial	Critical	1984 (15 redds)
Kachess Reservoir	Box Canyon Cr. Kachess R.	Adfluvial Adfluvial	Critical Critical	1984 (10 redds) 1999 (8 redds)
Cle Elum Reservoir	Cle Elum R. Waptus Lake	Adfluvial Adfluvial	Potentially extirpated? Potentially extirpated?	No confirmed redds No confirmed redds
Yakima River	Yakima R.	Fluvial	Not rated	2000 (NA)
Teanaway River	Teanaway R.	Resident	Potentially extirpated?	1996 (NA)
Rimrock Reservoir	Indian Cr. South Fork Tieton R. North Fork Tieton R.	Adfluvial Adfluvial Adfluvial	Healthy Healthy Not rated	1984 (101 redds) 1990 (192 redds) 2004 (insufficient data)
Bumping Reservoir	Deep Cr.	Adfluvial	Depressed	1990 (113 redds)
Naches River	Rattlesnake Cr. Crow Cr. American Cr.	Fluvial Fluvial Fluvial	Critical Critical Critical	1990 (35 redds) 1999 (6 redds) 1996 (34 redds)
Ahtanum Cr	Ahtanum Cr.	Resident	Critical	1993 (6 redds)
*Status from the WDFW Salmonid Stock Inventory database.				

Bull trout abundance in the Yakima Core Area has been tracked primarily through redd surveys conducted on index reaches in spawning areas. Comparable data from redd surveys in the Yakima Core Area are available from 1999 to 2012 (Table 6-2).

6.2.1 Keechelus Reservoir

Gold Creek Population. Keechelus Reservoir has one adfluvial bull trout population that spawns and rears in Gold Creek. Available redd survey data show wide variation, with a range from 2 in 1984 and 1985 to 51 in 1996. The recent average from 1999 to 2014 was 18 (Table 6-2). The USFWS (1998) considers the Gold Creek local population to be depressed, decreasing, and at risk of stochastic extirpation. WDFW rates the status of this stock as critical (WDFW 2004). No information is available about the status of resident bull trout. Widespread presence of brook trout raises the possibility of ecological competition and introgressive hybridization.

Gold Creek is one of several tributaries of Keechelus Reservoir, but has the only known spawning habitat for bull trout in the upper Yakima River. The lake provides FMO habitat for subadult and adult fish.

Spawning occurs from early September to mid-October. It is suspected that migrating bull trout spawners may enter the creek in July or earlier; however, migration timing is likely affected by channel dewatering patterns and water temperature during this time.

6.2.2 Kachess Reservoir

Kachess Reservoir was a natural lake comprised of two basins separated by an eastward-dipping reverse fault (Foster 1960). At full pool, the reservoir holds 239,000 acre-feet of water with a surface area of 4535 acres. Two local populations reside in the reservoir and spawn in upstream tributaries. One spawns in Box Canyon Creek and the other spawns in the upper Kachess River. Both of these populations are relatively small with each having a limited amount of spawning and rearing habitat available below waterfalls that block further upstream access. Several other smaller tributaries also flow into Kachess Reservoir but not known to support bull trout (Reiss et al. 2012).

Box Canyon Creek Population. Box Canyon Creek originates in the Alpine Lakes Wilderness Area and flows into Kachess Reservoir from the northwest near its northern end. The reach accessible to migratory fish is relatively short with an impassable waterfall (Peekaboo Falls) located at its upstream end approximately 1.6 miles above the lake.

Juvenile rearing occurs in the entire 1.6-mile accessible reach. Adult bull trout move into Box Canyon Creek in mid-July to mid-August, prior to spawning, and numerous fish migrate to and hold in the large pool directly below Peekaboo Falls. The spawning period for the Box Canyon Creek population begins in early September and can extend through mid-October. It is possible that a resident component exists as well, although this has not been confirmed.

Table 6-2. Redd counts for bull trout populations in the Yakima basin, 1999-2014 (WDFW 2014a).

	Year																
Location	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Avg
Yakima River																	
Keechelus to Easton		2	1		1			3	1				0				1
N.F. Teanaway							2	1	0	0	1	0	0	0	1	0	1
Keechelus Reservoir																	
Gold Creek	40	19	15	31	9	20	7	8	6	40	29	23	7	7	12	19	18
Kachess Reservoir																	
Kachess River		15	14	0	16	8	3	0	22	2	2	15	33	8	13	7	11
Box Canyon Cr	17	10	14	15	8	19	8	8	2	8	21	30	31	9	6	10	14
Cle Elum Reservoir																	
Cle Elum & Waptus		0	0	0	0			0	0	0	0						0
Naches River Fluvial																	
Rattlesnake Cr.	44	45	57	69	54	32	15	40	13	37	36	64	42	42	32	23	40
American River	30	44	36	27	30	40	35	55	31	22	39	47	40	54	54	36	38
Crow Cr.	19	26	6	9	9	6	4	8	8	2	5	9	7	9	5	2	8
Bumping Reservoir																	
Deep Creek	107	147	51	120	57	97	73	95	130	145	178	199	192	169	108	78	122
Bumping River		0				0			0	0	2	0	0	0		0	0
Rimrock Reservoir																	
SF Tieton River	161	144	158	141	178	178	205	189	152	266	259	194	234	226	151	192	189
Indian Cr.	205	226	117	100	101	50	91	106	58	130	200	144	147	174	10	28	118
N.Fk Tieton R (above Clear Lk)						1		1	37	28	15	18	11	17	10	19	16
Ahtanum Creek																	
N.Fk. Ahtanum Cr	7	11	20	17	12	8	6	7	8	1	3		1	2	2	1	7
M.Fk. Ahtanum Cr		10	1	6	8	11	5	6	5	3	9	15	11	8	7	6	7
S.Fk. Ahtanum Cr		5	14	13	7	5	3	4	5	3	6	2	4	2	1	2	6
Grand Total	**630**	**702**	**503**	**548**	**489**	**475**	**457**	**528**	**477**	**687**	**795**	**760**	**760**	**727**	**412**	**423**	**586**

Complete bull trout redd surveys have been conducted since 1984. Redd counts have been highly variable with the first 10 years having very low to zero counts. This was probably due in large part to limited adult access to the creek as several years from the late 1980s through the mid-1990s were drought years in the Yakima basin. Chronic passage problems that occur at the mouth were not yet fully recognized or monitored at that time (Reiss et al. 2012). From 1999 to 2014, the average number of bull trout redds in Box Canyon Creek was 14, and has ranged from 2 (2007) to 31 (2011) (Table 6-2).

Kachess River Population. The upper Kachess River is the smaller of two streams in what is locally known as the Kachess/Mineral system. Mineral Creek joins the river approximately 1.2 miles above the reservoir (at full pool) and contributes an estimated 75 percent of the combined flow of the two streams (Meyer 2002). Even though Mineral Creek provides more flow, the stream is referred to as the Kachess River below this confluence. Reiss et al. (2012) refer to it as the upper Kachess River to differentiate it from the short reach remaining below Kachess Dam before it flows into Lake Easton on the Yakima River.

The upper Kachess River adfluvial population spawns primarily in the upper Kachess River above the Mineral Creek confluence, although a few redds are sometimes found below this point. While Mineral Creek contains some suitable spawning habitat, bull trout do not appear to spawn there. Juvenile bull trout use both Mineral Creek and the upper Kachess River for rearing with their distribution extending to the lake. Kachess Reservoir provides FMO habitat for subadult and adult fish. Adults have been observed to migrate into the upper Kachess River in October, after fall rains have re-watered the reach above the lake (Meyer 2002). It is possible that a resident component exists as well although this has not been confirmed.

The USFWS (1998) considered the Kachess River population to be depressed, decreasing, and at risk of stochastic extirpation. At the time, this subpopulation did not include the upper Kachess River local population, as bull trout spawning had not been observed yet in the upper Kachess River and a local population was not recognized. WDFW rates the status of the Kachess Lake stock (which included the upper Kachess River population) as critical; further stating that it was very near extirpation (WDFW 2004).

6.2.3 Cle Elum Reservoir

While there is uncertainty about both historic and current bull trout distribution within the Cle Elum watershed, two potential local bull trout populations, one spawning in the Cle Elum River and the other spawning in Waptus River above Waptus Lake are currently recognized. It is uncertain if these bull trout populations have persisted. No bull trout have been observed within the Cle Elum basin since 2003.

Cle Elum River Population. The Cle Elum River population is defined as bull trout that may be present in the mainstem upper Cle Elum River and its tributaries. Both adult and juvenile bull trout have been found in the upper Cle Elum River but not a single confirmed bull trout redd has been documented in the river or any of its tributaries. Redd surveys have been sporadic and incomplete. It is probable that adfluvial bull trout were present in Cle Elum Reservoir following construction of the dam. There is not much data about bull trout population status after dam construction. NOAA Fisheries reportedly captured 17 bull trout in floating Merwin traps set in Cle Elum Reservoir from 1990 to 1991 for a sockeye restoration feasibility study (Pasley 1993, as cited in Reiss et al. 2012), but these fish may have been misidentified lake trout, which are relatively abundant (Reiss et al. 2012). No bull trout redds have been confirmed in surveys that have been conducted in the Cle Elum River or Waptus/Waptus Lake areas since 2000 (Table 6-2).

In 1996, biologists from Central Washington University observed several adult bull trout during a snorkel survey below Salmon la Sac Bridge (Craig 1996, as cited in Reiss et al. 2012). Due to their size (reported as "large"), the observers speculated that they might be migrating adfluvial fish (James 1998 – 2000, as cited in Reclamation 2000). In 2002, two adult bull trout were observed by USFWS snorkelers just below the potential barrier mentioned above (Mallas 2003); however, these fish were not of the size characteristic of adfluvial adults. Yakama Nation efforts targeting lake trout removal at Cle Elum Reservoir have successfully removed 150 lake trout from the reservoir in the fall and winter of 2013/2014. No bull trout were caught (Anderson 2014a). In summary, it is uncertain if a viable adfluvial bull trout population still inhabits Cle Elum Reservoir; it is also unknown if a resident component exists in the upper Cle Elum River.

Although an angler reportedly caught a bull trout in Cooper Lake in 2007, several subsequent hook-and-line and snorkel surveys in the Cooper River produced none. Therefore, a separate Cooper River bull trout population is not recognized. Any adfluvial bull trout seeking to migrate up the Cooper River would likely be precluded by a steep series of cascades which begins just over a half-mile upstream of the river mouth.

Waptus Lake Population. The Waptus Lake population includes bull trout present in Waptus Lake, the Waptus River above the lake, and the river below the lake (but above a barrier waterfall occurring at about river mile 2.5). The Waptus River is the larger of the two major tributaries of the upper Cle Elum River, entering the river about 5.5 miles above Cle Elum Lake. The Waptus originates as the outflow from several lakes high in the Alpine Lakes Wilderness about two miles upstream of Waptus Lake. From the outlet of Waptus Lake, the river flows for approximately 8.5 miles to its confluence with the upper Cle Elum River.

This population was last officially rated while combined with Cle Elum Lake. The USFWS (1998) considered the Cle Elum/Waptus River population to be depressed, decreasing, and at risk of stochastic extirpation. WDFW rates the status of this stock as unknown (WDFW 2004). For the purposes of this document the status of the Waptus population should be considered unknown.

There have been very few bull trout redd surveys conducted in the Waptus River. These include incomplete surveys conducted by WDFW in 1997 to 1998 and a single survey in the reach below the barrier waterfall conducted by the USFWS in 2003. Also in 2003, the USFWS conducted a redd survey in a reach extending from Waptus Lake upstream approximately 0.6 mile. No bull trout redds were observed in any of these surveys (USFWS 2004).

Catch records compiled by WDFW documented historic bull trout presence in the 1940s and early 1950s when they were evidently abundant according to anecdotal accounts. The species presence in the lake was further documented by WDFW in 1996 when a single juvenile was captured in a gill net and again the next year when an adult was caught by hook-and-line (Anderson 2001, as cited in Reiss et al. 2012). In 2003, the USFWS sampled the lake via angling for 6 to 8 hours and captured numerous brook trout but no bull trout. Juvenile bull trout were reportedly observed in the Waptus River (specific location unknown) during snorkel surveys conducted by the Forest Service in 1990, but an extensive presence/absence survey conducted by the USFWS in 2003 throughout the length of the river produced only one potential bull trout observation, which was made above the lake (USFWS 2004). A fin clip was taken from a juvenile fish observed and captured above the lake in 2003. The results of the genetic analysis for this fish indicated it was an F2 hybrid, a cross between a brook trout and a bull trout/brook trout hybrid (Reiss et al. 2012).

It is believed that Waptus Lake once supported a healthy and likely distinct population of adfluvial bull trout. At this point, the evidence suggests that while some bull trout may persist in Waptus Lake, a viable population may not. It is also possible that a resident component exists in the Waptus subbasin.

6.2.4 Yakima River

Yakima River Population. The upper Yakima local population, if it can actually be considered distinct, appears to be very small (Reiss et al. 2012). The USFWS did not identify an upper Yakima local population at the time of listing (63 FR 31647), but WDFW has recognized a mainstem stock based on old catch records and general observations (Reiss et al. 2012). Bull trout redd surveys conducted along the 11-mile upper Yakima reach between Keechelus Dam and Lake Easton have identified relatively few redds. When the first redd survey was conducted in 2000, two redds were found near Crystal Springs, less than a mile below Keechelus Dam. Surveys were conducted in 6 of the next 14 years with 6 additional redds found (Table 6-2).

Since spring Chinook salmon and brook trout are present in the Keechelus reach and spawn at about the same time as bull trout, bull trout redds need to have associated fish for a positive identification. Only a few of the bull trout redds observed over the period of record had fish associated with them. The two bull trout redds observed in 2000 had four bull trout within the immediate vicinity (Reiss et al. 2012). A bull trout was also observed holding on a redd (located at the mouth of Cabin Creek) in 2001.

During surveys conducted in 2006, three adult bull trout (one believed to be a brook/bull hybrid) and one subadult were observed during snorkel surveys conducted in the upper mile of the reach (Reiss et al. 2012). Other bull trout observations upstream of Easton Dam include a juvenile bull trout located within the lake in 2001, a bull trout captured by an angler in Lake Easton, three adult bull trout observed near Keechelus Dam, and one adult bull trout located near Kachess Dam. Genetic analysis done on a limited number of bull trout observed in the Yakima River has assigned these fish to other local populations (Reiss et al. 2012).

Given these limited observations, it is difficult to ascertain the demographics and life history of the potential bull trout population in the mainstem Yakima River (Reiss et al. 2012). The bull trout that have been observed could belong to a single population group that spawns above Lake Easton but will migrate long distances when conditions (e.g., water temperatures) are favorable. It is also possible that some are fluvial fish belonging to an undocumented spawning population. Additionally, bull trout observed in the upper Yakima River may have originated from populations upstream of upper Yakima storage dams.

6.2.5 Teanaway River

North Fork Teanaway River. Currently, only a single population is recognized in the Teanaway system, and it is classified as fluvial/resident (WDFW 2004). Redds have been observed only in the upper 1.5 miles of the North Fork Teanaway River. Surveys have been conducted since 2005 with counts ranging from 0 to 2 with an average of 1 (Table 6-2). A viable population may no longer exist in the North Fork Teanaway River. If it does, it appears to be on the brink of extirpation. The last bull trout sighting was in 2009 and consisted of a single bull trout (Reiss et al. 2012).

The USFWS (1998) considers the North Fork Teanaway River subpopulation to be depressed, decreasing, and at risk of stochastic extirpation. WDFW rates the status of the North Fork Teanaway River stock as critical (WDFW 2004). Results of genetic analyses show the North Fork Teanaway River population is genetically distinct from all other populations in the Yakima basin (Reiss 2003; Small et al. 2009), though the sample size was very small (Reiss 2003).

6.2.6 Rimrock Reservoir/Clear Lake

Two local populations of bull trout reside in Rimrock Reservoir and spawn in upstream tributaries. One of the populations spawns in Indian Creek and one spawns in the South Fork Tieton River. A third population spawns in the North Fork Tieton River above Clear Lake. Since natural lakes did not occur at Rimrock and Clear Lake, the creation of these reservoirs created adfluvial populations where fluvial populations would have existed before.

Indian Creek Population. Indian Creek flows into the northwest end of Rimrock Reservoir. Indian Creek originates in the William O. Douglas Wilderness Area and approximately 5 miles of the stream is accessible to bull trout. Several springs, but no perennial tributaries, contribute flow to this accessible reach (Reiss et al. 2012). In extremely dry years, short reaches of the creek dewater.

The spawning period for the Indian Creek population occurs primarily during September but can extend through mid-October. Complete redd surveys have been conducted in Indian Creek since 1988. The number of redds increased steadily over the first 8 years to average over 200 redds between 1995 and 2000 (Reiss et al. 2012). Beginning in 2001, redd numbers declined to an average of 94 redds (Table 6-2). A large winter flood in 1996 that scoured the primary spawning and rearing areas for multiple age classes may have affected adult recruitment for several years after (Reiss et al. 2012). Redd counts ranged from 130 to 200 from 2008 to 2012 (Table 6-2). However, massive flood and mudlow events occurred in the fall of 2013/winter of 2014 in Indian Creek (Anderson 2014b; Torretta 2014). Flooding, sediment, and debris flows that occurred in the fall potentially destroyed some redds early in the season and may have discouraged bull trout from spawning (Anderson 2014b). Redd counts have been very low since these events: 10 in 2013 and 28 in 2014 (Table 6-2). In 2014, surveyors noted that the massive sediment and debris flow that occurred during the previous year altered the stream bed and channel composition in the spawning area and appeared to discourage spawning (Anderson 2014b). The limited spawning that was observed occurred in a spring-fed area above the area affected by the debris flow.

The USFWS (1998) did not consider the Indian Creek population individually, but considered its status as part of the Rimrock "subpopulation" and identified it as stable and increasing. WDFW similarly groups the Rimrock adfluvial populations and rates the status of this stock as healthy (WDFW 2004).

Juvenile bull trout use the entire length of Indian Creek for rearing. Rimrock Reservoir provides FMO habitat for subadult and adult fish. Adult bull trout enter the creek in late August/early September just prior to beginning of spawning (James 2002a).

South Fork Tieton River Population. The South Fork Tieton River supports a single local population of adfluvial bull trout. It is possible that a resident component exists as well although this has not been confirmed.

Since 1999, an average of 189 redds has been counted annually (Table 6-2). The South Fork Tieton River population has been the most stable bull trout population over time in the Yakima basin and is currently the strongest in terms of abundance (Reiss et al. 2012).

Juvenile bull trout primarily rear within the spawning area and have also been found in several of the creeks in which spawning activity has not been documented. Rimrock Reservoir provides FMO habitat for subadult and adult fish. It appears that adult bull trout enter the South Fork Tieton River prior to spawning earlier than other populations in the Yakima basin. A copy of a local angler's fishing journal provided to Eric Anderson documented his catch from 1987 to 1994 and included bull trout caught in June. Snorkel surveys in 2000 to document spawning migration timing found adult bull trout moving into the river in late July (James 2002a). The spawning period for the South Fork Tieton River population occurs primarily during the month of September but can extend through mid-October.

North Fork Tieton River Population. The North Fork Tieton River originates in the Goat Rocks Wilderness and flows first into Clear Lake, a small 5,500 acre-feet impoundment, then flows into the west end of Rimrock Reservoir. Spawning and rearing occurs within the North Fork Tieton River and a small, unnamed tributary to this river. Bull trout may use Clear Lake or Rimrock Reservoir for FMO habitat. Below Clear Creek Dam, the North Fork Tieton River flows for about 0.7 mile before entering Rimrock Reservoir.

Surveys are conducted in an index reach approximately 2.3 miles in length, which ends at the barrier waterfall. Survey efforts can be hampered by poor visibility associated with glacial till. An average of 16 redds have been observed since 2001, with a range of 1 (associated with incomplete surveys in 2004 and 2006) to 37 redds in 2007 (Table 6-2) (Anderson 2014b).

The spawning period for the North Fork Tieton River population occurs primarily during September but can extend through mid-October. Problems have been encountered in attempting to annually conduct complete redd surveys in the North Fork Tieton River. The river is glacial-fed and is usually milky with glacial flower until late in the summer. Its hydrology is "flashy" and river discharge quickly changes from stable and clear to high and turbid after fall rains or high daytime temperatures, both of which are common during the bull trout spawning period. This results not only in difficult survey conditions but also in conditions in which redds become undetectable if an event occurs before or between surveys. Bull trout spawning activity was confirmed on the North Fork in 2004 when 14 bull trout were documented including 2 adults (greater than 500 mm TL), 5 subadults (200-299 mm TL), and 7 juveniles (less than 199 mm) and a single redd.

6.2.7 Bumping Reservoir

A single adfluvial local population of bull trout is associated with Bumping Reservoir, spawning and rearing in Deep Creek. The upper Bumping River is the other major tributary to the reservoir. Limited bull trout spawning and rearing have been observed in the approximate one-mile reach of this stream accessible below a barrier waterfall (the stream is extensively braided approximately doubling the length of its accessible habitat). Subsequent genetic analysis of approximately juveniles collected in the upper Bumping River showed them to be indistinct from Deep Creek bull trout (Reiss et al. 2012).

Deep Creek Population. Deep Creek supports a single local population of adfluvial bull trout. Spawning and rearing primarily occurs in Deep Creek from the reservoir upstream to a natural passage barrier created by a waterfall (Reiss et al. 2012). Some limited spawning also occurs in the lower portion (about 0.25 mile) of Copper Creek and in upper Bumping River. Bumping Reservoir and the upper Bumping River provide FMO habitat for subadult and adult fish. Adult bull trout generally enter Deep Creek in late July to mid-August. Spawning begins in late August and is usually completed by mid-September. This spawning period is earlier than any other local population in the Yakima basin.

The USFWS (1998) considered the Deep Creek population to be depressed, decreasing, and at risk of stochastic extirpation. The WDFW rates the status of this stock as depressed (WDFW 2004). Both of these ratings warrant reconsideration (Reiss et al. 2012).

Redd counts for the Deep Creek population are variable, ranging from 51 (2001) to 199 (2012) (Table 6-2). On average, there has been 122 redds since 1999. Population size estimates based on redd counts indicate that population is currently one of the strongest in the Yakima basin (Reiss et al. 2012).

Redd count data also shows the effect dry years, and thus the occurrence of reach dewatering, have on this population's reproductive success. The effect is evident in the redd counts obtained during particularly dry years (e.g., 1993, 1994, 1996, 2001, 2003, and 2005) when the number of redds observed ranged from 12 to 73 (Reiss et al. 2012).

6.2.8 Naches River

The Naches River is the main tributary of the Yakima River entering just north of the city of Yakima. It begins approximately 45 miles upstream at the confluence of the Bumping and Little Naches Rivers (the American River flows into the Bumping River about 3.5 miles above this point). Major tributaries of the Naches River include the Tieton River and Rattlesnake Creek. With the exception of storage dams, which block upstream migration on the Bumping and Tieton Rivers, bull trout are able to migrate freely within the system. Below these dams, there are 16.5 miles of habitat available to fish on the Bumping River and 21 miles on the Tieton River. Numerous smaller tributary streams also flow into the Naches River. Three local bull trout populations comprise the Naches River fluvial populations.

American River Population. These populations spawn in the American River, Rattlesnake Creek, and Crow Creek (tributary to the Little Naches River) and all use the mainstem Naches River as FMO habitat, as well as possibly the mainstem Yakima River upstream and downstream from the confluence with the Naches River. There is limited evidence of movement outside of the Naches River although one fish tagged during the WDFW radio telemetry study (Mizell and Anderson 2010) moved into the Yakima River and one bull trout sampled at Roza Dam (RM 205.9) genetically assigned back to Rattlesnake Creek (Small and Martinez 2011). The contribution to the Naches River fluvial populations from fish entrained out of Rimrock and Bumping Reservoirs is largely unknown but appears to occur to some limited extent; two of 13 adult bull trout trapped in 2003 after spawning in Rattlesnake Creek assigned to the South Fork Tieton River population, evidence that entrained fish may be contributing to Naches River fluvial bull trout populations (Small and Martinez 2011). However, these populations remain distinct from populations above the reservoirs, indicating that one-way gene flow since the time of dam construction (about 100 years) is not homogenizing populations (Small et al. 2009).

Rattlesnake Creek Population. Rattlesnake Creek supports a single local population of bull trout, which displays a fluvial life history type; a resident component may exist as well but this has not been confirmed. The primary spawning area for this population is located in the south fork above the wilderness boundary at RM 14 and extends about seven miles upstream; it includes Little Wildcat and Shell Creeks. Juvenile bull trout are assumed to rear in Rattlesnake Creek all the way down to the mouth; adult FMO habitat is primarily the Naches River below the Rattlesnake confluence but some adults also utilize FMO habitat upstream (Mizell and Anderson 2010). An unknown but assumed small number of adult bull trout evidently migrate up the Tieton River and the mainstem Yakima River as well. Adult bull trout migrate into Rattlesnake Creek in late June and July and are in close proximity to their spawning grounds by mid-August. The Rattlesnake Creek population spawns primarily during the month of September. Annual redd counts have been highly variable with counts ranging from 13 to 69. From 1999 to 2014 there has been an average of 40 redds (Table 6-2).

The USFWS (1998) did not consider the Rattlesnake Creek population singularly but considered the Naches River "subpopulation" (i.e., all three Naches River fluvial populations) to be depressed with an unknown trend. WDFW similarly lumped the Naches River fluvial populations and rated the status of this stock as critical (WDFW 2004).

Results of genetic analyses show this population is genetically distinct from all other Yakima basin populations but did cluster with the other Naches River fluvial populations, indicating some degree of gene flow either currently or historically (Reiss 2003; Small et al. 2009).

Crow Creek Population. Crow Creek supports a single local population of bull trout that displays a fluvial life history; a resident component may occur as well but this is unconfirmed. The creek is the only known bull trout spawning stream in the Little Naches

drainage despite its large size and the presence of suitable habitat elsewhere. The spawning area for this local bull trout population extends from about a mile below the wilderness boundary (RM 5.2) to about 4.5 miles above with most spawning concentrated in the upper end of this reach. There is no known spawning activity in the smaller tributaries. Juvenile bull trout rearing likely occurs throughout the length of Crow Creek. Adult FMO habitat includes the Little Naches River, the mainstem Naches River, and likely the Bumping and American Rivers although this is unconfirmed. Timing of spawning migration is unknown but likely occurs in the late summer, similar to other Naches fluvial populations.

This population appears to be quite small. After relatively high counts the first two years of surveying, the number of observed redds plummeted and has not bounced back (Table 6-2). Since 2001, an average of only seven redds has been counted annually in Crow Creek.

Results of genetic analyses show this population is genetically distinct from all other Yakima basin populations, but clusters with the other Naches River fluvial populations, indicating some degree of gene flow (Reiss 2003; Small et al. 2009).

6.2.9 Ahtanum Creek

The Ahtanum Creek drainage supports what is currently treated as a single local population of bull trout. There are known spawning areas in the upper reaches in all three forks and Shell Neck Creek, a tributary to the North Fork. However, there is a falls at RM 2.5 on the South Fork Ahtanum Creek that is believed to be a barrier to upstream migration. Juvenile rearing occurs in the upper reaches and may extend all the way to the confluence of the forks. Adults are assumed to utilize the entire drainage as FMO habitat. It is possible that some adults migrate seasonally into the mainstem Yakima River when conditions (i.e., water temperatures) are suitable (see below), but timing of migration from FMO areas to spawning reaches is unknown.

Currently, this population is considered a resident/fluvial life history type. Low streamflows due to irrigation withdrawals, thermal barriers, and habitat conditions in lower Ahtanum Creek limited migratory access to the mainstem Yakima River as early as 1880 with the construction of numerous irrigation diversions. These conditions persisted through the 1900s and beyond. Migratory conditions have improved in the last decade but there is very limited evidence of fluvial connectivity. A smolt trap has been operated by the Yakama Nation at the mouth of Ahtanum Creek since 2000 to enumerate juvenile steelhead and coho leaving the drainage (Anderson 2010). Only one out-migrating adult bull trout has been caught in the trap during its operation.

The USFWS considers the Ahtanum Creek population to be depressed, decreasing, and at risk of stochastic extirpation (USFWS 2002); the WDFW rates the status of this population as critical (WDFW 2004). If future genetic analysis determines that each of the forks represents a distinct, isolated population, each of these populations would warrant a

depressed or critical status. Genetic analysis concurs with this lack of connectivity to the larger fluvial system (Yakima or Naches Rivers). Genetic samples were collected from all tributaries in the Ahtanum Creek drainage and were analyzed as one population. The population was unique when compared to all the other Yakima basin populations and did not cluster with the Naches River fluvial populations (Reiss 2003; Small et al. 2009).

The Proposed Action includes the O&M of three fish screen structures located on Ahtanum Creek, but does not include any irrigation diversions on this tributary, and these diversions are all associated with either WIP or private diversions. Because the Proposed Action will not influence habitat conditions in Ahtanum Creek, no further analysis Ahtanum PCEs is provided.

6.3 Yakima Core Area Environmental Conditions

The Yakima Bull Trout Action Plan (Reiss et al. 2012) provides a current assessment of threats to the bull trout in the Yakima Core Area. These threats include:

- **Agriculture** – Riparian degradation, sedimentation, impaired water quality, and harassment. Irrigation return flows can be warm and contain increased levels of sediment, nutrients, and contaminants. Specific areas impacts include Yakima River mainstem, lower Rattlesnake Creek, Big Creek, lower Taneum Creek, Teanaway River, and Ahtanum Creek.

- **Altered flow** – Impacts associated with flow regimes that are significantly altered in magnitude, timing, and duration through water storage operations and/or water withdrawals. Water withdrawals reduce instream flow (sometimes dewatering stream reaches) and increase water temperatures.

- **Angling** – Combination of hatchery-stocked rainbow trout, large catch limits, use of bait and easy public access can result in high angling pressure than can result in angling-related injury and mortality. Poaching is of concern in Gold Creek, Box Canyon Creek, Deep Creek, South Fork Tieton River, and Indian Creek.

- **Development** – Impacts related to residential development along bull trout bearing waters, includes riparian degradation, erosion, sedimentation, channel disturbance, chemical contamination, and harassment of bull trout. Human population growth in the Yakima Core Area is anticipated to increase about 45 percent by 2020 (YSFWPB 2004).

- **Dewatering** – Restricts fish habitat access, quantity and quality, and increasing risk of stranding. Reservoir drawdown can increase predation and physiological stress in trying to access spawning streams.

- **Entrainment** of bull trout through unscreened outlet works of storage dams, irrigation diversions can result in physical injury, isolation from upstream habitats, and/or entrainment into irrigation systems.

- **Forest management** – Can have negative impacts on stream condition including hydrology, sediment load, riparian health, and water temperatures. These can result from current and past forest management practices including forest roads. Forest management has degraded habitat conditions and access in the upper Yakima River, Cle Elum River, Taneum River, Ahtanum Creek, Teanaway River, Naches River, and the Tieton River.

- **Grazing –** Livestock grazing on adjacent lands can result in riparian degradation, sedimentation, impaired water quality, and bull trout harassment. Livestock grazing have particularly degraded bull trout habitat in Ahtanum Creek, Teanaway River, and the Tieton River.

- **Introduced species** – Presence and potential impacts (e.g., introgression, competition, predation, and disease transmission) associated with the introduction of lake, brook, or brown trout.

- **Limited extent of habitat** – Habitat quantity (i.e., stream distance accessible) that has been altered in streams whose lower reaches were inundated by reservoir construction.

- **Low abundance** – A demographic threat resulting from a low population census size as estimated from annual redd counts. Populations receiving a significant threat level under this threat are believed to be at an elevated risk of extirpation.

- **Mining** – Negative impacts on stream health resulting from mining operations (oil, natural gas, coal, precious metals, and gravel). Mining has impacted water quality and channel complexity.

- **Passage barriers** – Artificial barriers to fish passage, including storage dams, diversion dams, recreational dams constructed by the public, culverts, and passage problems associated with irrigation reservoir depletion that preclude passage into spawning tributaries (i.e., dewatering at the mouth of a stream on a reservoir bed). Fragmentation of habitat may be contributing to loss of genetic diversity.

- **Prey base** – Impacts that have negatively affected the availability of food (fish and macroinvertebrates).

- **Recreation** – Impacts associated with recreational use of lands adjacent to bull trout bearing waters (includes riparian degradation, erosion and sedimentation, channel disturbance, and harassment of bull trout). Does not include impacts of associated forest roads or angling pressures on bull trout.

- **Transportation networks** – Impacts associated with major roads or highways (paved) or rail lines.

The following sections contain a more specific overview of habitat conditions in the Yakima Core Area that effect bull trout.

6.3.1 Water Quality and Hydrology

Chapter 4 of this BA contains an assessment of water quality and hydrological conditions in the Yakima Core Area. The "Regulated River Context" in Section 4.2.2 describes the primary ways hydrology has changed in associated with flow regulation for irrigation and flood control purposes. Water quality and hydrology in spawning and rearing tributaries located outside the Action Area are also subject to varying degrees of alteration. It is outside the scope of this BA to evaluate water quality and hydrology alterations outside the Action Area, though the next section provides context for some of these alterations.

6.3.2 Watershed Conditions

Forest practices, agriculture, urbanization, flow regulation, along with diking and streambank protection have simplified stream channels, damaged riparian habitat, and impaired the ability of streams to interact with their floodplains and aquifers across the Yakima subbasin (YSFWPB 2004). Gravel resources have been mined up to the river's edge, urban development has encroached into the river corridor, and floodplain and riparian habitat has become tracts of agricultural land (YSFWPB 2004).

Bull trout are less likely to use streams for spawning and rearing in areas with high road density, and are typically absent at mean road densities above 1.1 kilometer per square kilometer (1.7 miles per square mile) (Quigley and Arbelbide 1997). The extensive road network throughout the Yakima Core Area has generally reduced habitat quality. In particular, the Teanaway and Little Naches drainages have high road densities and corresponding reductions in habitat suitability.

Before 1905, riparian corridors and habitat were estimated to have covered 2 percent of the land area in the Yakima basin; that area has decreased to 0.5 percent currently (Quigley and Arbelbide 1997). Healthy riparian areas contribute to the amount of LWD in streams, to channel dynamics, to nutrient loads; therefore, to community structure, and to lower water temperature; these factors can have far-reaching effects both upstream and downstream (Bolton and Shellberg 2001). Loss of these functions is typically associated with reduced productivity of fish populations.

The upper Yakima River, upper Naches River, Ahtanum Creek, Teanaway River, and Taneum Creek watersheds all have long histories of forest management. For example, in a 1997 analysis conducted in the upper Yakima, 56 percent of the vegetation within the

watershed was characterized as immature for hydrologic function (USFS 2005). The watershed has many roads constructed for timber harvest purposes, with a road density of 2.2 kilometers per square kilometer (3.6 miles per square mile) (USFS 2005). Detrimental impacts from timber management can include the removal of LWD, and the reduction in riparian vegetation which results in water temperature increases, accelerated erosion, and de-stabilization of stream channels.

Past forest management has led to changes in natural disturbance regimes. Past and ongoing fire suppression, increased tree densities and forest fuel continuity, and residential development along the wildland-urban interface, are among the factors that can lead to larger and more severe wildfires. Uncharacteristically, severe wildfires can lead to levels of increased mass wasting, increased sediment delivery to streams, reduced stream shade that increases water temperature, and other effects to the aquatic environment that exceed the natural range of variation and physiologic tolerance levels of bull trout. Wildfire can improve aquatic habitats and benefit fish populations in natural situations of well-connected habitats and mixed-severity fire. However, isolated populations with limited access to suitable habitat, like those in the Yakima Core Area, can be extirpated by exposure to severe wildfire or other extreme disturbance events.

During the summer of 2012, the Table Mountain Fire (42,312 ac) and Yakima Complex fires (2,300 ac) burned within the Yakima Core Area. The Table Mountain Fire occurred in the Swauk Creek drainage and had large areas of high-severity fire at higher elevations. Bull trout currently are not present in this watershed. The Yakima Complex consisted of many smaller fires, the largest of which was the Wild Rose Fire, which occurred in the Tieton River drainage and burned about 500 acres. A fluvial population of bull trout is present in the Tieton River near the burned area. Analysis of the effects of both these fires on aquatic habitats is pending.

The Ahtanum, Teanaway, and Tieton watersheds within the basin also have a long history of cattle and sheep grazing dating back to the 1800s (NPPC 2001). Improperly managed livestock grazing can degrade bull trout habitat by removing riparian vegetation, which destabilizes streambanks, widens stream channels, promotes incised channels, lowers water tables, reduces pool frequency, increases soil erosion, and alters water quality (Howell and Buchanan 1992; Mullan et al. 1992; Overton et al. 1993). These effects can reduce overhead cover, increase summer water temperatures, and increase sediment in spawning and rearing habitats.

The expansion of agriculture and the associated use of pesticides and herbicides in the basin have resulted in the degradation of water quality within streams and rivers that are adjacent to, and downstream of, agricultural fields. Currently, 188,259 hectares (465,000 acres) are under irrigation in the basin. The Yakima basin ranks 5th nationally in total agricultural production (Reclamation 1999). In addition to degraded water quality, bull trout habitat within the basin has been adversely affected by irrigation diversions and water withdrawals (Snyder and Stanford 2001).

Historically, hard rock and placer mining occurred at several sites within the basin. These mining operations dredged, diked, and confined stream channels and leached toxic heavy metals such as mercury into the stream channels. Although no large mines have been constructed recently, there is a limited amount of small-scale suction dredging and hard rock mining still occurring in several watersheds including the Little Naches and Cle Elum (Dawson 1999; MacDonald 1999, both as cited in USFWS 2002). Suction dredge mining may alter the substrate composition and benthic insect community composition where in-channel mining activity occurs (Harvey and Lisle 1998). Studies indicate that such changes have occurred (Stanford et al. 2002) but mining has not been specifically identified as a root cause. In the upper Kachess River, a third-order tributary to Kachess Reservoir, tailings left from copper mining activities around the turn of the century have washed down during rainstorms (Meyer 2002). Now, because of the massive quantities of alluvial material that have been deposited, these tailings cause the frequent dewatering of the upper Kachess River in the summer and fall. The Swauk Creek drainage has been impacted by extensive hard rock and placer mining for gold, but bull trout have only been rarely found near the mouth of this creek.

Gravel mining has also affected bull trout in the Yakima basin. The Gold Creek gravel pit has lowered sub-surface water levels to an unknown degree and likely has contributed to the frequent dewatering of Gold Creek. The Selah Pit, a gravel mining operation near the city of Yakima, is the largest gravel pit in the State of Washington and covers over 93 hectares (230 acres).

Specific areas within the Yakima basin have grown in popularity as a preferred area for home sites. As the human population increased, more impacts to riparian areas and water quality have also increased (NPPC 2001). Damage includes increases in nutrient loading from septic systems and chemical applications, alterations to channel morphology, and effects from road construction. Areas where floodplain development is proceeding most rapidly are lower Little Creek and the Naches River (Anderson 2001).

6.3.3 Habitat Connectivity

Passage barriers within the Yakima Core Area have fragmented the bull trout metapopulation and limited migration to high quality spawning, foraging, and overwintering habitat. Of the 16 identified local populations, 12 are either completely or partially isolated by physical barriers. The USFWS has concluded that across the Core Area, low numbers of migratory bull trout accompanied by lack of passage, limits the potential for genetic exchange and the reestablishment of local populations if local extirpation occurs.

Population genetic studies have shown little gene flow among most local populations of bull trout in the Yakima Core Area. The genetic structure of twelve spawning populations of bull trout within the Yakima Core Area has been examined in two studies; one using six polymorphic microsatellite loci (Reiss 2003) and a second using sixteen loci (Hawkins and Van Bargen 2006; Small et al. 2009). Both studies found high variability among

populations. Small et al. (2009) observed that bull trout life history and physical requirements for spawning contribute to observed genetic differentiation. Bull trout have high spawning site fidelity in distinct headwater areas. Physical barriers can further isolate local bull trout populations.

Within the Yakima basin, relatively high gene flow was observed between the American River and Union Creek Naches fluvial populations, which are characterized by spawning grounds that are relatively close and do not have physical migration barriers (Small et al 2009 p. 12). Genetic differentiation observed for the Indian Creek and S.F. Tieton River populations appears to both reflect natal spawning site fidelity and the impact of the Tieton dam. There are no physical barriers between the Indian Creek and S.F. Tieton River local populations, yet these two populations are significantly different. However, they are more closely related to each other than to bull trout from other Naches River tributaries which are separated by storage dams. Genetic analysis from individuals from the nearest spawning tributary downstream of Tieton dam, Rattlesnake Creek, indicates that there is one-way geneflow from the Tieton basin populations into this tributary, presumably from bull trout entrained out of Rimrock Lake.

Several approaches to phylogenetic analyses all suggested that local populations in Ahtanum Creek and the North Fork Teanaway Rivers are highly differentiated from other populations in the Yakima subbasin, suggesting these populations may be composed largely of resident individuals (Small et al. 2009, pg. 10). In the Naches subbasin, bull trout from Deep Creek, isolated above Bumping Dam, are highly distinct from the other local populations in the subbasin (Small et al. 2009, pgs.10 – 11).

Telemetry studies of fluvial and resident bull trout also have provided insights about connectivity among populations and movement patterns (Mizell and Anderson 2010). The Naches River fluvial populations exhibit similar overwintering behavior in the mainstem Naches River, but timing varies significantly among populations (Mizell and Anderson 2010). Overwintering occurs in several deep pools where the populations intermingle over the winter months, then separate out for spawning. Across local populations, spawning site fidelity was found to be at or near 100 percent, supporting the results of genetic analyses. The Ahtanum population was found to be isolated or semi-isolated from the remainder of the Yakima basin, and the populations in each of the three forks of the Ahtanum are very nearly isolated from each other (Mizell and Anderson 2010).

Telemetry studies in the upper Columbia River core areas have found some individual bull trout moving between core areas. Whether these migratory individuals spawned successfully and contributed to gene flow among core areas is unknown. PIT-tag infrastructure in the Yakima Core Area have documented one instance of a bull trout moving upstream into the Yakima basin from outside the watershed. In June 2011, a bull trout originating from the Entiat River was detected at Prosser Dam, and then subsequently detected in the mainstem Columbia River (at Rock Island and Rocky reach) and Entiat River in subsequent years.

6.4 Critical Habitat PCEs

6.4.1 Analytical Approach

Within designated critical habitat areas, the PCEs for bull trout critical habitat are those physical and biological features that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Based on current knowledge of the life history, biology, and ecology of the bull trout and the characteristics of the habitat necessary to sustain its essential life-history functions, the USFWS has determined that the following PCEs are essential for the conservation of bull trout. Also summarized are the conditions within the Yakima Core Area related to each PCE.

The USFWS evaluates activities that cause adverse effects to critical habitat to determine if they are likely to "destroy or adversely modify" critical habitat to an extent that it no longer serves the intended conservation role for the species nor retains the function of those PCEs that relate to the ability of the area to support the species. Activities that may destroy or adversely modify critical habitat are those that alter the PCEs to such an extent that the conservation value of critical habitat is appreciably reduced (75 FR 63898).

This BA will assess whether proposed actions may directly or indirectly affect PCE's related to bull trout critical habitat.

In the baseline analysis for each PCE, Reclamation identified whether a PCE is present or not present in an area and how it contributes to the habitat use for which an area was designated. In areas where a PCE is present and fully functioning for its intended use, Reclamation described the PCE as "Fully Functional." Where baseline factors might limit the performance of a PCE, Reclamation described the PCE as "Not Fully Functional." Finally, where a PCE is not supported within an area or is so degraded to make no meaningful contribution to a designated use, Reclamation described a PCE as "Not Present." In the effect analysis for each PCE, Reclamation described how our proposed actions influences each PCE and determines how and to what extent the proposed actions affect each PCE. Where a proposed action degrades a PCE to such a degree to affect a change in the function and use of a designated critical habitat area for the use it was designated, Reclamation described the effect as "adverse." Where a proposed action influences, but does not alter the function of a PCE, Reclamation described the effect as "insignificant." Where a proposed action may influence, but the effects are so small that they are not detectable, Reclamation described the effect as "discountable;" meaning those effects that are extremely unlikely to occur (USFWS and NOAA Fisheries 1998).

6.4.2 Bull Trout Use of Designated Critical Habitat

The PCE effects baseline description and effects analysis is organized based on geographic area and life-history considerations, with explicit attention given to spawning/rearing (SR) and foraging, migratory, and overwintering (FMO) uses. The upper Yakima Adfluvial and Naches Adfluvial areas each contain five local bull trout populations located upstream of the storage reservoirs (Table 6-3). For these populations, SR habitat is upstream of the Project reservoirs and outside the Action Area (USFWS 2010). Access to SR habitat is influenced by varial zone habitat conditions within each project reservoir's drawdown area. FMO habitat is located in each population's respective reservoir. Areas downstream of the dams, including the Keechelus Reach of the upper Yakima River, lower Cle Elum River, lower Kachess River, the Tieton River, Bumping River, and Lake Easton, serves as FMO habitat to bull trout entrained out of project storage reservoirs. The upper Yakima River above Easton Dam may provide SR habitat for bull trout entrained out of project reservoirs.

For the upper Yakima population, SR and FMO habitat is designated for the Keechelus reach of the upper Yakima River (USFWS 2010). This is the area within the Action Area where juvenile bull trout presence is most likely to occur, though even in this reach there is no direct evidence of juvenile occupancy. Lake Easton is designated as FMO habitat, and bull trout may utilize the Yakima River below Easton Dam for FMO habitat as well. These areas are all located within the Action Area. Detections at Roza Dam provide the best indication of frequency and timing of bull trout presence in the mainstem Yakima River downstream of Easton Dam to the Naches River confluence. Between 2001 and 2013, 0 to 5 bull trout have been detected annually. Bull trout have been detected at Roza from September through June, but 91 percent of the detections have been from September through March.

Three local populations are located within the Naches Fluvial area. While SR areas for these populations are located in tributaries outside the Action Area, FMO habitat is within the Action Area (USFWS 2010). The Naches River from Yakima Confluence to Little Naches / Bumping River confluence provides FMO habitat and connectivity for the Naches Fluvial populations, and Naches Adfluvial individuals entrained from project reservoirs. Cowiche Creek is identified as providing FMO habitat to the Naches Fluvial populations. Since this tributary is affected by operational spill from French Canyon Dam, it is within the Action Area.

Available bull trout radio-telemetry data provides detailed information of foraging and overwintering habitat use in the Naches River. Bull trout presence in overwintering grounds along the Naches River was generally between mid-November and Mid-April (Mizell and Andersen 2006). The majority of fish were located in holes and riffles along the mainstem Naches River from RM 40 (Cliffdale) to RM 17 (Wapatox Diversion Dam). In mid-April, fish became more active and moved either upstream of downstream of their winter habitat, up to 1.25 miles. By mid- to late-June, the majority of fish had initiated upstream movement. Fish from the Rattlesnake population moved more quickly and reached Rattlesnake Creek by

late May to early June. Fish in the American and Union populations moved upstream more slowly, and reached staging grounds below the Union Creek/American River confluence by mid-August to early September. Union Creek fish moved into the spawning grounds en masse in late September, while American bull trout movement was more diffuse and ranged from mid-late September to early October.

While currently unoccupied by a local bull trout population, Taneum Creek is designated as critical habitat (USFWS 2010). The lower 2.3 miles of this tributary receives operational spill from KRD and therefore within the Action Area.

USFWS has also identified that the lower mainstem Yakima River (between the Naches River and Columbia River confluences) provides FMO habitat (USFWS 2010). While some bull trout originating from outside the basin may traverse through this area, available data indicates that this is a relatively rare occurrence. Given both its distance from SR habitats and the low occurrence of out-of-basin bull trout, bull trout occupancy in the lower Yakima River is expected to be low. Available bull trout observations are consistent with this expectation. Despite extensive monitoring by the Yakama Nation of adult salmonids at Prosser Dam, there is a single bull trout observation at this location. This fish originated from the Entiat basin and was detected at Prosser on June 30, 2011. Additionally, an adult bull trout was captured in the mainstem Yakima River near Benton City by WDFW biologists in 1997. Bull trout radio-tracking investigations conducted from 2004 through 2005 of Naches and Ahtanum local bull trout populations detected no fish movement into the Yakima River (Mizell and Andersen 2010). One bull trout detected at Roza Dam during this investigation was genetically similar to fish located in the stilling basin below Tieton dam. The lower mainstem Yakima River is thought to be primarily used as migratory or rearing habitat for small numbers of adult and sub-adult bull trout. The USFWS has identified this area as essential for maintaining connectivity between all local populations within the Yakima Core Area and connection to the Columbia River FMO.

Table 6-3. Habitat delineations for PCE analysis.

Name	Geographic Area	Local Population	Habitat Type within Action Area
Upper Yakima Adfluvial			
	Kachess Reservoir	Kachess River	FMO
	Kachess Reservoir	Box Canyon	FMO
	Keechelus Reservoir	Gold Creek	FMO
	Cle Elum Reservoir	Cle Elum River	FMO
	Cle Elum Reservoir	Waptus	FMO
Upper Yakima Fluvial			
	Yakima River	Upper Yakima	FMO and SR

Name	Geographic Area	Local Population	Habitat Type within Action Area
Naches Adfluvial			
	Rimrock Reservoir	Indian Creek	FMO
	Rimrock Reservoir	South Fork Tieton	FMO
	Rimrock Reservoir	North Fork Tieton	FMO
	Bumping Reservoir	Deep Creek	FMO
	Bumping Reservoir	Bumping River	FMO
Naches Fluvial			
	Naches River	Rattlesnake Creek	FMO
	Naches River	Crow Creek	FMO
	Naches River	American Creek	FMO
Unoccupied Tributaries			
	Cowiche Creek	Naches Fluvial (FMO)	FMO
	Taneum Creek	N/A	FMO
Yakima Mainstem			
	Yakima River	All	FMO

6.4.3 Analysis of PCEs in this Assessment

For the purpose of this assessment, Reclamation recognizes that each PCE works in concert with others to support a designated use. Often, there is overlap between relevant factors for several PCEs. For example, PCEs 5 and 8 each consider water temperature, but in different ways. This section clarifies how Reclamation evaluated each PCE.

PCE 1

PCE 1 requires "springs, seeps, groundwater sources and subsurface connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia." PCE 1 plays different roles depending on the habitat type. In spawning and rearing habitats, groundwater influence can provide an important cue for spawning behaviors (75 FR 63898, page 63930, citing Baxter and Hauer 2000, page 1476). In FMO habitat, groundwater can provide a source of thermal refugia and water quality. The importance of this contribution to FMO habitat is relative to other sources of thermal refugia and water quality. Where groundwater influence plays a relatively small role in determining thermal refugia and water quality, the PCE was considered as present, but providing a limited contribution. For example, in deep reservoir environments, the thermal regime of the reservoir and tributary inflow renders groundwater influence a relatively insignificant factor in determining the presence of thermal refugia and adequate water quality. In these areas, Reclamation evaluated the presence of thermal refugia under PCE 5 and water quality under PCE 8.

PCE 2

PCE 2 requires "migration habitats with minimal physical, biological, or water quality impairments between spawning, rearing, over-wintering, and freshwater and marine foraging habitats, including, but not limited to, permanent, partial, intermittent, or seasonal barriers." Generally, PCE 2 was considered as present in waterbodies where bull trout are able to migrate between different habitats even if some impediments exist. Where impediments exceed the minimal threshold described in the PCE and bull trout migration behaviors are significantly affected by an impediment, the PCE is described as not fully functioning. There are areas where impediments exist both within the Action Area and within spawning tributaries upstream of the Action Area. In this circumstance, the PCE is described as not fully functioning, and passage barriers under Reclamation influence are distinguished from separate passage barriers outside the Action Area. In order for this PCE to be considered as not present, impediments would have to be so severe that little meaningful migration can take place. To evaluate this PCE, Reclamation considered physical impediments downstream of facilities, including water temperature barriers.

A recurrent effect on PCE 2 in reservoirs is associated with the exposure of the varial zone. The varial zone is the migration corridor where a tributary flows into a reservoir which is periodically inundated or dewatered with fluctuating reservoir water surface levels (e.g., full pool levels or various drawdown levels). A varial zone is seasonally present when the reservoir is drawn down below the point where the habitat changes from lentic conditions representative of the Action Area. Degradation of the varial zone occurs when high amounts of sediment from upstream tributaries deposits within a reservoir, forming delta-like zones at the mouths of tributaries. Reservoir drawdowns can expose greater amounts of the varial zone. Varial zones can present impediments to bull trout migration in different ways. In most instances, a lack of habitat complexity and cover in varial zones may expose migrating bull trout to an increased risk of predation. In limited cases, varial zones can expose physical barriers as well.

PCE 3

PCE 3 requires "[a]n abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish." This PCE was considered as present and contributing to FMO habitat where a sufficiently abundant and diverse prey base allows for growth of both individual and populations of bull trout. Where the prey base is present to support individual growth, but may limit the growth of a population, PCE 3 was considered present, but providing a limited contribution to FMO habitat. If the prey base was not sufficient to influence bull trout use of a particular area, PCE 3 was considered as not present.

Adverse influence can occur where water quality conditions cause an imbalance in the relationship between phytoplankton and zooplankton production. This can reduce dissolved oxygen levels, increase algae induced turbidity, and disrupt primary productivity in ways that directly and indirectly influence the production of bull trout prey. As these processes occur within a reservoir, they may influence downstream conditions.

PCE 4

PCE 4 requires "complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes, that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks, and unembedded substrates to provide a variety of depths, gradients, velocities, and structure." PCE 4 was considered as present when a habitat exhibits some complex features. Some limiting factors may reduce the contribution of complexity to FMO habitat. Reclamation's analysis focused on the influence of hydrologic conditions on the interface with riparian zones. In manmade environments such as reservoirs, the complex features and the processes that maintain them differ from those in natural environments. Shoreline areas of reservoirs present a similar case. This BA notes that reservoir operation influences shoreline complexity; however, reservoir complexity was evaluated with an understanding of the migratory habits of bull trout and their use of critical habitat within the context of the Critical Habitat Subunit. As such, the function of this PCE is described, in part, using habitat outside the Action Area as well as habitat within the Action Area with access through an open migration corridor. The total habitat complexity may be less in a reservoir environment when not at full storage; however, functional complexity refers to the availability of habitats within the Action Area in addition to an open migration corridor (PCE 2) allowing fishes to use a variety of river and reservoir environments.

PCE 5

PCE 5 requires "water temperatures ranging from 2° to 15° C with adequate thermal refugia for temperatures that exceed the upper end of this range." Cold water temperatures are an important characteristic of bull trout FMO habitat. To evaluate this PCE, baseline seasonal temperatures were evaluated as to whether they influenced bull trout use of the habitat. PCE 5 was considered as present when water temperatures were within 2° to 15° C for those times bull trout were likely to use the habitat area. The PCE was considered present but limited, where temperatures exceeded 15° C, but thermal refugia persist. The effects of water temperature on water quality, habitat complexity, migration, and prey base are discussed within those respective PCEs.

PCE 6

PCE 6 requires “In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure the success of egg and embryo over-winter survival, fry emergence, and young of the year and juvenile survival.” Spawning and rearing habitats is restricted to the Keechelus reach of the Yakima River within the Action Area evaluated in this assessment.

PCE 7

PCE 7 requires "a natural hydrograph including peak, high, low, and base flows, or if flows are controlled, minimal flow departure from a natural hydrograph.” PCE 7 addresses the timing and amount and timing of streamflow, a characteristic that is by definition not present in a reservoir environment. Where critical habitat was designated as a reservoir, the BA notes that PCE 7 is not present. In the streams and rivers affected by Reclamation’s projects, the presence and function of PCE 7 were evaluated.

PCE 8

PCE 8 requires “sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited” (75 FR 63898, page 63932). To evaluate this PCE, Reclamation looked to the direct effects of several water quality parameters and total water quantity on bull trout behaviors. While a thorough discussion of water quality occurs under this PCE, the effects of water quality on migration, prey base, thermal refugia, and complex habitat processes are discussed in greater detail under their respective PCEs. This PCE was considered present when water quality conditions are suitable for bull trout when bull trout are likely to inhabit the reservoir. PCE 8 was considered as present, but limited if some impairments occur while bull trout may be present. If water quality conditions are rarely suitable for bull trout, PCE 8 was considered as not present.

Evaluation of water quality in reservoir environments requires a basic understanding of two important phenomena: reservoir stratification and nutrient cycling. Especially in deeper reservoirs, water quality conditions can vary with depth in the reservoir. Generally, warmer water congregates at the top of a reservoir (epilimnion) and cooler water at the bottom (hypolimnion). Wind events, depth, surface area, tributary inflow can all affect this stratification, and at times, cause the temperature strata to break down and the water in the reservoir to mix. Like temperature, dissolved oxygen levels can also stratify.

Suitable water quality conditions for bull trout can only exist where both temperature and dissolved oxygen concentrations are both present within the same strata. The influence of reservoir operation on water temperature depends largely on when releases occur and where the water is drawn from. For example, in reservoirs that release water from the bottom of the dam, operations may deplete cold water supplies, warming the reservoir, but cooling the river

below. Similarly changes in water volume and temperature can affect nutrient cycles in a reservoir. In a healthy reservoir, primary and secondary production exhibits a balance between phytoplankton and zooplankton communities. Warm-water temperatures, nutrient loads, and low dissolved oxygen can favor the development of inedible phytoplankton communities. This can increase sediment loads in the reservoir, disrupt zooplankton communities, and in extreme cases, cause increased biological oxygen demand and lead to anoxic conditions in a reservoir.

PCE 9

PCE 9 requires "low levels of nonnative predation, interbreeding, and competition." Reclamation described this PCE as present where no self-sustaining populations of nonnative species exist within a waterbody. The PCE was described as not fully functioning where self-sustaining populations compete or prey on bull trout, but not at levels that would dissuade bull trout use of a waterbody. PCE 9 was considered as not present where high levels of hybridization with brook trout occur, where competition or predation prevent bull trout use of the waterbody, or where nonnative species are actively stocked within a waterbody. In some cases, nonnative species can simultaneously constitute predators, competitors, and prey to bull trout.

6.4.4 Critical Habitat Baseline

Table 6-4 summarizes the baseline condition of bull trout critical habitat PCEs as Functional, Not Fully Functional, or Not Present. The table is divided into three main areas: 1) the upper Yakima (Keechelus, Kachess, and Cle Elum Reservoirs and the Yakima River above Easton, and the lower Kachess and Cle Elum Rivers); 2) the Naches (Rimrock and Bumping Reservoirs and Clear Lake and the Bumping, Naches and Tieton Rivers, and Cowiche Creek); and 3) the mainstem Yakima River from Easton downstream to the Columbia River and lower Taneum Creek.

Two areas are included that do not currently have local populations of bull trout, Cowiche Creek and Taneum Creek. These two sites are included in the Action Area as they are affected by the Proposed Action. Within the Action Area, Cowiche Creek and Taneum Creek may provide FMO habitat, consistent with expected use of adjacent mainstem area.

In contract, two sites that have had or currently have bull trout local populations (Teanaway and Ahtaneum Creeks) are not being included in this baseline description and effects analysis because the Proposed Action has no effect on critical habitat in these areas.

Table 6-4. Bull trout critical habitat PCEs – baseline conditions.

Upper Yakima Adfluvial and Fluvial Bull Trout PCE Baseline Summary				
	Keechelus Reservoir	**Kachess Reservoir**	**Cle Elum Reservoir**	**Yakima R above Easton, and lower Kachess and Cle Elum Rivers**
PCE 1 **Hyporheic Flow**	**Functioning**			**Not Fully Functioning**
PCE 2 **Migration Habitats with Minimal Barriers**	**Not Fully Functioning**		**Functioning**	
PCE 3 **Food base**	**Functioning**			**Differs between reaches**
PCE 4 **Complex Habitats**	**Functioning**			**Differs between reaches**
PCE 5 **Water Temp and Refugia**	**Functioning**			**Not Fully Functioning**
PCE 6 **Substrate**	**Reservoirs not Designated SR Habitat**			**Functioning**
PCE 7 Natural **Hydrograph**	**Not Present in Reservoirs**			**Not Fully Functioning**
PCE 8 **Water Quality**	**Functioning**			**Not Fully Functioning**
PCE 9 **Low Levels of Non-native predation & Competition**	**Unknown**		**Not Present**	**Not Fully Functioning**
Naches Adfluvial and Fluvial Bull Trout PCE Baseline Summary				
	Rimrock Reservoir	**Clear Lake**	**Bumping Reservoir**	**Bumping, Naches, and Tieton Rivers, Cowiche Creek**
PCE 1 **Hyporheic Flow**	**Functioning**			**Not fully functioning.** (Tieton River and lower Naches) **Functioning** (Bumping, upper Naches River, lower Cowiche Creek)
PCE 2 **Migration Habitats with Minimal Barriers**	**Functioning**	**Not Fully Functioning**	**Functioning**	
PCE 3 **Food base**	**Functioning**			
PCE 4 **Complex Habitats**	**Functioning**			**Not Fully Functioning**
PCE 5 **Water Temp and Refugia**	**Functioning**		**Not Fully Functioning**	

Naches Adfluvial and Fluvial Bull Trout PCE Baseline Summary				
	Rimrock Reservoir	**Clear Lake**	**Bumping Reservoir**	**Bumping, Naches, and Tieton Rivers, Cowiche Creek**
PCE 6 **Substrate**	**Not Designated Spawning Rearing Habitat**			
PCE 7 **Natural Hydrograph**	**Not Present in Reservoirs**			**Not fully functioning.** (Tieton and lower Naches Rivers, lower Cowiche Creek) **Functioning** (Bumping, upper Naches River,)
PCE 8 **Water Quality**	**Functioning**		**Not Fully Functioning**	**Functioning**
PCE 9 **Low levels of Non-native predation & Competition**	**Unknown**			**Functioning**
Taneum and Mainstem Yakima PCE Baseline Summary				
	Mainstem Yakima River from Easton to Naches River Confluence	**Mainstem Yakima River Confluence with Naches River to Columbia River Confluence**	**Lower Taneum Creek**	
PCE 1 **Hyporheic Flow**	**Not Fully Functioning**		**Functioning**	
PCE 2 **Migration Habitats with Minimal Barriers**	**Functioning**	**Not Fully Functioning**	**Functioning**	
PCE 3 **Food base**	**Functioning**			
PCE 4 **Complex Habitats**	**Not Fully Functioning**			
PCE 5 **Water Temp and Refugia**	**Not Fully Functioning**		**Functioning**	
PCE 6 **Substrate**	**Not Designated Spawning Rearing Habitat**			
PCE 7 **Natural Hydrograph**	**Not Fully Functioning**		**Functioning**	
PCE 8 **Water Quality**	**Not Fully Functioning**			
PCE 9 **Non-native predation & Competition**	**Functioning**	**Not Present**	**Not Fully Functioning**	

1. *PCE 1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia*.

Reservoir FMO Habitats. PCE 1 is present, but provides a limited contribution to FMO habitat in the five reservoirs. Therefore, Reclamation characterizes it as functioning for all five reservoirs. In reservoir environments, subsurface connectivity and thermal refugia are a function of several factors including thermal stratification within the reservoir, tributary inflow, wetland influence, and groundwater recharge. In deep reservoirs such as Keechelus, Kachess, Cle Elum, and Rimrock, thermal stratification tends to be the primary driver of subsurface connectivity and thermal refugia. This relationship is more thoroughly described in the discussion of PCE 5. Tributary inflow may also play a role in providing subsurface connectivity between cold water refugia in the reservoir and tributary habitat. Groundwater influence does not appear to provide a significant contribution to FMO habitat in these reservoirs.

River SR Habitat. Potential SR habitat is restricted to the Keechelus reach of the upper Yakima River. PCE 1 is present and functioning in the Yakima River above Easton Dam. A large area of upwelling springs and groundwater inputs occurs about 2.5 miles downstream of Keechelus Dam in the area known as Crystal Springs. These springs add a substantial amount of water to contribute to surface water flow and augments discharge levels above those released from the Keechelus Dam.

River FMO Habitat. PCE 1 is present and functioning for the lower Kachess and Cle Elum Rivers, supporting functional FMO habitats. However, the mainstem Yakima River from Easton downstream to the confluence of the Columbia River, as well as the lower Bumping, Naches, and Tieton Rivers downstream of the dams, are not fully functioning. Floodplain disconnection can impair PCE 1. By the time Critical Habitat was designated, significant floodplain encroachment had already occurred in the basin. On average, 66 percent of five alluvial reaches evaluated have been physically disconnected (Eitemiller et al. 2000). In the upper Yakima basin, an average of 60 percent of the floodplain has been lost and from 57 to 85 percent of the floodplain in the lower Yakima River has been lost (Snyder and Stanford 2001).

Flow regulation can also affect PCE 1 by reducing the extent of alluvial floodplain habitat and the role of alluvial aquifers in maintaining cold water in streams. Ring and Watson (1999) theorized that hydrologic regulation, particularly of spring freshets, has dramatically decreased the frequency with which the alluvial floodplain aquifer is recharged, reducing the amount of shallow aquifer water that would help provide for cool water temperatures and thermal refugia. The degree to which shallow groundwater movement associated with canal seepage and irrigation application can replicate this shallow aquifer recharge process is unclear, though it does appear to occur to some extent.

Despite these alterations, the work of Stanford and Gonser (1998) and others (Kinnison and Sceva 1963) have revealed the general location of some important areas for alluvial groundwater exchange along the main river corridor of the Yakima River. Many of these locations are within the stream segments designated as critical habitat. For example, several alluvial floodplain areas in the Easton reach and the mainstem Yakima reach through the Kittitas and Yakima valleys were noted as being gaining reaches due to inputs of springs and groundwater sources. The alluvial floodplain areas that constitute much of the Easton and mainstem Yakima reaches are considered major areas of surface water/groundwater exchange.

Lower Cowiche and Taneum Creeks are considered to be functional for this PCE, because these areas are not subject to storage regulation or significant winter diversions. However, floodplain disconnection has occurred in these areas.

2. *Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.*

Reservoir FMO Habitats. PCE 2 is present and functional at Cle Elum Reservoir and provides access to SR habitat in tributaries. Flows in the Cle Elum River and Waptus River are sufficient to maintain physical connectivity between the reservoir and these tributaries at all times. PCE 2 is present at both Keechelus and Kachess Reservoirs providing access for adult FMO habitat in the reservoirs and SR habitat in upstream tributaries. However, migration conditions can become impaired during dry years at Gold Creek (Keechelus) and Box Canyon Creek (Kachess), and upper Kachess River (Kachess), and potentially between the two basins that comprise Kachess Reservoir. At Box Canyon Creek, passage impairments are associated with the varial (drawdown) zone within the Action Area. Since habitat disconnection in the varial zone and between the two Kachess basins is an ongoing effect from project operations, it is discussed in greater detail in the effects section. At Gold Creek and the Kachess River, disconnection can occur both upstream of the Action Area and within the Action Area. In addition to varial zone passage barriers in Gold Creek and the upper Kachess River, dewatering and associated passage barriers also occur further upstream, outside of the Action Area. Migration barriers in upstream reaches outside the Action Area are discussed to provide a greater context of migration PCE baseline conditions between the reservoir and upstream spawning area.

In the upper Kachess River, dewatering extends approximately 0.25 to 0.30 mile downstream into in the varial zone, and extends an additional 1.0 to 1.3 miles upstream, outside of the Action Area (Meyer 2014). While there has been no formal investigation into the upstream dewatering, it is hypothesized that historic logging practices cause this area to dewater. The valley bottom forest has been logged and the river channel is now destabilized. As a result, the stream channel has widened and sediments have been eroded and redistributed in a manner that contributes to shallow or subsurface flows and periodic dewatering.

Preliminary assessment information is available regarding dewatering in Gold Creek. Monitoring conducted in 2013 identified two district dewatered reaches in the lower 3 miles of the creek. The lower dewatered reach extends from RM 0.5 to RM 0.66 at maximum extent. Sediment aggradation associated with the reservoir full pool extends to RM 0.5. Dewatering in this reach is an interplay of floodplain disturbance associated with local road construction, sediment aggradation associated with reservoir operations, and a large log jam which caused a channel avulsion between 2006 and 2011 (NSD 2014). In 2013, dewatering in this reach lasted between 10 and 19 days.

In 2013, the Gold Creek upper dewatered reach was 1.09 miles long at full extent and persisted for approximately 70 days (NSD 2014). From the initial investigation, the researchers concluded that natural dewatering likely occurred historically during drought conditions, but that landscape alterations in the valley exacerbated the problems. Gold Creek Pond, a gravel borrow pit created from the construction of I-90, 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).

The effect of Gold Creek stream dewatering upstream of the Action Area is significant. This period of low flow and dewatering from August through October coincides with bull trout migration and spawning (Craig 1997). Bull trout mortalities have been found along this stretch when surface flow in Gold Creek was eliminated (Craig 2002, as cited in Reclamation 2000). Dewatering of the main channel of Gold Creek has been documented in several years between 1993 and 1998 (Wissmar and Craig 2004), 2000 and 2003 (Larrick 1998 – 2000, as cited in Reclamation 2000), and in 2013 (NSD 2014). Dewatering of the channel isolates upstream migrants from the spawning areas, and also strands fish, which can result in direct mortality and reduced spawning. For example, Wissmar and Craig (1998) estimated that 63 percent (1993) and 24 percent (1994) of the adult bull trout died in Gold Creek.

Thirteen streams flowing into Keechelus Reservoir, including Gold Creek, were included in a package of improvements associated with the I-90 Snoqualmie Pass East Project. These improvements include fish passage, aquatic habitat, improved hydrologic connectivity, lower stream velocities, improved channel migration, floodplain restoration, restored capacity for sediment transport, and reduced sediment and temperature (FHWA and WSDOT et al. 2008). Completion of these projects will improve bull trout habitat in Keechelus Reservoir by improving fish passage, connecting habitats currently separated by the highway, increasing aquatic habitat, restore instream physical processes, improve water quality by treating storm water runoff, and improve groundwater flow. Fish passage projects completed in 2013 include Rocky Run Creek which provided access to 0.15 miles of upstream habitat (WSDOT 2014). Projects receiving funding for the 2013 – 2015 biennium include Resort Creek, Townsend Creek, and Price Creek (WSDOT 2014). Positive results are beginning to appear with observations of deer and other mammals using the Gold Creek underpasses. Since the 1950s Gold Creek was the only stream in the Keechelus Reservoir area known to have

spawning bull trout. Resort and Rocky Run Creeks had previously been impassable for bull trout because of culverts and concrete slabs associated with the old I-90 roadway. Since the removal of those barriers, Central Washington University researchers have found bull trout moving into both creeks (James 2014).

Migration habitat between FMO habitat in Rimrock and Bumping Reservoirs and their respective SR habitat is considered to be Functioning. There is one documented instance in 2001 when Indian Creek became disconnected through the varial zone. South Fork Tieton River passage is maintained through current operations, which provides 127,000 acre-feet of storage through August 10 to meet passage needs. PCE 2 is considered Not Fully Functioning at Clear Creek Lake due to poor functioning of the existing fish passage facilities. Since these are ongoing effects of project operations, they are described in detail in the effects section.

River SR and FMO Habitats. Key mechanisms influencing migration conditions in the rivers located downstream of the storage reservoirs are physical barriers, flow regimes, and water quality. While a general description of current conditions is provided here, a full discussion evaluating the effects of the Proposed Action is provided in the effects section. The physical effect of the storage dams on migration was in effect at the time critical habitat was designated. In the mainstem river reaches below the reservoirs, PCE 2 is functioning.

All mainstem diversion dams have fish ladders. These ladders were designed for anadromous salmonids and are likely effective for adult bull trout as well (Reiss et al. 2012). Despite periods when passage may be temporarily restricted (for example due to short-term closures during flood events), these diversion dams do not constitute significant migration barriers for bull trout. Historically, Easton Diversion Dam operations may have limited bull trout migration into the Keechelus to Easton reach in drought years. During extreme water short years, when the mini flip-flop operation between Keechelus and Kachess Reservoirs could not be implemented, Reclamation would close the Easton diversion ladder from late May through October to prevent spring Chinook spawning in the Keechelus reach when the flows in the Keechelus to Easton reach cannot be managed for the maintenance of spring Chinook spawning. This Easton Dam closure has not occurred since Reclamation modified the outlet works at Kachess Dam in 1996, enabling the mini flip-flop flow regime to be reliably implemented. If adult bull trout were below Lake Easton, and if they used the existing ladders, the migration would be blocked during periods when the ladder was shut down. The ladder could be re-opened after the spring Chinook spawning season (October) in which case bull trout migrations into the Keechelus to Easton reach could resume. Although not monitored for bull trout passage, there have been no reports of adult bull trout using the Easton ladder.

Surface flows throughout the water year are sufficient to maintain hydrologic connectivity within the mainstem river reaches and between the mainstrem reaches and associated tributaries. Within the Action Area, Reiss et al. (2012) identified no physical or flow-related passage barriers within the Action Area in their threat assessment for the Yakima basin

fluvial populations. Water levels do not drop enough to constitute a migration barrier for adult or sub-adult bull trout. Even in reaches with highly altered hydrographs and simplified channel complexity and morphology (i.e. high width:depth ratios) such as the Cle Elum reach or through the Yakima Canyon in the mainstem Yakima reach, flows are sufficient to provide passable conditions during all periods of the year. No known low flow passage impediments have been documented as a result of low discharge levels or in-channel obstructions. Similarly, high flows of such duration as to limit instream migration are infrequent and typically not of sufficient magnitude to create a high flow passage block for adult or sub-adult bull trout, or occur at a time of year (e.g., high September flows in the Tieton) when they are not expected to create passage problems. In the Ahtanum Creek, irrigation diversions (which are not part of the Proposed Action, as they are either diverted by use of WIP, or there is no federal contract for the water), do result in diminished summer and fall flows; however, were not considered passage barriers due to timing (Reiss et al. 2012).

Water temperatures during the summer period (August to September) are sufficient to limit or delay upstream migration of bull trout for a short period of time in most reaches of the Yakima River. Due to the timing of these high water temperatures, bull trout presence is expected to be very unlikely in the lower Yakima River (see Section 6.4.2). Temperatures over 15ºC may begin to inhibit bull trout movement, while water temperatures approaching or exceeding 20ºC may restrict bull trout movement entirely for brief periods when temperatures are highest. Since most reaches in the Yakima River typically approach 20ºC during the summer, it is suspected that bull trout movement or volitional migrations have been affected for varying durations during this time period in the environmental baseline. It is unknown at this time what effect cool water upwelling from groundwater or springs may have in creating thermal refugia. However, it is suspected that these cool water refugia exist in many of the Yakima reaches wherever springs and groundwater recharge areas are found. Bull trout will certainly utilize these habitat refuge areas during migration periods that coincide with elevated water temperatures in the Yakima River. At all other times of the year, water temperatures do not constitute a migration barrier for these fish.

The lower Cowiche and Taneum Creeks are functioning for FMO habitat as they are not subject to storage regulation or significant winter diversions.

3. *An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.*

Reservoir FMO Habitats. PCE 3 is present in and provides limited contribution to FMO habitat in the reservoirs. Keechelus, Kachess, Cle Elum, and Bumping Reservoirs are relatively unproductive, but productivity is consistent with high elevation oligotrophic reservoirs. This PCE is considered functional.

Based on the information available, all of the reservoirs are oligotrophic (lacking nutrients and usually containing plentiful amounts of dissolved oxygen without stratification). Historically, salmon carcasses that spawned in the streams above the lakes contributed

nutrients. This source of nutrients is now absent, although stocked and naturally reproducing kokanee provide some nutrients to the system. The effect of the storage dams on anadromous access was in effect at the time Critical Habitat was designated. Available sediment cores at Cle Elum Reservoir indicate a significant reduction in phosphorus between approximately 1883 to 1906 which is believed to correspond with anadromous exclusion caused by the construction of the crib dam (Mongillo and Falconer 1982). There was also a spike in phosphorus believed to correspond with land inundation when the permanent dam was constructed in 1933. This analysis has not been conducted at the other project reservoirs. However, it is reasonable to expect that decreases in phosphorus occurred due to the exclusion of anadromous fish associated with crib or permanent dam construction at all the project reservoirs. Similarly, temporary phosphorus increases likely occurred when the reservoirs inundated new areas. Existing data suggest that the Yakima River basin reservoirs have limited nutrients, especially phosphorus and trace elements (Hiebert 1999; Lieberman and Hiebert 2003; Mongillo and Faulconer 1982). Creating storage reservoirs also increased the lake size while simultaneously decreasing nutrient input. The result is that the aquatic environment was larger, but with decreased nutrient loading (Lieberman and Hiebert 2003).

Since reservoir operations are an ongoing action, the potential effects of water storage and release on reservoir limnology are discussed in the effects section.

River FMO Habitats. Based on available, though limited data of Yakima River food base, Reclamation concludes that PCE 3 is present and contributes to SR habitat is the Keechelus reach of the upper Yakima, and FMO habitat in mainstem river reaches below reservoirs. In general, upper basin areas have lower levels of biological impairment than comparable sites in the lower Yakima basin. This spatial pattern of food base quality generally corresponds with likelihood of bull trout presence (higher elevation areas where bull trout most likely have the least food base impairment). At the Yakima River at Cle Elum site, no impairment to fish, invertebrate, or algae communities was observed. Lower down in the watershed, near the Umptanum Tributary, moderate impairment to fish communities was observed. Based on existing information it appears that both the upper and lower Naches reaches have adequate channel connectivity, habitat complexity, and streamflow regimes to support a diverse array of aquatic and terrestrial invertebrates and forage fish species. Cuffney et al. (1997) found site condition ratings based on fish, invertebrate, and algal community condition indices at three sites in the Naches subbasin had only moderate or no impairment.

No data on biological impairment or condition ratings for fish, algae, and invertebrate populations has been collected for the Bumping or Tieton Rivers. It is assumed that invertebrate and fish communities in the Tieton River are at least moderately impaired due to the seasonal variation in streamflows and degraded habitat complexity conditions that exist in this reach in the environmental baseline. However, invertebrate and forage fish populations are still likely to be sufficient in the Tieton River to support bull trout food requirements, despite the highly regulated flow regime in this reach.

There is limited food base information for the lower Cowiche and Taneum Creeks. It is presumed to be functional for FMO needs.

4. *Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks, and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure*.

Similar to PCE 3, the functionality of PCE 4 generally improves as you move up the watershed and development and land management pressures decrease. In lower portions of the Yakima Core Area, many of the features or outcomes associated with development and land management (e.g., roads, residential development, agriculture, and livestock grazing) contribute to loss of wetlands and riparian areas and impair habitat complexity in aquatic environments. Roads and development constrain stream channels, and riprap and levees designed to protect property and reduce flooding simplify habitats and alter hydrologic function, especially when LWD is removed or reduced in size or distribution. This in turn can alter sediment deposition patterns, LWD transport, and pool development.

Reservoir FMO Habitats. PCE 4 is present, providing limited contribution to FMO habitat in the five reservoirs and Clear Lake. Reservoir depth and relatively small areas of shallow shoreline provide some habitat complexity and contribution toward FMO habitat. Depth allows temperature (PCE 5) and water quality conditions (PCE 8) to support bull trout use when they are known to be present. Shallow shoreline habitat allows increased primary productivity (PCE 3) that can support a diversity of prey fish and macroinvertebrates. Drawdowns expose the varial zone of tributaries. Habitat complexity is affected by changing the habitat features from a reservoir environment to a river type environment. Though river and stream habitats in the varial zone are different from those in the reservoir and degraded from unregulated systems, they still offer a variety of environments and a migration corridor (under most circumstances) that can be used by bull trout.

There is no shoreline development along Keechelus Reservoir, though water sports activities on the lake are believed to influence habitat quality. While the active pool of reservoir is significantly depleted over the course of the irrigation season (up to 94 percent), a conservation pool of over 156,000 acre-feet remains which cannot be accessed.

Kachess Reservoir quality appears to be good (Reiss et al. 2012). The effects of reservoir depletion during the summer and early fall are of less concern in Kachess Reservoir than in any of the other Yakima basin impoundments. The reservoir has a historic pool of well over 400,000 acre-feet that is located lower than the outlet works and cannot be accessed for irrigation withdrawal.

Along Cle Elum Reservoir, neither the sparse shoreline development nor water sports activities on the lake are believed to significantly impact habitat quality. Cle Elum Lake is the largest storage reservoir in the Yakima basin. Although it does experience significant drawdown in the summer, a 265,000 acre-foot historic pool cannot be accessed.

Shoreline development in Rimrock Reservoir is low density, thus it is not believed to influence habitat quality; water sports activities on the surface of the reservoir are not likely an issue either given the preference of bull trout for deep water. As in all of the storage reservoirs in the Yakima basin, Rimrock Reservoir is drafted heavily during the irrigation season and the reservoir pool remains depleted for much of the winter. In contrast to the other storage reservoirs, operationally, Rimrock is capable of being nearly emptied.

Bumping Reservoir is the smallest storage reservoir in the Yakima basin and does experience significant drawdown in the summer. However, a 14,000 acre-foot historic pool cannot be accessed. As a result, Bumping Reservoir, which has the highest refill ratio in the basin, recovers quickly when irrigation releases cease. The effects of reservoir depletion on FMO habitat quality and quantity are unknown but not believed to be significant.

River SR Habitat. PCE 4 is present in and contributes to SR habitat in the mainstem Yakima River above Easton. The Keechelus to Easton reach (RM 214.5 to RM 202.5) is approximately 12 miles long. This reach is characterized by numerous side channels, log jams, and braided channels. The upper portion of this reach is considered to be high quality rearing and spawning habitat for salmonids, with comparatively little influences from development. The channel has an excellent riparian corridor and has a large amount of complex structure associated with the channel.

River FMO Habitat. PCE 4 is present and Not Fully Functioning in the lower Cle Elum River, Yakima River downstream from Easton Dam, as well as the Naches, Bumping, and Tieton Rivers. Channel complexity in the upper Yakima basin has been affected by development of the Yakima Basin. Stream channels are more simplified and fragmented today than during the start of development in the late 1800s. Road and dike construction and gravel mining constricted floodplains in the Easton, Cle Elum, and Ellensburg reaches, resulting in channel simplification and floodplain disconnection (YBFWRB 2009). Snyder et al. (2002) used aerial photography to estimate that the percent of floodplain disconnection was 59 percent in the Cle Elum River and 69 percent in the Kittitas reach.

While flow regulation and development have impacted natural processes, adequate amounts of LWD and boulders and inherent channel morphology and geologic characteristics (connected side channels and access to alluvial floodplains) remains in the Yakima River to maintain some areas of complex stream channels in most reaches (USFS 1996a). This is particularly true of the uppermost reaches; the Keechelus to Easton reach (which also serves SR habitat for the Yakima River local bull trout population) and the Easton reach. These areas contain sufficient amounts of LWD, deep pools, braided channels, and both connected

side channels and spring brook channels to maintain diverse and heterogeneous habitats that are critical to the successful rearing and overwintering of salmonid species, including steelhead.

Relatively high amounts of channel complexity exist in the mainstem Yakima River from the confluence of the Cle Elum River to confluence of the Naches River. This long and diverse reach alternately flows through the fairly confined alluvial Cle Elum and Kittitas valley and the confined Ellensburg and Yakima Canyon. Despite the fact that these areas have experienced substantial development from agriculture, urban growth, and transportation factors, as well as flood control and flow regulation impacts, and the resulting habitat simplification, the habitat maintains some complexity. This is especially true in the unconfined alluvial reaches of the Cle Elum and Kittitas valley where the channel has access to the floodplain and where significant braiding and side channel connectivity is still observed. Pool frequency and quality has been reduced as a consequence of river development and flow regulation yet several deep scour pools, corner pools, and undercut banks are still evident in this reach of the Yakima River due to channel morphology and gradient interacting with streamflow to maintain enough stream power to create and maintain these pools. Significant channel braiding occurs in the unconfined alluvial areas adding channel complexity in the mainstem Yakima River.

LWD recruitment in the Naches basin has been affected by human activities. Construction of the storage dams on the Tieton and Bumping Rivers removed headwater LWD source areas. Natural lakes on these streams, except the Tieton, may have acted to some extent as LWD "traps" before the dams were built. Further down the system, diversion structures may impede the transport of LWD though, to large extent, LWD is simply passed over these structures as part of operations. Forestry management and floodplain isolation, and channel simplification also affect LWD recruitment.

Since water management is an ongoing action, the effect of flow regulation on riparian conditions and LWD recruitment is discussed in the effects analysis.

No comprehensive assessment of pool frequency and quality exists for the streams in the Naches watershed. McIntosh et al. (1994) compared pool frequency in 80 km of tributaries in the Naches basin (Little Naches River, Rattlesnake Creek, and American River) from data collected in the 1930s and 1940s, with that collected in 1990 to 1992. They found that pool frequency had increased in both managed and unmanaged areas. However, none of the surveyed areas were affected by flow regulation and improved conditions were attributed to a recovery from intensive sheep and cattle grazing that had occurred in the 1880s and early 1900s. The Naches and Tieton Watershed Analyses (USFS 1996b) both reported that none of the streams they surveyed for frequency of pools per mile met expected levels of pool frequencies.

PCE 4 is present in and contributes to the lower Cowiche and Taneum Creek FMO habitat, but is considered not fully functional due to habitat simplification.

5. *Water temperatures ranging from 2 °C to 15 °C (36 °F to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.*

Reservoir FMO Habitats. PCE 5 is present and provides FMO habitat in the five storage reservoirs. Keechelus, Kachess, and Cle Elum Reservoirs are cool and deep. These three reservoirs strongly stratify during the summer providing suitable cool temperatures (generally suitable temperatures occur below 5 to 8 meters at Keechelus, below 15 meters at Kachess Reservoir, and 10 meters at Cle Elum Reservoir).

Rimrock and Bumping on the other hand are warm reservoirs (see Section 4.3.2). Rimrock strongly stratifies during the late summer period providing suitable temperatures at approximately 10 meters depth and is thus functioning for this PCE. PCE 5 is present in Bumping Reservoir, but is not properly functioning for FMO habitat during summer in some years. This reservoir weakly stratifies and is prone to mixing events during moderately windy events. In some years, the warm epilimnion can extend from 5 meters to full thickness. Thermal refugia may be provided by cold tributaries.

River SR Habitat. PCE 5 is Not Fully Functioning in the Yakima River above Easton for SR purposes. While average daily temperatures are less than 10°C from November through June, they can exceed 15°C in the late summer and early fall.

River SR and FMO Habitat. PCE 5 is present but not fully functioning in areas identified in the 303(d) list for elevated temperatures. Within the upper Yakima basin, numerous tributaries entering storage reservoirs have elevated temperatures. While these tributaries are located outside the Action Area, they can affect conditions within the Action Area. Notably, warm temperatures observed in the Cle Elum River downstream of the dam are influenced both by warm contributions to Cle Elum Reservoir (Cle Elum River, Cooper River, and Thorp Creek) plus warming of the reservoir's epilimnion. A TMDL water quality study has examined high water temperatures observed in the Naches River and Cowiche Creek. Maximum temperatures above 23ºC were observed throughout the watershed. Factors influencing observed water temperatures include effective shade provided by riparian vegetation, channel width, air temperate, tributary water temperatures, effluent point source discharges into Cowiche Creek, hyporheic exchange and groundwater interactions, and discharge.

Since reservoir operations are an ongoing action, the potential effects of water storage and release on downstream water temperatures are discussed in the effects section.

6. *In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.*

The only potential spawning and rearing area within the Action Area is the Keechelus reach of the upper Yakima River. Based on information about gravel suitability for Chinook spawning, Reclamation concludes that the baseline condition is Functioning. While this reach has experienced a reduction in sediment and wood inputs from instream sources, substrate conditions remain acceptable and of high enough quality to support spawning activity for substantial numbers of Chinook salmon that utilize this reach every year. Evaluation of gravel characteristics within spring Chinook redds in the upper Yakima River found 11 to 16 percent fines and egg-to-fry survival rates of 59.6 percent (Fast et al. 1991). These results were within the values reported by other researchers, indicating generally good substrate condition.

7. *A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.*

Reservoir FMO Habitats. PCE 7 Natural Hydrograph is not present in the five reservoirs and Clear Lake.

River SR Habitat. Altered flow regimes have the potential to affect access to spawning and rearing grounds, and habitat features associated with redd site selection and egg incubation, habitat features associated with juvenile rearing, and food availability and access. Important habitat features for spawning and rearing include water depth and velocity, substrate size and stability, hyporheic exchange, and cover. These habitat features are influenced both by flow conditions at the time redds are selected and eggs incubate and habitat forming flows which shape habitat features over longer time periods. Since flow in the Keechelus reach is regulated to meet Project objectives, PCE 7 is considered not fully functioning. Since flow regulation is an ongoing effect of project operations, it is discussed in greater detail in the effects section.

River FMO Habitat. Flows in regulated sections of the Action Area providing FMO habitat are affected by both storage operations and water diversions. Flow regimes may affect habitat access, habitat complexity, and food availability and access. PCE 7 is not fully functioning in the lower Kachess and Cle Elum Rivers, the mainstem Yakima River from Easton to the Columbia River, the lower Naches downstream of the Tieton River confluence and the Tieton River. Due to the relatively modest size of Bumping Reservoir and the number of unregulated tributaries in the upper Naches basin, the Naches River and its

tributaries upstream of the Tieton confluence still exhibit a largely normative flow regime (YBFWRP 2009, p. 113). Since flow regulation is an ongoing effect of project operations, it is discussed in greater detail in the effects section.

Designated Critical Habitat tributaries within the Action Area (Taneum Creek and Cowiche Creek) are not directly affected by operations of the five storage dams, though they do convey operational spill and return flow. French Canyon Dam on North Fork Cowiche Creek functions as a reregulation reservoir, enabling fluctuating water demands to be met by spilling and diverting water from this small reservoir, rather than by fluctuating the diversion rate from the Tieton River and spilling extra water. A storage right for a capacity of 1,264 acre-feet was confirmed by the *Acquavella* Adjudication. The source for this stored water can be either the North Fork Cowiche Creek or the Tieton River.

There is one individual water contract for water diversion on lower Cowiche Creek (Appendix A). This water diversion, along with operational spill and return flows, is discussed in detail as an effect of project operations. Other tributary diversions on Cowiche and Taneum Creek are not part of the Proposed Action, since Reclamation has no contract with these water users. While irrigation diversions on lower Cowiche and Taneum Creeks result in low summer flows, PCE 7 for the lower Cowiche and Taneum Creeks is considered functioning for FMO habitat as there is little to no storage on these tributaries, and winter stockwater diversions are relatively small.

The Action Area also includes Ahtanum Creek, but is limited to the footprint required to operate and maintain fish passage facilities on this tributary. Water diversions on Ahtanum Creek are not part of the Proposed Action, as they are either diverted by private users with no contract with Reclamation, or are associated with Wapato Irrigation Project operations. Water diversion on Ahtanum Creek results in low late summer flows, but due to the timing of this flow regime impact, bull trout migration in not believed to affected (Reiss et al. 2012), nor are bull trout believed to be present to experience these late summer low flow conditions.

8. *Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.*

The condition of this PCE is variable across the Yakima Core Area. In spawning areas, water quality and quantity is generally good. In rearing areas, conditions are variable, with some degradation in both water quality (primarily due to increased sedimentation) and quantity. In FMO habitat in the lower portions of the Yakima Core Area, numerous reaches are 303(d) listed for impairments due to pollutants and high water temperatures.

Reservoir FMO Habitats. PCE 8 suitable water quality is present and functioning in Keechelus, Kachess, Cle Elum, and Rimrock Reservoirs. However, this PCE is not fully functioning for Bumping Lake due to its depth and mixing characteristics that result in a lack of stratification. As a result there are warm temperatures throughout the reservoir.

River SR Habitat. Due the thermal regime (see PCE 5), PCE 8 is present but not fully functioning for spawning and rearing in the Yakima River above Easton.

River FMO Habitats. The mainstem Yakima River from Easton downstream to the confluence with the Columbia River is not fully functioning due to TMDL listings.

Lower Cowiche and Taneum Creeks are not fully functioning because of agricultural inputs.

9. *Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.*

Various non-native fish species have been stocked throughout the Yakima Core Area in the past for a variety of purposes including increased recreational angling opportunities. While this no longer occurs in connected waterways, several species of non-native fish are present throughout the critical habitat unit and likely have negative effects to bull trout including competition, hybridization, and predation. Brook trout are widely distributed in the unit. While negative interactions are occurring with non-native fish species, the magnitude of this effect cannot be quantified.

Reservoir FMO Habitats. The status of PCE 9 is unknown for Keechelus, Kachess, Rimrock, Clear Lake, and Bumping Reservoirs. PCE 9 is Not Fully Functioning present for Cle Elum Reservoir. Both lake trout and brook trout are known to occupy this basin. Past lake trout stocking practices increased non-native predation and competition to the degree that bull trout no longer appear to use Cle Elum Reservoir.

River SR and FMO Habitats. Cold water salmonid species, particularly brook trout, were introduced into the upper Yakima and Naches basins in the mid-1900s. Although non-native species are no longer stocked in mainstem river areas where there is potential to interact with native species, they have become established in many areas of the basin with self-sustaining, naturally reproducing populations. Currently, there are naturally reproducing populations of brook trout throughout the upper Yakima and Naches River portions of the Action Area (WDFW 1998). However, it is not known to what degree these species diminish this PCE.

6.5 Effects of the Proposed Action

6.5.1 Direct and Indirect Effects

This section describes the potential effects of Reclamation's Proposed Action on the ESA-listed bull trout in the action areas within the Yakima Core Area. Since all occupied habitat is designated Critical Habitat, habitat effects are described in the analysis of bull trout critical habitat PCEs.

Stranding

Bull trout may become stranded in the varial zone as reservoirs are drawn down for water deliveries. Stranded bull trout are subject to direct mortality from desiccation and predation, in addition to physical stress in non-lethal circumstances. There are observations of bull trout adults and juveniles becoming stranded in pools when the Gold Creek and Kachess River tributaries dewater (Meyer 2002). While the reports of stranded bull trout are located upstream of the Action Area, Reclamation assumes that there is the potential for adult bull trout moving upstream to spawn during the low-natural flow period to become stranded where tributary traverses the varial zone. Juvenile stranding is not considered likely to occur, as the varial zone does not include the structural habitat features required for juvenile rearing. The Bull Trout Tributary Monitoring and Emergency Passage Program included in the Proposed Action (Section 3.3.4) is intended to minimize harm to migrating bull trout from stranding.

Along the remaining shoreline areas, shoreline bed characteristics, rate of reservoir drawdown, bull trout habitat use, and bull trout behavior are all factors expected to influence the potential for stranding. The varial zone is relatively simple along much of the reservoir perimeter, though there are relict stumps and other areas with LWD where pools have scoured and temporarily hold water as the reservoir level drops. Behaviorally, bull trout tend to forage in the littoral zone in the fall and spring, and move to deep water in summer, generally due to temperature constraints (McPhail and Baxter 1996). The maximum rate of reservoir drawdown is during the summer irrigation period. Thus, bull trout are generally expected to be in deeper waters as the water recedes. Additionally, sub-adult and adult bull trout occupy the reservoirs. Based on bull trout size ranges reported for 2+ age class fish, Reclamation expects bull trout to be at least 150 mm when they occupy the reservoirs. Fish of this size are not expected to occupy the shallowest shoreline margins. Based on these factors, Reclamation concludes that while there is potential for stranding along the shoreline, it would be infrequent.

Entrainment

Entrainment through the storage dam outlet works can cause injury and result in mortality of entrained bull trout individuals. The effect of entrainment on habitat connectivity and forage food base is discussed in the Critical Habitat effects analysis.

Factors that influence entrainment risk at reservoirs include fish species present and associated behavior, fish size, fish distribution in the reservoir, population abundance, intake location, depth of water withdrawal, seasonal drawdown, hydraulic capacity of intake, approach velocity at intake, and water temperature and dissolved oxygen (CH2M Hill 2007). Fish species most susceptible to entrainment tend to be smaller (generally less than 100 mm) young-of-the-year fish, which tend to be both more abundant and less capable swimmers than older age classes. Since bull trout do not migrate down to lakes for rearing until they are 2+ to 4+ years, they are expected to be less susceptible to entrainment than fish species which occupy the reservoirs at much younger ages.

Bull trout entrainment is anticipated either when water is released over the spillway, or when fish are in relatively close proximity to the outlet structure and the approach velocity exceeds the fish's swimming ability. Bull trout appear to move in response to temperature, generally remaining below the thermocline in the summer where temperatures range from 7.2 °C to 12.8 °C (reviewed by Thomas 1992). In the spring and fall, bull trout move near surface waters when temperatures fall below 12.8°C. While bull trout movement data is not available for Yakima basin reservoirs, observations at Chester Morse Lake are consistent with this pattern. In the summer time, the average bull trout depth in this 40 meter reservoir is 18.5 m, just below the thermocline depth of 10 to 15 m (SPU no date). Bull trout are expected to be near the surface at all reservoirs during the spring and fall when the reservoirs have not stratified. During summer stratification, bull trout are expected at 15 to 20 m depth at Cle Elum, 10 to 15 m. depth at Kachess, 8 to 15 m. depth at Keechelus, 10 to 20 m depth at Rimrock, and 5 to 6 m depth at Bumping, where water temperatures are suitable for rearing (Figures 4-46, 4-48, 4-50, 4-52). Bull trout are most likely to be near the outlet works when the reservoir is drawn down to an elevation that places the outlet works depth in this zone of suitable temperatures. Even when the reservoir is at this elevation, bull trout would have to be located at the downstream end of the reservoir, where the outlet works are located, to be susceptible to entrainment.

Due to a reduction in hydraulic head, both hydraulic capacity and approach velocity for the intake decreases as reservoir elevation decrease. Risk of involuntary movement through the outlet works due to approach velocity exceeding swimming capacity is; therefore, greatest at higher reservoir elevations. In their literature review of entrainment risk factors, CH2M Hill (2007) identified that approach velocities exceeding 5 fps were most likely to entrain fish.

Entrainment studies have been conducted at Rimrock, Keechelus, and Kachess Reservoirs to document the number of entrained individuals located downstream of the reservoirs. Entrained bull trout were only detected at Rimrock Reservoir. At Rimrock Reservoir, a total of 19 bull trout were captured from late-August through mid-October from 2001 to 2003 (Hiebert et al. 2003a, 2003b; James 2002a). Based on these figures, annual entrainment rates are estimated to be 46 to 145 bull trout per year. Detected bull trout ranged from 107 to 650 mm in length. The majority of fish detected were subadults between 150 and 200 mm in length. Entrainment was most likely to occur when discharge exceeded approximately 1,700 cfs, particularly as flows increased during the initial ramp up period (Hiebert et al. 2003a, 2003b). These conditions were observed during September when a significant component of the adult population is located in spawning tributaries.

No bull trout were detected during entrainment studies at Kachess and Keechelus Dams, though the presence of bull trout observed downstream of the dams indicates that entrainment at least occasionally occurs. At both of these reservoirs, relatively few fish of the size expected for subadult and adult bull trout were observed. Individuals greater than 150 mm in length comprised 1.5 percent and less than 0.5 percent of the individuals captured at Keechelus, and Kachess, respectively. It has been hypothesized that the likelihood of bull

trout entrainment is reduced at Kachess and Keechelus Reservoir due to the large historic lake that is never drained and the location of the outlet works at these reservoirs.

The number of total fish detected during entrainment studies differed between reservoirs. An average of 8,032 total fish were detected each year during the Rimrock studies, but only 526 fish were detected at Keechelus in 2010, and 2,272 at Kachess in 2011 (Hiebert et al. 2003a, 2003b; James 2002b, Appendix L). Unfortunately, this data does not enable us to draw conclusions about the likelihood of entrainment at each dam. Methodology and sampling intensity varied between the Rimrock efforts and Kachess/Keechelus efforts. Additionally, information is not available about population abundance within the reservoirs, so it is not clear if greater catch per unit effort results, as is observed when comparing Kachess and Keechelus results, reflects a greater likelihood of entrainment at Kachess because of differences in outlet works configuration, or reflects higher fish abundances in Kachess to begin with (Table L-2).

Eighteen of the 19 bull trout detected downstream of Rimrock Reservoir, were dead at the time of capture, or had significant injuries and subsequently died (Hiebert et al. 2003a, 2003b; James 2002b). Since no bull trout were detected downstream of Kachess and Keechelus, the condition of bull trout entrained out of these reservoirs cannot be directly evaluated. However, examination of entrained kokanee detected in entrainment studies as all three reservoirs indicates that the condition of fish entrained through the outlet works differs between dams, and that kokanee entrained out of Rimrock Reservoir fare the worst. Approximately 19 percent of kokanee detected downstream of Rimrock Reservoir were alive in each year studied (Hiebert et al. 2003a, 2003b; James 2002b), compared with 33 percent of kokanee at Kachess Reservoir and 71 percent of kokanee at Keechelus Reservoir.

Even though entrainment is documented at Rimrock, it does not appear to affect bull trout abundance and extinction risk probability for populations located in this reservoir. Available life-cycle modeling of 100-year stochastic simulations under chronic entrainment scenarios consistent with observed entrainment rates, the population was stable and produced roughly 20 times the number of eggs required to maintain its population size (Underwood and Cramer 2007). The population appears to be stable under observed entrainment rates. The resiliency of the population was then tested by simulating a catastrophic entrainment rate of 50 percent mortality of all subadults residing in the reservoir every 15 years. This catastrophic simulation tests rates far in excess of any entrainment rates ever observed. Under this scenario, adult abundance was reduced by 40 percent within 4 years of the event, but roughly 15 times more eggs were still produced than was needed to fully seed available rearing streams with juveniles, and a full recovery to maximum production occurred within 9 years.

Water diversion

Entrainment

Fish screens are located at sites diverting water either as part of the irrigation divisions, or under individual contract with Reclamation (Appendix A). These fish screens help prevent injury or mortality of fish that would otherwise be entrained into irrigation and power canals. In order for a bull trout to be exposed to potential entrainment at a water diversion, a bull trout would have to be present at the time water was diverted. In general, bull trout are not expected to be routinely present at a diversion while water is diverted. If a bull trout is present, fish screens are expected to prevent entrainment, with minimal potential harm from the fish facility itself.

Fish screen criteria is intended to be protective of fry-sized salmonids at low water temperatures (NOAA Fisheries 2011a), as this life-stage and environmental condition creates the highest screen impingment risk. The sole location where bull trout juveniles could potentially come into contact with a project water diversion and associated fish screen is the Easton diversion. Even at this location, juvenile presence is considered unlikely. There are no observations of successful juvenile rearing in the Keechelus reach or the tributaries to the Keechelus reach. Even though juvenile presence cannot be discounted from this 11 mile reach and its tributaries, Easton Lake itself is designated as FMO habitat, and given the lentic characteristics of this impoundment, is not expected to support bull trout until they start a downstream migration, expected at 2+ to 4+ years. Even if juvenile bull trout were to encounter the fish screens at the Easton diversion, it is anticipated that the fish screens would successfully exclude any bull trout with minimal risk of harm. There are no documented O&M concerns that have been identified with the Easton fish screens. While this screen site currently has 1/8 woven wire mesh (criteria at time of installation), it will be upgraded to 3/32 mesh (current NOAA Fisheries criteria) when the mesh needs replacement.

Throughout the rest of the Action Area, adult and sub-adult bull trout are the life stages expected to potentially come into contact with project diversions. Risk of impingement on screens is lower for adult salmonids than adult and sub-adult fish, since adults and sub-adults are stronger swimmers. Similarly, potential for increased predation associated with fish screening facilities is not anticipated to be a concern for adult and sub-adult bull trout. The maintenance of clear bypass systems is essential to prevent delay or injury at the bypass systems.

In the mainstem Yakima River between Easton Dam and the Columbia River confluence, adult bull trout presence is likely to be relatively infrequent, particularly downstream of the Naches River confluence. If bull trout are present in the mainstem Yakima River, they are most likely to occur outside the irrigation season (March 15 to October 15). Since water is diverted year-round at Roza Diversion Dam, and bull trout presence is routinely observed at this site, it is reasonable to expect bull trout presence while water is diverted. While the

Roza screen facilities have been prioritized for upgrades so that the facility is more protective of fry, particularly egg-sack fry in the area, the existing fish screening structure at this site is expected to be protective of adult salmonids. Water is also diverted year-round at the Chandler Facility. Bull trout presence is expected infrequently at this location (less than 1 bull trout per year), but when present, the current screening facilities are expected to be protective of bull trout. Bull trout are expected to rarely encounter other diversions along the mainstem Yakima River, given both the operating season for these diversions and the relatively low numbers of bull trout expected in the mainstem river. If bull trout are present when water is diverted, fish screens should successfully prevent any bull trout entrainment and result in little to no harm.

Bull trout from the Naches fluvial populations, and any bull trout that have been entrained out of Rimrock and Bumping Reservoirs, are expected to routinely occupy the Naches River. Bull trout occupancy of the Naches River is highest between RM 0.5 (American River confluence) and RM 17 (Wapatox diversion). Bull trout are generally holding in overwintering habitat from Mid-November to Mid-April. When diversions of project water begin in mid-March, adult and sub-adult bull trout could be present, particularly when bull trout activity increased in Mid-April. Along with other sites in the Yakima Basin, existing facilities are expected to be protective of any present bull trout.

When irrigation diversions are shut down, bull trout may become stranded at locations where water ponds instead of draining completely. Reclamation conducts fish salvage activities at these locations. Fish salvage records at Reclamation facilities during periods of canal shutdown between 2004 and 2013 indicate that the only site where bull trout are observed is at the Wapatox fish screen, where between zero and two bull trout have been observed annually.

Delay

Reclamation operates a series of fish ladders to provide passage at diversion structures. Passage conditions at these facilities are affected by the hydrological conditions at the time bull trout are migrating. Based on stream temperature and available bull trout observations, bull trout are not anticipated to be in the lower Yakima River when individual ladders are closed on diversion dams during the low flow summer period. Should a bull trout be present in the lower river during the low flow period, the implementation of Title XII flows and additional conserved water provides sufficient flows for proper operation of at least one ladder per diversion dam (see Section 4.2.2, “Summer Flows”). While operational constraints may cause flows to temporarily fall below the Title XII instream flow levels for short-durations, bull trout are not expected to be in the lower Yakima River during the time of year (July and August) when this may occur.

Under the YRWEP program, Reclamation installed fish passage structures that met NOAA Fisheries' criteria at the time of construction. While the Wapatox ladder does not meet NOAA Fisheries' criteria (this facility was not constructed under YRBWEP, rather Reclamation assumed O&M responsibilities with the purchase of the Wapatox Powerplant and water right), in 2007 Reclamation repaired this facility so that it meets its original design criteria. No passage delays or other issues have been observed following the 2007 repair. Even when designed to NOAA Fisheries' passage criteria, it is recognized that upstream migration delays or stress can still occur under some circumstances. In a steelhead radio-telemetry study, Hockersmith et al. (1995) observed delays at each of the five fish ladders they studied. It is difficult to draw conclusions about the exact role the diversion dam and ladder facilities played in this delay, as behavioral factors associated with decreasing temperatures and normal overwintering holding behavior was reflected in the passage timing observations. Some of the time a steelhead spent downstream from a particular dam can be attributed to cold temperatures, rather than passage difficulties. Still, given that the proportion of individuals that passed a mainstem dam within 2 days ranged from 37 to 93 percent in the Hockersmith study, it is reasonable to expect that delays on the order of a few days occur. Routine visits to check facilities for debris clogging help minimize the amount of time that a ladder may not provide adequate passage. Additionally, short-term closures at some ladder facilities during flood flows help prevent sediment deposition that can result in longer term passage problems. No observations of fish passage problems were noted in the Yakima Basin Bull Trout Radio Telemetry Study (Mizell and Anderson 2010).

Maintenance Activities

Reservoir

Maintenance activities within the reservoir occur in the dry, when the reservoir is drawn-down due to normal operations. No direct effects due to potential mechanical or physical injury from machinery or placed rocks are expected.

With activities utilizing heavy machinery, there is potential for accidental spills of contaminants (fuel, oil, grease, and hydraulic fluids). Minimization measures and BMPs will be in place to ensure that accidental spills and contaminant releases do not occur. All equipment will be stored and refueled a minimum of 150 feet from any surface water feature when not in use.

Due to sediment disturbance associated with the use of heavy machinery on the reservoir bed, a temporary increase in sediment mobilization (when the area is re-watered) above baseline levels could occur. Any increases in sediment mobilization are expected to be low intensity (barely detected above baseline conditions), short-term, and localized to the maintenance area.

River

The more detailed review of potential effects of maintenance activities on salmonids is described in Section 5.4.4 is germane to bull trout as well. However, due to bull trout distribution in the action area, potential effects are often less likely to occur. Notable exceptions include the Yakima River upstream from Easton, the Tieton River, the Bumping River, and the Naches River from mid-November through Mid-April. Potential effects to bull trout from maintenance activities are anticipated from: worksite isolation and fish salvage (Activity 1b/1c) in the Upper Yakima, Bumping, Tieton, and Naches Rivers; herbicide application (Activity 1d); rock placement associated with Activity 3c/3d; in-water work associated with Activity 4bii at hydromet stations; debris removal (Activity 5b); and sediment, gravel, and debris removal at fish facilities (Activity 6c). Due to its recurring nature and location, routine dredging operations to maintain the fish passage facilities at Nelson dam in particular may affect bull trout. A full effects analysis was conducted for this activity in Reclamation's previous consultation (USFWS reference number 13260-2008-F-0018) and is incorporated by reference.

Fish salvage records at Reclamation facilities during periods of canal shutdown between 2004 and 2013 indicate that the only site where bull trout are observed is at the Wapatox fish screen, where between zero and two bull trout have been observed annually.

6.5.2 Critical Habitat Effects

Table 6-5 summarized the effects of the Proposed Action on the nine bull trout PCEs.

Table 6-5. Summary of the effects of the Proposed Action. For "may adversely affect" determinations, expected conditions relatively to the baseline (maintain or improve) are indicated.

Upper Yakima Adfluvial and Fluvial Bull Trout PCE Effects Summary				
	Keechelus Reservoir	Kachess Reservoir	Cle Elum Reservoir	Yakima R above Easton, & lower Kachess and Cle Elum Rivers
PCE 1 Hyporheic Flow	NLAA			
PCE 2 Migration Habitats with Minimal Barriers	LAA | Improve		NLAA	NLAA | Improve
PCE 3 Food Base	NLAA			
PCE 4 Complex Habitats	NLAA			NLAA | Improve
PCE 5 Water Temp and Refugia	NLAA			LAA | Maintain

Upper Yakima Adfluvial and Fluvial Bull Trout PCE Effects Summary				
	Keechelus Reservoir	Kachess Reservoir	Cle Elum Reservoir	Yakima R above Easton, & lower Kachess and Cle Elum Rivers
PCE 6 Substrate	Not Present			NLAA
PCE 7 Natural Hydrograph	Not Present			LAA | Improve
PCE 8 Water Quality	NLAA			
PCE 9 Low Levels of Non-Native Predation & Competition	NLAA		Not Present	NLAA
Naches Adfluvial and Fluvial Bull Trout PCE Effects Summary				
	Rimrock Reservoir	Clear Lake	Bumping Reservoir	Bumping, Naches, and Tieton Rivers, Cowiche Creek
PCE 1 Hyporheic Flow	NLAA			
PCE 2 Migration Habitats with Minimal Barriers	NLAA	LAA | Improve	NLAA	
PCE 3 Food Base	NLAA			
PCE 4 Complex Habitats	NLAA			NLAA | Improve
PCE 5 Water Temp and Refugia	NLAA			
PCE 6 Substrate	Not Present			NLAA
PCE 7 Natural Hydrograph	Not Present			LAA | Improve for Tieton and lower Naches Rivers, Cowiche Creek NLAA for Bumping and upper Naches Rivers.
PCE 8 Water Quality	NLAA			
PCE 9 Low Levels of Non-native Predation & Competition	NLAA			

Taneum and Mainstem Yakima PCE Effects Summary				
	Mainstem Yakima River from Easton to Naches River Confluence	Mainstem Yakima River Confluence with Naches River to Columbia River Confluence	Lower Taneum Creek	
PCE 1 Hyporheic Flow	NLAA			
PCE 2 Migration Habitats with Minimal Barriers	NLAA			
PCE 3 Food Base	NLAA			
PCE 4 Complex Habitats	NLAA			
PCE 5 Water Temp and Refugia	LAA | Maintain		NLAA	
PCE 6 Substrate	Not Present			
PCE 7 Natural Hydrograph	LAA | Maintain		NLAA	
PCE 8 Water Quality	NLAA			
PCE 9 Non-native predation & Competition	NLAA	Not Present	NLAA	

PCE 1 Springs, Seeps, Groundwater Sources

Reservoir FMO Habitats. The operation of the five storage reservoirs is not likely to adversely affect this PCE. Routine operations influence groundwater interaction between the reservoir and shoreline areas. There is an insignificant influence on aggregate conditions in the reservoirs. PCE 1 is present at the five storage reservoirs but provides a limited contribution to FMO habitats and does not play a large role in water quantity or water quality in the reservoirs.

River SR and FMO Habitats. Reservoir operations are not likely to adversely affect this PCE and will maintain the function of this PCE. Groundwater influence from reservoirs is unlikely to alter the function of springs, seeps, and groundwater sources for the SR habitat in the mainstem Yakima above Easton Dam.

PCE 2 Migration Habitats with Minimal Impediments

Reservoir FMO Habitats. Reclamation concludes that the Proposed Action may adversely affect bull trout migration, but by implementing the Bull Trout Tributary Monitoring and Emergency Passage Program (Section 3.3.4), conditions will be improved relative to baseline function. Increased winter and spring streamflows for fisheries purposes combined with irrigation deliveries may result in lower pool elevations relative to baseline conditions (see Section 4.2.2). Thus, project operations are expected to result in varial zone passage barriers in some years at Keechelus, Kachess, and Rimrock (Indian Creek) Reservoirs, and frequency and extent of passage barriers may increase relative to baseline conditions. Varial zone dewatering was documented in 2001, 2003, and 2005 in Box Canyon Creek.

When model output for reservoir elevations were compared for Status Quo and Proposed Action scenarios, the data suggests that passage difficulties are at risk of occurring earlier or being more severe in 29 percent of years modeled at Kachess, and 18 percent of years modeled at Keechelus. This estimate is conservative and very general in nature because 1) it is based in best professional judgment regarding the relationship between reservoir elevation and passage condition and has not been field verified; 2) it considers only reservoir elevation when evaluating passage risk, when tributary discharge is also a critical variable in determining passage risk (and influences passage conditions outside the Action Area), and 3) actual operations can be more nuanced than modeled operations in balancing water withdrawals between the five system storage reservoirs.

Kachess Reservoir encompasses two basins that become distinct, though connected by a channel, when the reservoir elevation drops to 2,220 feet. Box Canyon Creek and Kachess River both enter the upper basin. Local fisheries biologists have expressed concern that a passage barrier forms between the two basins when the reservoir elevation is sufficiently low. An examination of the topographic map for this area indicates that there is an inflection point at 2,204 feet and that fish passage is considered improbable at this elevation (Thomas 2015a). An analysis of historic data indicates that Kachess Reservoir was lower than 2,204 feet in 9 years out of the 29 year record (Thomas 2015a). Under modeled Status Quo operations, the reservoir also drops below 2,204 feet in 9 years, but under the Proposed Action, the frequency increases to 10 years. However, under the Proposed Action, passage problems are likely to form later in the summer. Historically, Kachess Reservoir dropped below 2,204 feet in August in 2 years, and the median date when this elevation was reached was September 9th. Under the Proposed Action model results, the earliest date when the Kachess Reservoir fell below 2,204 feet was September 14th, and the median date this elevation was reached was September 22nd. The maximum duration when the Kachess Reservoir elevation is below 2,204 feet is expected to be longer under the Proposed Action scenario (175 days as opposed to 139 days). However, this is a result of the reservoir taking longer to be refilled, rather than storage content being depleted earlier during the irrigation season. Thus, bull trout passage back to wintering habitat is affected more than access to spawning habitat.

In order to minimize effects to bull trout from passage barriers that form between storage reservoirs and spawning tributaries, Reclamation has proposed the implementation of the Bull Trout Tributary Monitoring and Emergency Passage Program (Section 3.3.4). Reclamation will monitor and record tributary passage conditions at Kachess, Keechelus, and Rimrock Reservoirs (including the basin separation with Kachess Reservoir) from mid-July through mid-October, implement emergency passage measures, and salvage stranded bull trout. Dewatering risk indicators will be developed and future changes in operations may be identified and implemented. A good example of a situation where this monitoring and salvage has occurred is Box Canyon Creek which can sometimes experience dewatering that can occur in dry years directly upstream of the creek's mouth. The time period this occurs coincides with the immigration of pre-spawn bull trout. With the Kachess Reservoir level significantly lowered from irrigation water withdrawal, the mouth is located on the lakebed. Above this point, the creek spreads out over unconsolidated sediments on the bed and can go dry up to several hundred yards upstream. These conditions were observed in three of the first six years of the last decade (2001, 2003, and 2005) and required implementation of remedial passage projects to allow pre-spawn bull trout to enter Box Canyon Creek. Monitoring efforts are intended to increase Reclamation's understanding about the conditions that result in passage problems, so that they can be more effectively addressed in the future (bull trout monitoring and emergency passage program). Rapid emergency fish passage efforts (creating a visqueen-lined channel so that adequate water remains in-channel to provide passage) will ensure that bull trout have access to their spawning grounds. In order to offset potential impacts in the varial zone (Action Area), salvage operations may opportunistically extend into upstream dewatered areas. With the implementation of the bull trout monitoring and emergency passage program, passage connectivity should be maintained or improved over baseline conditions.

While physical impacts caused by the existence of the storage dams is outside the scope of the Proposed Action, bull trout entrainment caused through reservoir operations is considered as an effect of the Proposed Action. In this sense, entrainment can result in an impediment to migration. Any surviving bull trout entrained out of Rimrock and Bumping Reservoirs have access to suitable spawning habitat. Recent genetics work shows there is genetic contribution of Rimrock-origin fish in the fluvial Naches populations, indicating that some one-way genetic exchange from the Tieton basin populations occurring as fish are entrained, survive, and end up spawning with the Rattlesnake Creek fluvial population (Small et al. 2009). For bull trout entrained out of upper Yakima reservoirs; however, it is uncertain that fish entrained out of upper Yakima reservoirs could locate appropriate spawning grounds. While the Keechelus reach of the Yakima River is designated as SR habitat, the ability of this habitat to support this use is not confirmed. In order to address this migration barrier created by Project Operations, Reclamation has proposed the Interim Bull Trout Trap and Transport at Keechelus and Kachess Reservoirs conservation measure (Section 3.3.3). While entrainment out of Keechelus and Kachess could still create a migration impediment, implementation of this conservation measure is expected to improve conditions relative to baseline function.

When Clear Creek Dam was rebuilt in 1997, fish passage facilities were constructed to enable passage between Rimrock Reservoir and Clear Lake. Fish passage is important at this location, because bull trout spawning in the North Fork Tieton River may travel down the Clear Creek Dam spillway into Rimrock Reservoir. Due to the poor design of fish passage facilities, existing passage conditions at Clear Lake are poor. Presently there are two sequential fish ladders at Clear Creek Dam: 1) a pool and weir ladder is located on the upper section of the spillway and provides passage, and 2) a denil ladder was placed on the lower section of the spillway that has been determined to be too steep for successful bull trout passage and easily becomes clogged with sediment. In the past decade, fisheries biologists hypothesized that under some flow conditions at least some bull trout can ascend the bedrock spillway in the lower spillway section (Thomas et al. 2014). In 2007, Reclamation changed Clear Creek Dam operations so that the outlet works are used to regulate discharge instead of the spillway, resulting in more stable flow condition on the spillway. A PIT-tag study initiated in 2012 suggests that this operational configuration can provide adequate passage conditions for some but not all bull trout attempting to move upstream of Clear Creek Dam. Of the 24 unique bull trout that were tagged in 2012 and 2013, subsequent detections indicate that 2 fish (8 percent) migrated downstream of Clear Creek Dam and 18 fish (75 percent) overwintered in Clear Creek for at least 1 winter (Thomas 2015b). Of the 2 fish that moved downstream of Clear Creek Dam, 1 fish has successfully migrated upstream above the dam 2 years in a row, and the other attempted but did not succeed in migrating back upstream. Genetic analysis indicates that this successful migrant is a bull trout x brook trout F1 hybrid. An additional 11 bull trout were captured and 10 of these fish were tagged downstream of Clear Creek Dam in 2014. Genetic information indicates that all 11 of these fish originated from North Fork Tieton River. Out of the 10 fish originally captured downstream of Clear Creek Dam and tagged, 1 fish was detected attempting to move upstream of the dam. To date, there is no evidence that this fish has successfully migrated upstream. As new information is acquired, Reclamation will refine Clear Creek Dam operations, as possible, to aid bull trout passage upstream of the spillway. Additionally, through the Interim Bull Trout Trap and Transport Program, Reclamation will actively move bull trout originating from the North Fork Tieton back upstream into Clear Lake. While the Clear Creek Dam is expected to continue to constitute a barrier to some bull trout attempting to migrate upstream, Reclamation anticipates that passage conditions will improve relative to baseline conditions due to improved operational control of the Clear Lake elevation, a better understanding of passage conditions at varying flows, and active relocation efforts.

The operation of Rimrock Reservoir is not likely to adversely affect passage of bull trout into the South Fork Tieton River, as 127,000 acre-feet will be maintained through August 10th. The issue is habitat access created when a bridge on Forest Service Road 1200 was constructed years ago. The natural channel of the river was relocated to flow under the bridge through a notch blasted out of bedrock. A waterfall begins to form at this location when the reservoir is drafted below 131,000 acre-feet. It is believed to become impassable for bull trout attempting to migrate upstream when the pool volume drops below 127,000

acre-feet (Thomas 2001). An informal agreement (now part of the Proposed Action) is in place with Reclamation to maintain at least this minimum pool through August 10th of each year, the date Yakima basin biologists agree bull trout have likely concluded their spawning migration into the South Fork Tieton River. Under current operations, heavy drafting of Rimrock Reservoir does not begin until early September and the reservoir has held more than 127,000 acre-feet on August 10th (average 177,155) for the 32 years since modern-day operations (i.e., flip-flop) were initiated in 1981.

Within the context of the existing dams, there will be an insignificant effect on the connectivity in the Yakima River. Improved operations at Easton Dam will provide more frequent passage to and from spawning and rearing habitat upstream of Easton Dam (see Section 3.1.4). While fish delay can still be observed even at functional fish ladders, bull trout exposure to ladder facilities is expected to be low in the lower Yakima River. Bull trout use of fish ladder facilities at Nelson, Wapatox, and Tieton Canal diversion dams are all expected to be higher. All fish ladder sites are maintained and operated year-round. Additional detail about fish ladder operations and the effects on adult salmonid fish passage is available in Section 5.4.3 "Adult Migration."

PCE 3 Abundant Food Base

Reservoir FMO Habitats. The operation of the five storage reservoirs is not likely to adversely affect PCE 3 and in most cases will maintain this PCE. 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).

A strong determent of lake productivity is allochthonous nutrient inputs. Catchment size and watershed position influences nutrient loading. The ratio of lake size to catchment area will determine nutrient dilution. Marine derived nutrients from anadromous fish are an important mechanism for upstream nutrient transport. As discussed in the baseline section, the creation of crib and permanent storage dams significantly reduced nutrient inputs originating from anadromous fish. Additionally, the location of the outlet works can influence productivity by determining whether reservoir releases transport nutrients, phytoplankton, or zooplankton downstream. The effects of the temporal pattern and quantity of stored and released water must be considered in the context of these baseline conditions.

Reservoir operations can influence productivity by hydraulic residence time; water fluctuations in the littoral zone; the selective removal of nutrients, zooplankton, phytoplankton, or forage fish; and limited habitat area.

The flushing rate or hydraulic residence time of a reservoir 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.

When seasonal hydraulic resident times are examined by water year type, the flushing rate at Bumping Reservoir was always considerably faster than the other reservoirs, and Rimrock is unique in that the flushing increased from September to December, reflecting the high late summer releases made as part of the flip-flop operation (Table 6-6 and Table 6-7, Lieberman and Hiebert 2003). The hydraulic residence time in all years and at all reservoirs was greater than the 18 days needed to support zooplankton communities. With the exception of Bumping Reservoir, hydraulic residence times are within the 50 to 250 day time period required to establish phytoplankton populations. However, these calculated flushing rates may not accurately describe hydrodynamic conditions within the reservoirs. Water stored on top of natural glacial lakes result in bowl-shaped reservoirs, where some of the deepest waters may not be disturbed by high discharge; therefore, the water coming into the lake (depending on its density) may pass through at a much faster rate than what is calculated (Table 6-6 and Table 6-7, Lieberman and Hiebert 2003; Thornton 1990). Movement of riverine water through the reservoir was a function of both release depth, volume of releases at the dam, amount of inflow entering the reservoir and inflow density, primarily as a function of water temperature. For example, a faster flushing rate for Bumping Reservoir, could conceivably affect productivity in the lake during spring and fall plankton blooms since more of the surface layer would be released. Phytoplankton washout can adversely affect reservoirs with intermediate water residence time when flushing rate of the photic zone is high (e.g., during spring periods of high inflow) (Carmack et al. 1979). However, if the flushing rate does not exceed the mean doubling time of the phytoplankton assemblage, increased inflow may enhance phytoplankton productivity by increasing nutrient availability.

Table 6-6. Average flushing rate for May 1 to August 31 for each reservoir. Flushing rate was figured by taking the average volume of reservoir divided by discharge from the reservoir from May 1 to September 31 for each year noted. River flows, snowpack levels, and rainfall all were taken into consideration when determining that 1998 was a normal water year, 1999 was a wet water year, 2000 was a normal water year, and 2001 was a dry water year (Lieberman and Hiebert 2003).

Reservoir	Flushing Rate 1998 (normal water year)(days)	Flushing Rate 1999 (wet water year) (days)	Flushing Rate 2000 (normal water year)(days)	Flushing Rate 2001 (dry water year) (days)
Keechelus	69	70	66	67
Kachess	282	258	273	95
Cle Elum	73	97	74	66
Bumping	30	20	36	54
Rimrock	110	109	130	183

Table 6-7. Average flushing rate for September 1 to December 31 for each reservoir. Flushing rate was figured by taking the average volume of reservoir divided by discharge from the reservoir from September 1 to December 31 for each year noted. River flows, snowpack levels, and rainfall all were taken into consideration when determining that 1998 was a normal water year, 1999 was a wet water year, 2000 was a normal water year, and 2001 was a dry water year (Lieberman and Hiebert 2003).

Reservoir	Flushing Rate 1998 (normal water year)(days)	Flushing Rate 1999 (wet water year) (days)	Flushing Rate 2000 (normal water year)(days)	Flushing Rate 2001 (dry water year) (days)
Keechelus	157	127	118	194
Kachess	112	168	133	144
Cle Elum	164	190	178	126
Bumping	44	27	36	40
Rimrock	51	69	90	42

Since Rimrock Reservoir was created by impounding a river and its deepest point is in front of the dam, water from the hypolimnion is discharged at all times. Since the remaining storage dams are bowl shaped, and the outlet works are not located within the deepest areas, the source of released water varies between the upper hypolimnion/metalimnion and epilimnion (Lieberman and Hiebert 2003). Releases of epilimnetic surface waters or even metalimnetic waters during plankton blooms often result in discharging greater numbers of zooplankton and phytoplankton than during non-bloom times. Ward (1975, as cited in Lieberman and Hiebert 2003) observed that dams that release water from the hypolimnion do not provide zooplankton to downstream reaches in sufficient quantities to supply a reliable food source for riverine biota. Hypolimnetic releases do sometimes deplete the system of nutrients (Soltero et al. 1973) and promote stream production (Neel 1963). Martin and Shroud (1973, as cited in Kennedy and Walker 1990) found that total organic carbon and

total phosphorus concentration were proportionately higher in the tailwater of Nolin Lake, a hypolimetic discharge reservoir, than in the Barren River Reservoir, which discharged epilimnetic water.

Minimum pool elevations for the five storage reservoirs ensure that adequate water remains year-round for zooplankton, benthic and aquatic macroinvertebrates, and forage fish production and overwintering. Operational minimum pool elevations are targeted at Clear Lake and Rimrock Reservoir, as these locations do not have a historic lake (see Section 3.1.4).

River SR and FMO Habitats. Minimum flow targets, ramping rates, and a more gradual implementation of flip-flop (Appendix K) also minimize or reduce chance of channel dewatering which could reduce aquatic macroinvertebrate and forage fish prey for the SR habitat in the Yakima River upstream of Easton, as well as the FMO habitats in the Yakima River downstream of Easton to the confluence with the Columbia River, the lower Kachess and Cle Elum Rivers; Bumping, Naches and Tieton Rivers, and Cowiche and Taneum Creeks.

PCE 4 Complex Aquatic Habitats and Process

The emphasis for this PCE is on the "processes that establish and maintain these features." The mechanism that Project O&M is expected to affect complex aquatic habitats and process is through flow regulation and any facility maintenance activities that affect bank hardening. Since proposed maintenance activities will maintain the footprint of current facilities (HydroMet stations, fish screen bypass) without expanding the footprint, the effect of maintenance activities on PCE 4 is expected to be minor and not of sufficient size to effect complex aquatic conditions relative to baseline conditions.

Operational changes included in the Proposed Action generally target minimum flows during the winter period that are too low to result in geomorphic change and higher pulse flows during the spring outmigration period that may have geomorphic potential. Flows with the most potential to cause a geomorphic response are likely associated with large storm events or spring snowmelt. In the Yakima basin, these flows are provided by tributaries without reservoir regulation and flood control operations at the storage dam.

As discussed in Chapter 4, when Status Quo operations are compared to historic conditions, results indicate that geomorphically significant flows are provided for fewer days. This result is observed downstream from each storage reservoir except Bumping. However, this may reflect the model was more reactive to flood control releases than real-life operations, essentially spilling water in fewer days.

While there are limitations associated with the comparison of modeled and historic data for this analysis, the magnitude of change in the time metric downstream the upper Yakima basin reservoirs suggests that flow changes that have evolved over time may have

inadvertently resulted in fewer days with geomorphically active flows when compared to historic conditions. More detailed investigation would be necessary to distinguish modeling artifacts from representative flow changes, and better characterize the suite of ecologically significant components of these flow events: timing, duration, magnitude, frequency, and rate of change (Poff et al. 1997).

Spring reservoir releases provided to benefit outmigrating smolts may offset this somewhat by attempting to mirror unregulated flows as much as possible.

Reservoir FMO Habitats. Operation of the five storage reservoir will not likely adversely affect PCE 4, and will maintain the existing complex habitats within reservoirs.

River SR and FMO Habitats. The Proposed Action is not likely adversely affect PCE 4 and will increase complex habitats relative to baseline conditions by increasing winter and spring flows that increase side channel connectivity. Outmigration flow improvements will also likely increase side channel connectivity as well.

Flow regulation does have the potential to impact riparian conditions and LWD recruitment. Flow regulation and water diversion has contributed to impaired floodplain function along alluvial reaches of the river (Snyder and Stanford 2001). Cottonwoods (*Populus spp*.) are a primary species along these alluvial floodplain reaches of the Yakima basin. Braatne and Jamieson (2001) found that very little recruitment to cottonwood stands in the alluvial floodplain reaches of the Yakima and Naches Rivers is occurring. They concluded this was mainly a result of the highly modified flow regime of the Yakima and Naches Rivers. However, the impact of flow regulation on riparian conditions is best considered in the context of broader factors. The lack of cottonwood stand development and decreased LWD supply and recruitment is strongly associated floodplain disconnection and development from flood control dike and levy construction, and highway and railroad construction.

Taneum Creek provides limited contribution of PCE 4 due to habitat simplification.

PCE 5 Water Temps Ranging from 2 to 15 ^{o}C (36 to 59 ^{o}F) with Adequate Thermal Refugia

Reservoir FMO Habitats. The Proposed Action is not likely to adversely affect PCE 5 in the five storage reservoirs. Water temperature conditions would be maintained. In general, Keechelus, Kachess, and Cle Elum and Rimrock Reservoirs have thermal refugia during the summer critical period. Bumping Reservoir is a warm shallow reservoir that can mix easily. Thermal refugia may exist in cold tributary flows.

River SR and FMO Habitats. Operation of the five storage reservoirs is likely to adversely affect PCE 5. The Cle Elum River will continue to exceed temperature ranges for this PCE. This adverse finding is somewhat offset as there are no bull trout currently present in the river downstream of Cle Elum Dam.

The Proposed Action is likely to adversely affect the Yakima River from Easton to the confluence with the Columbia River though overall conditions will be maintained. Lower Taneum Creek water temperatures are not likely to be adversely affected.

PCE 6 Spawning and Rearing Substrate

Reservoir FMO Habitats. PCE 6 spawning and rearing substrate is not present within the five storage reservoirs.

River SR & FMO Habitats. PCE 6 is present in the Yakima River upstream of Easton which serves as spawning and rearing habitat. The Proposed Action is not likely to adversely affect this PCE. PCE 6 is not present in the remaining reaches of river that serve as FMO habitat.

Sediment and turbidity is generally low within and immediately below the five storage reservoirs. Many forest management activities, roads, and activities on private lands do contribute to sedimentation and turbidity, but are outside Reclamation's jurisdiction.

Reclamation also has a strong set of BMPs that minimize sedimentation and turbidity.

PCE 7 Natural Hydrograph, or if Flows are Controlled, Minimal Flow Departure from a Natural Hydrograph

River SR and FMO Habitat. The Proposed Action will likely adversely affect PCE 7 in the Yakima River upstream of Easton, the Tieton River, the lower Naches, and the lower Yakima River. However, there will be overall improvements in flow releases relative to baseline conditions. This uppermost reach of the Yakima River is approximately 11 miles in length from the outlet of Keechelus Dam to Lake Easton. It is the only documented spawning area for the local bull trout population inhabiting the mainstem Yakima River. Other mainstem areas subject to flow regulation are utilized by bull trout as FMO habitat.

Habitat suitability for spawning bull trout is largely driven by stream temperature, substrate size, and groundwater interactions (Pratt 1992; Rieman and McIntyre 1993; Rieman et al. 1997; Baxter et al. 1999). Specific flow characteristics include sufficient flow to wet appropriate spawning grounds, appropriate depth (approximately 0.5 to 2 ft.) and velocity (approximately 0.5 to 1.25 ft./ sec., WDFW and Ecology 2008) and sufficient flow stability during the incubation period to prevent both redd scour and redd dewatering. Juvenile, subadult, and adult rearing and hold streamflow requirements include adequate depth (less than 1 ft.) and velocity (0.9 to 2.8 ft./ sec.) (WDFW and Ecology 2008). Flow and channel characteristics which provide cover from undercut banks, overhanging vegetation, or large woody debris are also important for bull trout rearing and overwintering. Based on available information about winter rearing needs and studies from other basins and for other target species, it is reasonable to expect that winter flow regulation may negatively impact bull

trout if flows are not sufficient to provide these fish with adequate habitat features or result in passage barriers. High flows can cause energetic stress and could potentially move bull trout downstream.

In the upper Yakima basin, reduced winter flows may result in less diverse habitat and less overall habitat for rearing and overwinter bull trout. However, Reclamation has proposed winter minimum flows intended to minimize harm. These winter minimum flows were informed by previous instream flow recommendations. Of particular note are the IP flow recommendations, which were informed by on-the-ground knowledge about side channel activation. The one exception is the minimum flows identified at Cle Elum. Recent instream restoration enables an extensive side-channel complex to be activated at much lower flows, about 220 cfs. Additionally, Tieton River flow recommendations are not tied to side channel activation flows as much as a general increase in habitat area as flows increase. While Reclamation is not able to provide these flows in all years and provide irrigation water as proposed, and required by our contracts, Reclamation has specified minimum instream flows that are rooted in biological principles. Modeling indicates that anticipated flows capable of activating key side channels will be provided in 55 percent of the years examined for the Easton reach and Cle Elum River. The Keechelus reach is expected to have minimum flows sufficient to active side-channel habitat in approximately 21 percent of the years studied. While the flows identified for the Tieton River do not meet current winter minimum flow recommendations, they are still significantly higher than winter flows provided under baseline conditions, or if current operations were to be carried forward into the future (Figures 4-18, 4-19, 4-22, 4-23).

Bull trout from the American Union, Crow, and Rattlesnake fluvial populations are generally not thought to be significantly impacted by altered flow regimes. While there are high flows in the lower Naches in the late summer due to the flip-flop regime, pre-spawn bull trout have already moved well upstream by the time flows increase (Reiss et al. 2012). Due to summer irrigation deliveries, the upper Yakima River flow regime provides adequate flow for movement and suitable temperatures for migration (Reiss et al. 2012).

The lower mainstem Yakima River is thought to be primarily used as migratory or rearing habitat for small numbers of adult and sub-adult bull trout. Active and successful migration requires adequate streamflows for transportation and protection. Late summer regulated flows downstream of Parker and Prosser are lower than unregulated conditions (SOAC 1999). Title XII flows and additional streamflow provided through water conservation are sufficient for proper operation of at least one ladder per diversion dam and to provide instream flow for travel through the stream reaches (see Section 4.2.2, “Summer Flows”). Due to operational constraints, the flows may temporarily fall below the Title XII instream flow levels. However, the impacts to passage conditions associated with these fluctuations are expected to affect passage for a relatively short duration, on the order of hours rather than days.

Under some circumstances, low streamflows can result in high stream temperatures and create thermal barriers. Whether, and under what circumstances, changes in Project operations could reduce temperatures in the lower river in September and early October is a complex question. Air temperatures, riparian cover, basin-wide floodplain function, groundwater and return flow contributions, sediment load, and precipitation are all important factors. Vaccarro (1986) found in his modeling study that even radical changes in Project operations would result in only slight changes in temperatures in September at Prosser. Ring and Watson (1999) theorized that hydrologic regulation, particularly of spring freshets, has dramatically decreased the frequency with which the alluvial floodplain aquifer is recharged, reducing the amount of shallow aquifer water that would help provide for cool water temperatures and thermal refugia. The degree to which shallow groundwater movement associated with canal seepage and irrigation application can replicate this shallow aquifer recharge process is unclear, though it does appear to occur to some extent.

PCE 8 Water Quality and Quantity Sufficient for Reproduction, Growth, and Survival

Reservoir FMO Habitat. Potential effects from the Proposed Action for PCE 8 have largely been addressed by the effects analysis for PCE 3, and PCE 5. The Proposed Action could also affect PCE 8 by: increasing turbidity; creating thermal conditions unsuitable for normal growth and survival; and drafting reservoirs so that there is insufficient space for bull trout or resources they depend on. While increased turbidity could affect bull trout foraging or cause direct harm, turbidity of a sufficient scale to affect bull trout is not anticipated from the Proposed Action. Thermal stratification in the summer provides a range of temperatures for bull trout, and typical bull trout behavior is to vertically migrate in order to access both food resources and reside water that meets thermal requirements. Due to the large historic pools at the four reservoirs that were historic lakes, sufficient water for bull trout and bull resources (such as forage fish) are provided (see Table 3-5). At Rimrock Reservoir, Reclamation takes every reasonably practicable measure to maintain an end of season volume above 30,000 acre-feet in most years and above 10,000 acre-feet in all years. Reclamation therefore concludes the Proposed Action is not likely to adversely affect PCE 8 in reservoirs.

River SR and FMO Habitat.

Potential effects from the Proposed Action for PCE 8 have largely been addressed by the effects analysis for PCE 3, PCE 5, and PCE 7. The effects of Project Operations on water quality in general are discussed in Section 4.2.3. As discussed in this section, as TMDLs are implemented, the relationship between water diversion and water quality degradation from sediment and associated pollutants breaks down.

PCE 9 Sufficiently Low Levels of Non-native Predatory, Interbreeding; or Competing Species

None of the Proposed Actions specifically address the presence of non-native predator or competing species presence in the Yakima Core Area; nor will affect the temporal and spatial isolation of these exotics from bull trout. The Proposed Action is not likely to adversely affect PCE 9 in reservoir FMO habitats or in river SR & FMO habitats. This PCE is not present in the Yakima River from the confluence of the Naches River to the Columbia River because very few bull trout are located in this area.

6.6 Bull Trout Life History Context

An evaluation of bull trout population status requires an understanding of habitat conditions associated with each life-stage and migratory pattern. With the exception of the potential upper Yakima local population, the Action Area and potential effects from the Proposed Action are limited to FMO habitat. Spawning and rearing habitat conditions, which are located outside the Action Area, may be critical factors in current population status and trends. For example, McPhail and Murray (1979) studied bull trout in MacKenzie Creek, a tributary to upper Arrow Lake and concluded that limitations in juvenile rearing habitat formed an "ecological bottleneck," that substantially limits overall abundance of bull trout. MacKenzie Creek has a 29 km^2 watershed area, which is about the size of Deep Creek that enters Bumping Lake in the Yakima River basin. McPhail and Murray (1979) conclude, "Our data suggest survival of fry, not reproduction, is the "bottleneck" in MacKenzie Creek." They point out that young-of-the-year, yearlings, and 2-year olds all share the same small stream. The limitation of juvenile rearing area is reflected in the data of Pratt (1984), who showed that numbers of juvenile bull trout per habitat unit in the Flathead River basin increased as the habitat unit size increased. Baxter et al. (1999) concur with Fraley and Shepard (1989), both of whom studied the Flathead River basin, that quality spawning and rearing habitat are likely to be the primary limiting factors affecting bull trout population size in a specific basin. Baxter et al. (1999) point out that over 75 percent of bull trout spawning in the Swan Basin occurs in less than 10 percent of the available stream length. It is noteworthy that this example is in the Swan basin, which is considered a stronghold of regional significance for bull trout, where spawner abundance has been increasing over the past 15 years (Baxter et al. 1999).

The limiting factor that disqualifies most stream habitat as suitable for bull trout spawning and rearing is temperature (McPhail and Murray 1979; Farley and Shepard 1989; Goetz 1989; Reiman and McIntyre 1995). The threshold temperature for bull trout spawning is 9 ºC (McPhail and Baxter 1996), whereas it is 13 ºC for pacific salmon and trout. McPhail and Murray (1979) demonstrated that survival of bull trout eggs was highest (80 to 95 percent) to hatching at temperatures of 2 to 4 ºC and dropped to 0 to 20 percent at temperatures of 8 to

10 ºC. Further, lower incubation temperatures resulted in larger fry; temperatures of 8 ºC produced 22 mm fry while temperatures of 2 ºC produced 24.5 mm fry (McPhail and Murray 1979). The 8 to 10 ºC temperatures at which most bull trout eggs die are within the optimum range of temperatures (6 to 13 ºC) for egg survival of all five Pacific salmon (Beacham and Murray 1990) indigenous to the West Coast. Goetz (1989) suggested optimum water temperatures for juvenile bull trout rearing were about 7 to 8 ºC (44 to 46 ºF) and optimum water temperatures for egg incubation were 2 to 4 ºC (35 to 39 ºF). Fraley and Shepard (1989) found that 28 tributaries of the Flathead River basin in which adfluvial bull trout spawn are all characterized by maximum summer temperatures less than 15 ºC. Bonneau and Scarnecchia (1996) found that juvenile bull trout, when offered a temperature gradient of 8 to 15 ºC in a natural stream, all chose the coldest water available (8 to 9 ºC). Further, several studies found a negative correlation between juvenile bull trout densities for a stream and average stream temperature (Goetz 1994; Shepard et al. 1984).

As a result of the cold water requirement for spawning and rearing, bull trout spawning is often confined to headwater streams at high altitudes. Reiman and McIntyre (1995) found that juvenile bull trout occurred only as low as 4990 feet (1,520 m) elevation at 128 sample sites within the Boise River basin. Dambacher and Jones (1997) found in the Klamath and Columbia Basins of Oregon that bull trout occur in basins that ranged from 4790 feet to 7610 feet (1,460 m to 2,320 m) elevation and averaged 30 km2 in size. Goetz (1997) reported observations of juvenile bull trout in nine basins of the Oregon and Washington Cascade Mountains at elevations down to 2100 foot elevation, but eight of the nine basins were spring fed, and all had summer temperatures under 14 ºC maximum.

In those streams that have sufficiently cold water, the next stream characteristic that limits bull trout spawning is the availability of suitable spawning gravel and dependable year-round flow. Graham et al. (1982) studied the habitat characteristics chosen by bull trout for spawning from among 94 stream reaches where bull trout were present in the Flathead River basin. They found more redds in larger streams, with lower gradients and smaller gravels. They point out that larger streams are more likely to have dependable flow and low gradient sections desirable for spawning. McPhail and Murray (1979) also found that bull trout selected low gradient reaches for spawning. Graham et al. (1982) concluded that habitat requirements limit the amount of streams that qualify for spawning, and recruitment to the Flathead Lake was limited by the availability of spawning and rearing areas.

More recently, Baxter et al. (1999) were able to further refine the physical factors that distinguish suitable spawning areas for bull trout in the Swan River basin (tributary to the Flathead River) of Montana. Baxter et al. (1999) found that bull trout spawning density was positively correlated ($r = 0.76$ to 0.87; $P < 0.04$) with either the length or area within the spawning stream that was classified as bounded alluvial segments. They define these segments as alluvial valleys that are bounded on all sides (including up and downstream) by hillslopes or bedrock features. It is these bounded alluvial segments that contain the low gradient, and sorted gravel features that Graham et al. (1982) and McPhail and Murray

(1989) describe as preferred spawning habitat. Baxter et al. (1999) also noted that bounded alluvial segments are areas of ground-water upwelling which supply stable cool temperatures, and are often selected by bull trout spawners.

Although low gradient alluvial stream segments provide desirable spawning habitat, such stream segments are rare in headwater streams of the Yakima River basin. Craig (1997) noted that average stream gradients in bull trout spawning streams of the Yakima River basin were substantially steeper than for the streams of the Flathead River. Craig reports that gradients of high and medium density spawning reaches exceeded 6 percent in Bear and Indian Creek, in contrast to the Flathead basin where Fraley and Shepard (1989) reported that gradient in high and medium density spawning areas averaged 1.5 percent and 1.8 percent, respectively. Similar to the Yakima River basin, Dambacher and Jones (1997) reported that average gradients of bull trout streams in Oregon were 5 percent. The high gradients in Yakima River basin streams correspond to smaller channels higher in the watershed compared to spawning streams of the Flathead River, and Craig (1997) concludes that this difference indicates that, "Yakima River Basin adfluvial bull trout have an extremely limited spawning area." Along with the limited spawning area also goes a limited rearing area, because juveniles generally rear 2 to 3 years in the spawning area before migrating downstream (McPhail and Baxter 1996).

If a stream qualifies for supporting bull trout by having sufficiently cold water, a large enough catchment to produce a dependable year-around water supply, and physical features that retain gravels for suitable spawning sites, those same stream qualities must also support juvenile bull trout for 2 to 3 years before they reach a migratory size. Much like steelhead, migratory bull trout rear to "smolt" size in their natal stream before migrating downstream to larger streams or a lake. Most downstream migrant bull trout are age 2 and 3 in the Flathead River basin (Fraley and Shepard 1989), the Grande Ronde basin (Bellerud et al. 1997); and the Deschutes basin (Ratliff 1992). In the Flathead basin, bull trout emigrants are typically 115 to 120 mm at age 2 and 160 to 200 mm at age 3 (Fraley and Shepard 1989). Sexauer and James (1997) studied juvenile bull trout of the Yakima River basin in the South Fork Tieton River and Indian Creek and found in both streams that most juveniles residing there were 90 to 180 mm long. Thus, juveniles remaining in these Yakima River basin streams are consistent with an expected migrant size of 120 to 200 mm. The important point here is that the bull trout life history requires that bull trout rear in small cold streams for generally 2 to 3 years before they can migrate downstream into more productive streams or lakes where they are piscivorous and grow to maturity. Thus, the limited rearing area in suitable natal streams is far more likely to constrain the population size than the rearing habitat in productive downstream areas where subadult and adult rearing is completed.

Craig (1997) found that streams in the Yakima River basin with more than 20 redds had a 7-day summer mean temperature below 12 ºC, and no single day with a temperature greater than 14.8 ºC. Within the Yakima River basin, the lowest altitude tributaries that support bull trout are above Reclamation reservoirs (Gold Creek entering Keechelus Reservoir and Box

Canyon Creek entering Kachess Lake). The low elevation watersheds of Gold and Box Canyon Creeks stand out as substantially different as other bull trout spawning areas in the Yakima River basin. Both of these streams also have significant problems with degraded stream habitat, but most importantly, both have water temperatures that remain below 15 ºC in the summer and drop below 8 ºC in the early fall. According to Craig (1997), Gold Creek has a fish barrier falls located at km 11.4, and highest spawning densities are usually found in a spring-fed channel near km 6.6 and near the mouth of ephemeral Spring Creek. Both of these areas likely have upwelled groundwater that provides a unique thermal setting for such low altitude. Goetz (1997) reported that juvenile bull trout were found in Gold Creek only above the pond, where temperatures average 10 to 12 ºC.

In contrast, Goetz (1997) found no juvenile bull trout in or below Gold Creek pond, and temperatures there ranged from 12 to 16.5 ºC. Spawning in Box Canyon Creek is limited to the lower 2.5 km (1.6 miles) by a falls, and the suitable spawning sites within the accessible length are also limited (Craig 1997).

GIS analysis of digital elevation data was used to estimate the area of each bull trout watershed that was above and below 5,000 feet elevation. It determined these areas for only that portion of the catchment that was upstream of the lowermost limit of spawning, as reported by Eric Anderson, WDFW. This catchment area generally composed only a portion of the 6th field HUC containing the spawning stream. In these cases, the hydrologic units were bisected at the downstream limit of bull trout spawning. Lines of division were canted upstream depending on topography to provide a more accurate measurement of upstream catchment area. A 30-meter digital elevation model was converted into contour bands of 500-foot intervals to ease elevation analysis. The total area for the upstream catchment was calculated, as were the portions of these areas that lay within each contour. It was found that all bull trout spawning streams in the Yakima River basin had 45 to 70 percent of their catchment (the portion above the lowest spawning limit) above 5000 feet elevation, except in Gold and Box Canyon Creeks where less than 25 percent of the area was above 5000 feet. The actual area above 5000 feet elevation was 35 km^2 or less in Gold Creek, Box Canyon Creek, and North Fork Teanaway River, and the average number of spawners per year in these streams during 1996 to 1999 was small (Table 6-8). The largest catchment areas above spawning were in the American River basin (including Union and Kettle Creeks), the South Fork Tieton River, followed by Indian Creek. These analyses indicate that bull trout streams have a high portion of their catchment above 5000 feet, unless the stream has unique morphology that results in stream temperatures that are below 8 ºC by early fall. This is meaningful because, in general, a catchment of adequate size and at suitable elevation is physically necessary to produce enough cold, summertime baseflow to support bull trout rearing.

Table 6-8. Stream characteristics and redd counts in bull trout streams in the Yakima River basin. American River includes Union and Kettle Creeks. Redd counts from WDFW, Yakima.

Stream	Above Dam	1999-2014 Mean Count	Length of Spawning Reach (km)	1999-2014 Redds Per km	Catchment Area (km^2)	
					Above Lowest Spawning	Above 5,000 ft msl
N.Fk Teanaway, 'DeRoux Crk	N	1	3.0	0.2	5.0	2.8
MF Ahtanum Creek	N	7	3.0	2.3	40.0	19.9
NF Ahtanum Creek	N	7	7.6	0.9	44.8	32.0
American River	N	38	13.8	2.8	145.2	76.2
Rattlesnake Creek	N	40	9.1	4.4	85.6	45.5
Box Canyon Creek	Y	14	2.5	5.6	31.6	3.8
Gold Creek	Y	18	6.4	2.8	35.3	7.9
Deep Creek	Y	122	8.4	14.5	64.2	31.4
SF Tieton River	Y	189	9.7	19.5	137.1	76.9
Indian Creek	Y	118	9.2	12.8	41.5	18.5

GIS analysis was also used to determine the elevation profile of the streams used for bull trout spawning. The six streams for which there were no dams to block upstream access all had bull trout spawning that started at 3200 to 3600 feet elevation and continued upstream to 4000 to 5000 feet elevation. It included the elevation profile for each of these streams where steelhead spawning was confirmed through radio tracking by Hockersmith et al. (1995). In each case, the uppermost spawning of steelhead was about 1000 feet or more in elevation below the lowermost spawning of bull trout. In the five streams above reservoirs, bull trout spawning started as low as 2,300 feet in Box Canyon Creek above Kachess Reservoir and 2,500 in Gold Creek above Keechelus Reservoir. Only in the South Fork Tieton did spawning begin more than 1 km above a reservoir, and only in Indian Creek (Rimrock Reservoir) did spawning start right at the reservoir (Figure 5-11). These data indicate that spawning elevations of bull trout throughout the Yakima River basin, whether or not migratory access is open, are above the elevations of the reservoirs.

Craig (1997) studied the characteristics of streams where bull trout spawn above reservoirs in the Yakima River basin. Craig (1997) showed that mean number of redds in spawning streams above reservoirs during 1996 was highly and positively correlated to several measures of watershed size, including watershed area (R2 = 0.79), available stream length (R2 = 0.66), available habitat area (R2 = 0.65), and base flow (R2 = 0.65). The best multiple regression model to predict redd counts contained watershed area and base flow (R2 = 0.91; P = 0.001). These findings are congruent with studies in other basins that showed spawner abundance was related to the area of spawning and rearing area in natal streams, i.e. larger streams have larger rearing capacities (McPhail and Murray 1979; Fraley and Shepard 1989; Baxter et al. 1999). Craig (1997) also found that the highest density spawning reaches contained the smallest substrate and had narrower channels. Reiman and McIntyre (1995) also found bull trout persistence to be correlated with watershed area, with watersheds greater than 20 km^2 having a 50 percent probability of supporting bull trout, but those under 10 km^2 having less than 10 percent probability.

The final determination to list bull trout stated, “Bull trout in the mid-Columbia River area are most abundant in Rimrock Lake of the Yakima River basin and Lake Wenatchee of the Wenatchee River basin. Both subpopulations are considered “strong" and increasing or stable” (63 FR 31647). The two major spawning tributaries to Rimrock Reservoir are South Fork Tieton River and Indian Creek. As we have already shown, South Fork Tieton River has substantially greater catchment above 5000 feet and greater length of spawning area than any other stream surveyed above reservoirs (Table 6-8), which means it is the largest stream with the most rearing area. Further, Indian Creek was largely spring fed with highly stable temperatures at about 8 ºC. Thus, the high abundance of bull trout in Rimrock Reservoir is associated with the largest amount of desirable spawning habitat for bull trout above any lake in the Yakima River basin. Possible spawning areas are far more confined above Bumping Reservoir (Deep Creek only), Keechelus Reservoir (Gold Creek only), and Kachess Reservoir (Box Canyon Creek and Kachess/Mineral Creek) than they are above Rimrock Reservoir. Thus, the limited availability of spawning and rearing habitat dictates that healthy populations of bull trout in Bumping, Keechelus, and Kachess Reservoirs will not be as large as those in Rimrock Reservoir. Little is known about the bull trout population above Cle Elum Reservoir, although we do know that natural barriers limit access to some of the watershed. These barriers occur at 2500, 2700, and 3000 feet so this might limit or reduce bull trout spawning and rearing habitats.

6.7 Effects Conclusion

Reclamation has determined that future O&M activities in the Yakima River Basin may affect and are likely to adversely affect bull trout and its critical habitat in Keechelus Reservoir and Kachess Reservoir; the Yakima River from Keechelus Dam to the confluence with the Columbia River, the Bumping, Naches and Tieton Rivers, Rimrock Reservoir and Clear Lake, and lower Cowiche and Taneum Creeks.

6.8 Interrelated and Interdependent Effects

6.8.1 Operation of Privately-Owned Facilities

Project water is occasionally directly spilled into tributary streams that traverse KRD lands, or travel to the systems as return flows. When this occurs, tributary water and project water becomes co-mingled and cannot be separated. In these instances, water users that divert along this tributary system end up diverting a mixture of tributary and project water. Diversions at this location would occur in the absence of the Federal Irrigation Project, though it is possible that diversions may increase, due to the increase in available water. The potential effect to steelhead from this diversion of intermingled water is expected to be small when compared to the effect of diverting water originating from the tributary (an action entirely independent from the Federal Project and Proposed Action) and potential effects to tributary systems from operational spill.

The Taneum Canal Company has a tributary water right on Taneum Creek. Most of the lands which receive water from the Taneum Canal Company also lie within the KRD service area and have a KRD water allotment. By agreement between KRD and the Taneum Canal Company, KRD operates and maintains the ditch that delivers both the KRD and Taneum Canal Company water during the irrigation season. This agreement does not affect the amount of water that either KRD diverts from the Yakima River at Easton or the amount of water that the Taneum Canal Company diverts from Taneum Creek under its own water right. In the event that KRD terminated its deliveries to its water users, the Taneum Canal Company would continue to divert all of their water from Taneum Creek and deliver through the facility that is now jointly used with KRD. As such, impacts associated with the diversion of Taneum Creek flows by the Taneum Canal Company would occur with or without its O&M agreement with KRD.

Currently, KRD supplements flows in lower Taneum Creek by making releases down the Taneum Chute, but this activity is separate from their contract with the Taneum Canal Company. Steelhead are able to access the reach where the creek is used to convey KRD water. The diversion used to remove the water from the creek is screened and false attraction has not been identified as an issue at the site under current operations. KRD water is not released into the stream until flows in Taneum Creek drop to the point where users who have both Taneum Creek and KRD water make a call on their KRD water. This normally happens in June. As a result, flows in Taneum Creek are not augmented with KRD releases during the high runoff period, but they are augmented during the summer low flow period. As such there are no adverse flow related impacts to bull trout in Taneum Creek from KRD's delivery of water to Taneum Canal Company water users.

The operation of the Cowiche and Orchard Avenue hydroelectric plants and Leishman Powerplant occur within the irrigation distribution system. Additional diversions are not made for power generation, and water used is screened. No effects to bull trout are expected from these power operations. Bull trout occupy areas upstream of Tieton Dam, and the effects of hydropower generation at this facility was considered during FERC licensing and is part of the species baseline.

6.8.2 Recreation

Recreation use along the Tieton River increases in September in response to unique rafting opportunities created by high flow releases under the flip-flop operations. The recreation can potentially degrade riparian habitat. As dispersed camp sites have already been established through use, this effect has been captured through existing habitat conditions in the baseline.

6.8.3 Upper Yakima Check Dams

As discussed in Chapter 3, due to low flows in the upper Yakima from late-August through October associated with the flip-flop operation, some irrigators must install check or wing dams to have sufficient head to divert water. This practice is known to occur at the Westside diversion. This structure is constructed in the late summer when bull trout are not expected to be present. This structure does not span the entire channel width of the channel and does not create a passage barrier for migrating fish.

6.9 Cumulative Effects

Cumulative effects are those effects of future state or private activities, not involving federal activities that are reasonably certain to occur within the Action Area of the federal action subject to consultation.

6.9.1 In-Basin Habitat and Flow Improvements

Private and state actions described in Section 2.4 of this BA that benefit Yakima basin fisheries are expected to continue in the future. The actions include state and non-profit water conservation efforts expected to result in tributary instream flow improvements and continued habitat restoration efforts. Significant improvements in tributary habitat access and habitat quality are anticipated to result from water conservation efforts that benefit tributary systems. Levee setback efforts intended to reduce flood risk and improve instream habitat in key alluvial reaches are expected to be implemented. This includes floodplain restoration projects in the lower Naches River and Gap-to-Gap reach of the Yakima River identified in Yakima County's Comprehensive Flood Hazard Management Plan, and floodplain improvements in Kittitas County likely to occur as a result of the formation of the Kittitas County Flood Control Zone District.

6.9.2 Water Quality Improvements

Water quality improvements are anticipated in areas where TMDLs are developed and implemented. In particular, suspended sediment and turbidity and organochlorine pesticide TMDLs are in place for the upper Yakima River. A detailed implementation plan was developed in 2003 and TMDL targets anticipated to be met by October 2016 (Ecology 2013). Also in the upper Yakima, a draft temperature TMDL report has been developed. Implementation of the TMDL is expected to improve temperature conditions within several tributary streams (Ecology 2014b, p.xvii). A suspended sediment and DDT TMDL was developed for the lower Yakima River in 1998. This TMDL remains in place, and new DDT-reduction work will be covered by a new water quality improvement plan (Ecology 2012). A Pesticides and PCBs TMDL water quality study finding for the entire Yakima basin was developed in 2010.

6.9.3 Climate Change

The Climate Impacts Group at the University of Washington analyzed the effects of global climate change on the Pacific Northwest and on Washington in particular (Littell et al. 2009). That evaluation used up to 20 different General Climate Models and two different emission scenarios to explore potential impacts at three different time periods extending out to near the end of the century. The global climate models generally agree that future conditions in the Pacific Northwest will be warmer. While the effect of climate change on regional precipitation is variable among climate change models, a loss of snowpack is consistently projected (Salathé et al. 2009).

Climate change models indicate significant changes in runoff in the Yakima River basin. Generally, the projected increased air temperatures would cause some precipitation to fall as rain instead of snow, which would increase winter and early spring runoff and reduce the volume of runoff from snowpack that occurs in the late spring and early summer. The net effect is anticipated to be a shift in the peak runoff period to earlier in the season, with a corresponding decrease in spring and summer (projected at 12 to 71 percent of existing runoff) and increase in fall and winter runoff (projected at an increase of 4 to 74 percent of existing runoff). Fall and winter inflow to reservoirs would increase, and the reservoir system may not be able to capture and hold the increased flow for release during the high-demand period (spring and summer). Additionally, a decrease in spring and summer supply would cause water stored in reservoirs to be depleted at a faster rate to meet demand. The combined effects would likely cause a decrease in overall supply during the high-demand period (Reclamation 2012, p. 1/12)

Climate change is expected to result in a decline in the quantity of freshwater habitat for salmonid populations across Washington State (Manuta, Tohver, and Hamlet 2010, p. 187). The Yakima River basin is a transient watershed, one that is dominated by a mix of direct runoff from fall rain and spring snowmelt. Simulations predict that this type of watershed would be most affected by climate change, with accompanying impacts to fisheries. Specific impacts to fish are expected to include:

- Increased air temperature would increase water temperature, negatively impacting fish habitat.
- Elevated stream temperatures would increase thermal barriers to migration.
- Increased winter flood frequency and intensity would cause a negative effect on juvenile coho, Chinook, steelhead, and bull trout survival and reduction of survival rates for incubating eggs and rearing parr.
- Reduced spring snowmelt and summer and fall streamflows would impact summer-run steelhead, sockeye, and summer Chinook migrations.

- Diminished flows, in combination with increased water temperatures, would increase pre-spawn mortality for summer-run and stream-type salmonids.

The hydrologic effects analysis presented in Chapter 4 is based on an assumption that historic conditions are an appropriate representation of future conditions. Expectations associated with climate change challenge this assumption. Brekke et al. (2009) suggest that long-range planning and decision-making efforts consider a range of climatic variability wider than the historic record. In the Yakima basin, the one purpose of the Integrated Plan is to provide increased flexibility in water supply to adapt to potential climate change conditions (Reclamation and Ecology 2012). Potential effects from climate change are; therefore, best considered alongside changes to operations associated with implementation with the Integrated Plan. As stated in Chapter 3, future implementation of Integrated Plan activities fall outside the scope of this current consultation

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Chapter 7 Gray Wolf

7.1 Status of the Species in the Action Area

The USFWS listed the gray wolf (*Canus lupus*) as endangered under the ESA in 1973 (38 FR 14678). In 2008, the USFWS issued a final rule identifying a DPS of the gray wolf in the Northern Rocky Mountains (NRM) of the U.S. and has subsequently revised and removed the NRM DPS from the List of Endangered and Threatened Wildlife (74 FR 15123). The NRM gray wolf DPS encompasses the eastern one-third of Washington and Oregon, a small part of north-central Utah, and all of Montana, Idaho, and Wyoming. The listing determination from 2008 to 2011 was subjected to litigious and legislative actions. In April 2011, Congress passed legislation removing the NRM wolves from the ESA. Currently, the gray wolf is federally listed as endangered in the western two-thirds of Washington State and delisted in the eastern one-third of Washington State. In June 2013, the gray wolf was proposed for delisting (78 FR 35663).

As of March 2015, there are at least 68 wolves in 16 wolf packs with 5 successful breeding pairs in Washington State (WDFW 2015). Within the entire Yakima basin, there is one confirmed wolf pack, located in the Teanaway River watershed (Becker et al. 2014) which was first documented the spring of 2011. The estimated western edge of the pack's territory lies within a radius of 5 to approximately 15 km from Cle Elum Dam. During the spring of 2013, another pack was confirmed immediately east of the Teanaway pack referred to as the Wenatchee pack (Figure 7-1). It is likely that wolves pass through the higher elevation portions of the Project Area at various times. The trend lines for both wolf population and number of wolf packs in the general area of the Eastern Cascades is increasing, thus it is also likely that the number of wolves that may pass through the area will increase in the future.

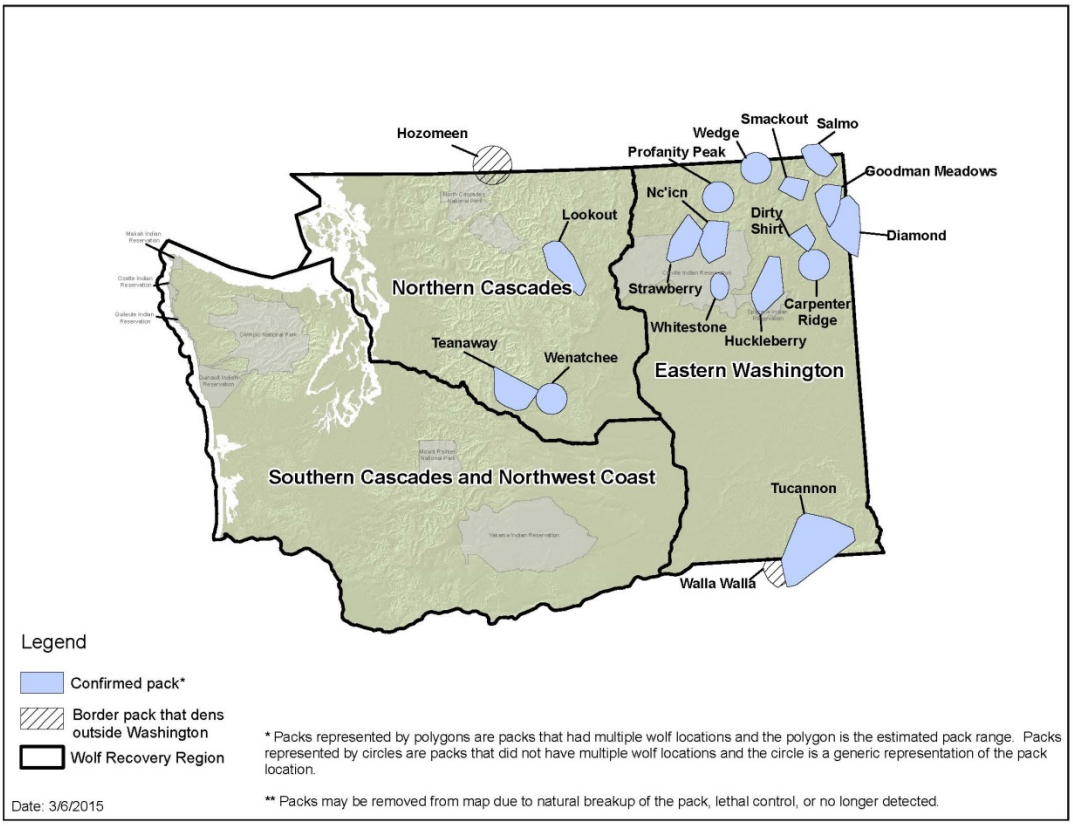

Figure 7-1. Wolf Packs in Washington as of March 2015 (WDFW 2015).

The gray wolf is carnivorous, feeding on most game with elk, deer, and moose expected to be the main prey in Washington (Wiles et al. 2011). Some food is scavenged. Wolves are highly social and typically live in packs of 5 to 10 members in size. Packs establish territories, usually about 200 to 400 square miles in size, and defend these territories from other wolves. From late April until September, pack activity is centered at or near den or rendezvous sites, as adults hunt and bring food back to the pups. At sexual maturity, wolves disperse from their natal pack to search for a mate and to start a new pack – dispersal may be to either nearby or distant unoccupied habitat. Wolves are habitat generalists, but mostly occupy forests and nearby open habitats with sufficient prey. The single greatest cause of wolf extirpation throughout its range has been the sustained deliberate human targeted extermination efforts (Fuller et al. 2003, Boitani 2003). If wolves are protected or partially protected from direct mortality and prey remains adequate, wolves adapt to human development to some degree, though road development in particular directly increases direct mortality through collisions (78 FR 35663).

7.2 Effects of the Proposed Action

7.2.1 Habitat Modification

Routine O&M activities, as summarized in Table 3-6, for the upper Yakima River watershed will not result in habitat modification for the gray wolf. Maintenance activities are focused on the existing outlet works, spillway, dam faces, and stilling basins of the five storage dams, as well as on gaging stations located in or near potentially suitable habitat in the upper Yakima River watershed. Access for maintenance crews and any necessary heavy equipment would be by existing roads. While collisions with vehicles can be a significant source of mortality for wolves, there would be little to no increase in vehicle traffic related to maintenance activities. Additionally, these routine O&M activities have been occurring in the same places and at the same rate using the same methods for decades. BMPs identified in Section 3.2.1 and minimization measures specified by activity type are designed to insure that habitat surrounding the project facilities remains in good condition.

7.2.2 Disturbance

Gray wolves can disperse over large distances. It is likely that wolves travel on or near project sites. Figure 7-2 and Figure 7-3, taken from the WDFW gray wolf sighting website (WDFW 2014b), show numerous recent sightings from 2012 to 2013. Additionally, WDFW's Priority Habitat System shows numerous sightings of gray wolves in the vicinity of Cle Elum, Little Kachess, Keechelus, Rimrock, and Bumping Reservoirs in the early 1990s (WDFW 2014c). It is possible that a wolf could be in the vicinity during routine maintenance activities at Reclamation storage facilities or gaging stations. Temporary disturbance caused by the noise of heavy equipment could cause a wolf to drift back into the adjacent forest. It is unlikely that any harm would result as adjacent suitable habitat is extensive. It is not likely that den sites would be located in the vicinity of the five storage dams, resulting in disturbance to pups or adults.

Regarding the potential effects of human disturbance on gray wolves, Fuller et al. (2003), as cited in 78 FR 35663, indicates that 1) wolves are habitat generalists and one of the most adaptable large predators in the world, 2) became extirpated in the southern portion of the subspecies' range only because of sustained deliberate human targeted elimination. Even active wolf dens can be quite resilient to nonlethal disturbance by humans (Frame and Meier 2007), and 3) vast areas of suitable wolf habitat and the current wolf population are secure in national parks, wilderness, roadless areas, lands managed for multiple uses, and areas protected by virtue of remoteness from human populations and are not available for or suitable to intensive levels of land development (78 FR 35663). In the unlikely event that a wolf may be in the vicinity of O&M activities associated with storage reservoir or gaging station maintenance, the individual has ample secure habitat to drift into, away from the temporary disturbance.

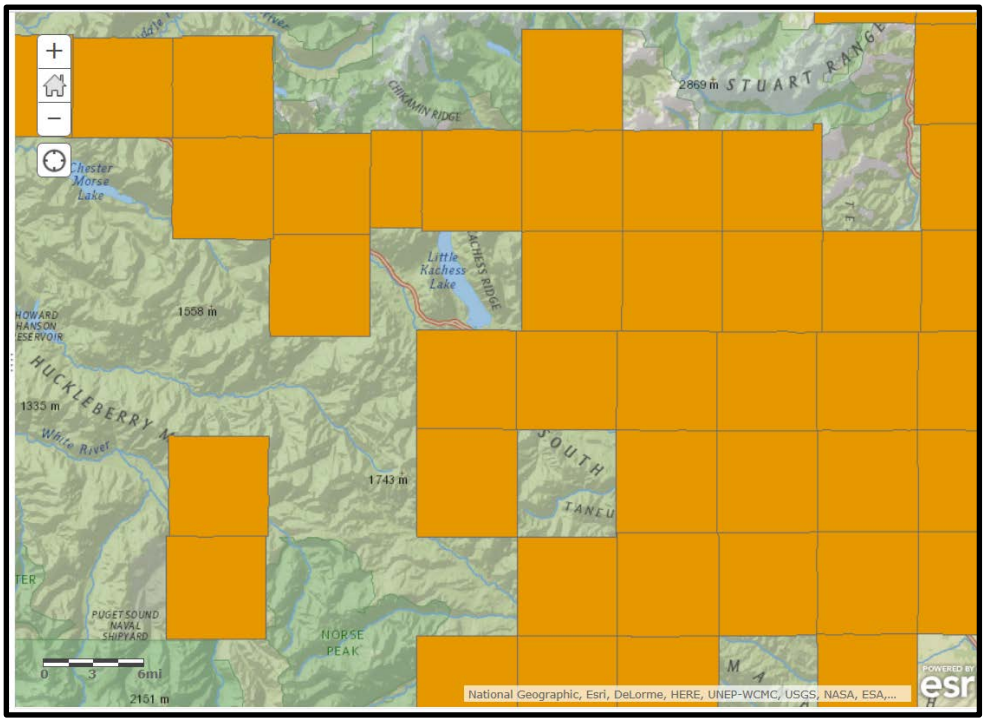

Figure 7-2. Recent wolf sightings or evidence of wolf activity in the vicinity of Keechelus, Kachess, and Cle Elum Reservoirs as displayed on the WDFW website (WDFW 2014b). Sightings were recorded in 2012 and 2013. Sightings are not confirmed.

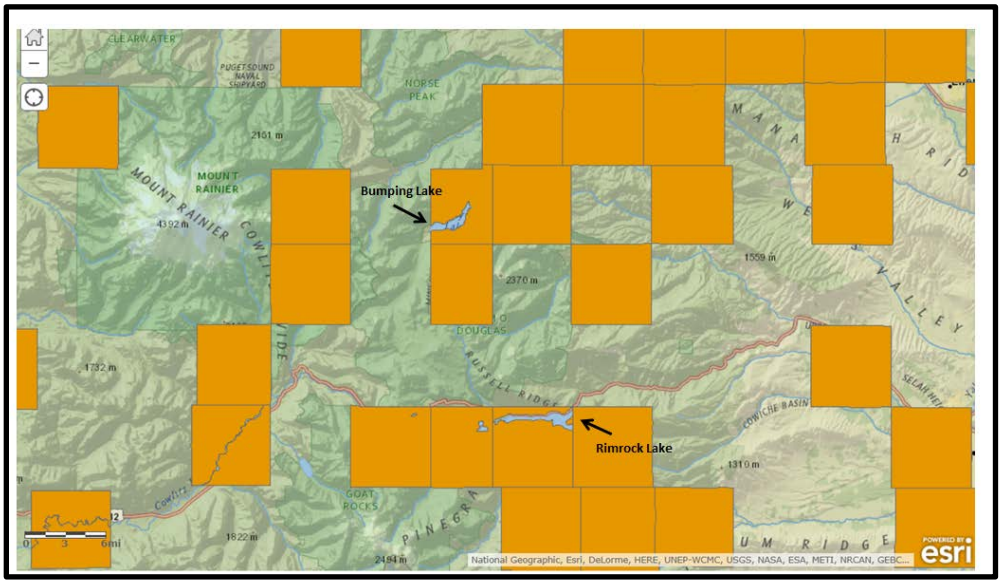

Figure 7-3. Recent wolf sightings or evidence of wolf activity in the vicinity of Bumping and Rimrock Reservoirs. Sightings were recorded in 2012 and 2013 (WDFW 2014b).

7.2.3 Effects Conclusion

Since gray wolves currently occupy the Yakima basin and have been documented in new locations during the past several years, it is possible that a gray wolf could be in the vicinity of Project facilities when maintenance activities occur. Reclamation concludes that the Proposed Action may affect gray wolf. However, no alterations to habitat are anticipated, and potential disturbance activities are not expected to be at a scale of impact resulting in take. Therefore, Reclamation concludes that the O&M of the Yakima Project, is not likely to adversely affect grey wolves.

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Chapter 8 Canada Lynx

8.1 Status of the Species in the Action Area

The Canada lynx (*Lynx Canadensis*) was listed as threatened on March 24, 2000 (65 FR 16052) and Critical Habitat for the lynx was designated on November 9, 2006 (71 FR 66008) and revised on February 25 2009 (74 FR 8616). Critical habitat for the lynx in Washington is located north of Lake Chelan to the border with Canada in Chelan and Okanagan Counties. No designated critical habitat is located within or near the Project Area. On September 26, 2013, the USFWS released a proposed rule to revise the designation of critical habitat for the contiguous U.S. DPS of the Canada Lynx and revised the boundary of the U.S. DPS (78 FR 59429). The major change is the inclusion of the New Mexico DPS.

The range of lynx populations extends south from the classic boreal forest zone into the subalpine forest of the western U.S., and the boreal/hardwood forest ecotone in the eastern U.S. Forests with boreal features extend south into the contiguous U.S. along the North Cascade and Rocky Mountain ranges in the west, the western Great Lakes Region, and northern Maine. Within these general forest types, lynx are most likely to persist in areas that receive deep snow and have high-density populations of snowshoe hares, the principal prey of lynx (Quinn and Parker 1987; Koehler 1990; Koehler and Aubry 1994; Mowat et al. 2000; McKelvey et al. 2000; Ruggiero et al. 2000). Lynx are adapted to cold temperatures and deep snows of boreal forest. In Washington, this generally includes conifer forests above 4,000 feet, such as lodgepole pine or Engelmann spruce-subalpine fir forests, and rarely dry lowland forests. Optimal lynx foraging habitat is vegetated with dense young stands of lodgepole pine that support high numbers of snowshoe hares.

Lynx are generally tolerant of humans (Staples 1995) with anecdotal reports indicating that lynx are not displaced by human presence, including moderate levels of snowmobile traffic (Mowat et al. 2000). McKelvey et al. (2000) re-analyzed data collected by Koehler (1990) and Brittell (1989) in north central Washington and found habitat use by lynx was not influenced by logging roads. Apps (2000) found six lynx in the southern Canadian Rockies that crossed highways within their home ranges, less than expected. Lynx movements may be negatively affected by high traffic volume on roads that bisect suitable lynx habitat, such as in the Southern Rockies, and in some areas, mortalities due to road kill are high. Timber harvest, recreation, and related activities are the predominant land uses affecting lynx habitat.

Lynx were trapped in Washington until 1991. Their numbers dwindled in the 1970s when old burns that had provided the best habitat became mature, and snowmobiles and new roads gave trappers greater access. The population estimate of Canada lynx in Washington as of 2001 ranges from 100 to 200 (Stinson 2001). Occurrence records from Stinson (2001) show two lynx occurrences in Kittitas County, several in Chelan County, with the bulk of records occurring in Okanogan County (Stinson 2001). Other lynx strongholds are located in high elevation forests in Ferry, Stevens, and Pend Oreille counties in northeastern Washington (Stinson 2001). Within the Project Area, the USFWS occurrence map for lynx encompasses Keechelus, Kachess, and Cle Elum Reservoirs and the upper Yakima River in Kittitas County (USFWS 2014b) (Figure 8-1). WDFW's Priority Habitat System also shows an occurrence record for lynx in the Bumping Lake area in Yakima County in the early 1990s (WDFW 2014c).

WDFW regularly surveyed lynx from 1990 through 2008 in Lynx Management Zones. Snow-tracking surveys documented lynx intermittently in northeastern Washington, except in western Okanogan County, where kitten tracks were consistently observed each winter. Maletzke et al. (2008) snow-tracked lynx during 2002 to 2004 and found increased hunting behavior in Englemann spruce and subalpine fir forests, where densities of snowshoe hares were relatively high. Koehler et al. (2008) used snow-tracking data to develop a model of lynx–habitat relationships that could be used to assess the potential distribution of lynx in Washington. They estimated about 3,800 km^2 of suitable habitat, indicating that Washington could support up to 87 lynx, but they believed this was an overestimate because it was based on an area where hare densities were high. In 2012, two females and two male lynx were captured in a study area in the Methow Valley Ranger District of Okanogan-Wenatchee National Forest and fitted with GPS collars to record their movements. Lynx occasionally move long distances away from typical habitat in what Aubry et al. (2000) and Squires and Laurion (2000) call "exploratory movements". Mowat et al. (2000) also described long distance movements (greater than100 km) by lynx. These movements are likely to result in observations of lynx out of "mapped" lynx habitat, which may explain the sightings of lynx near Bumping Lake.

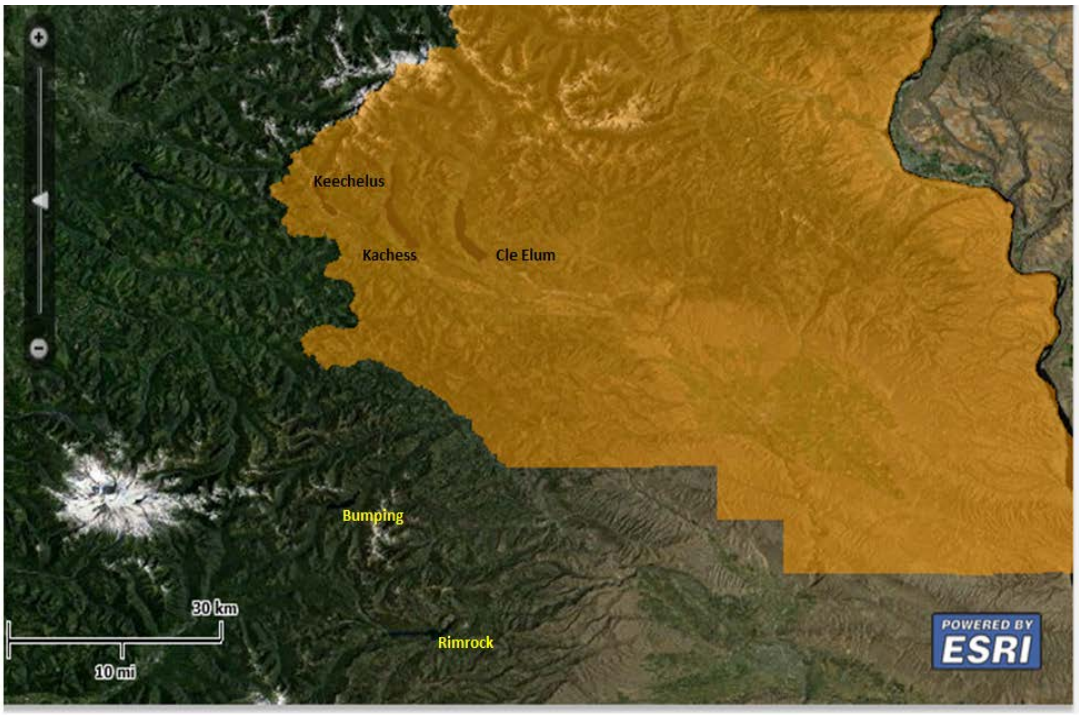

Figure 8-1. Canada lynx occurrence in the Project Area based on best available information (USFWS 2014b).

8.2 Effects of the Proposed Action

8.2.1 Habitat Modification

Routine O&M activities will not result in habitat modification for Canada lynx. Maintenance activities are focused on the existing outlet works, spillway, and stilling basins of the five storage reservoir. Access for maintenance crews and any necessary heavy equipment would be by existing roads.

8.2.2 Disturbance

The most suitable habitat for Canada lynx exists in coniferous forests above 4000 feet elevation. The five storage reservoirs are below that elevation: Keechelus is at elevation 2517 feet; Kachess is at 2254 feet; Cle Elum is at 2223 feet; Rimrock is at 2927 feet; and Bumping Lake is at 3427 feet. It is possible that lynx may use some habitat in the Project Area on a transient basis, for example the two sightings at Bumping Lake at 3427 feet elevation. The period of time crews are conducting maintenance activities is short (2 to 3 weeks at most) and confined to the outlet works, spillway channels, and dam faces. Burn pile activities will be confined to already disturbed areas. It is possible that a lynx may be traveling through the area adjacent to storage dam facilities and gaging stations during routine O&M activities. However, ample suitable habitat exists immediately adjacent to

these Project facilities in which the animal can move into to avoid any human activities or equipment. Vehicle traffic would not be increased above existing levels so that the risk of vehicle collisions should not be increased.

8.2.3 Effects Conclusion

Canada Lynx could be in the vicinity of Project facilities when maintenance activities occur. Thus, Reclamation concludes that the Proposed Action may affect this species. However, no alterations to habitat are anticipated, and potential disturbance activities are not expected to be at a scale of impact resulting in take. Therefore, Reclamation concludes that the O&M of the Yakima Project, is not likely to adversely affect Canada lynx.

Chapter 9 Grizzly Bear

9.1 Status of the Species in the Action Area

In 1975, the USFWS listed the grizzly bear (*Ursus arctos horribilis*) as threatened under the ESA (40 FR 31734). The grizzly bear's historic range covered much of North America from the mid-plains west to California and from central Mexico north through Alaska and Canada. At the time the Grizzly Bear Recovery Plan was developed, the grizzly bear was found in only 2 percent of its original range in the lower 48 states (USFWS 1993).

The North Cascades Grizzly Bear Recovery Zone is one of six recovery zones established in the U.S. as part of the Grizzly Bear Recovery Plan of 1993 (USFWS 1993). Keechelus, Kachess, and Cle Elum Reservoirs in the proposed Project Area lie within this recovery zone, which extends from the Canadian Border south to I-90. Rimrock, Clear Lake, and Bumping Reservoirs are outside the Recovery Zone (Figure 9-1). Figure 9-2 shows a close-up map of the extent of grizzly bear distribution in the Project Area.

An assessment by Almack et al. (1993) concluded that adequate habitat exists in the North Cascades of Washington to support a population of grizzly bears. Based on expert opinion and a database of sightings, the population in the North Cascades Ecosystem was estimated to be fewer than 20 animals (USFWS 2011). Two grizzly bear sightings were reported for the inlet areas and adjacent ridges at Kachess Lake and Cle Elum Lake in 1990 and 1994, respectively (WDFW 2014c). A 2011 documented sighting in Washington's North Cascade Mountains was the first verified occurrence in the North Cascade ecosystem since 1996 (USFWS 2011). There are no known grizzly bear denning sites in the proposed Project Area. Grizzlies are wide-ranging and the Cle Elum Bear Management Unit should be considered occupied in the larger scale.

Factors affecting grizzly bear recovery in the North Cascades recovery zone include very small population size, human disturbance, and population fragmentation resulting in genetic isolation (USFWS 2011). There is no data regarding population size, trend, survival, and reproductive rates for grizzly bear in the North Cascades in Washington. The likely isolation of the population in British Columbia from other populations limits the chance of natural recovery given the small population size.

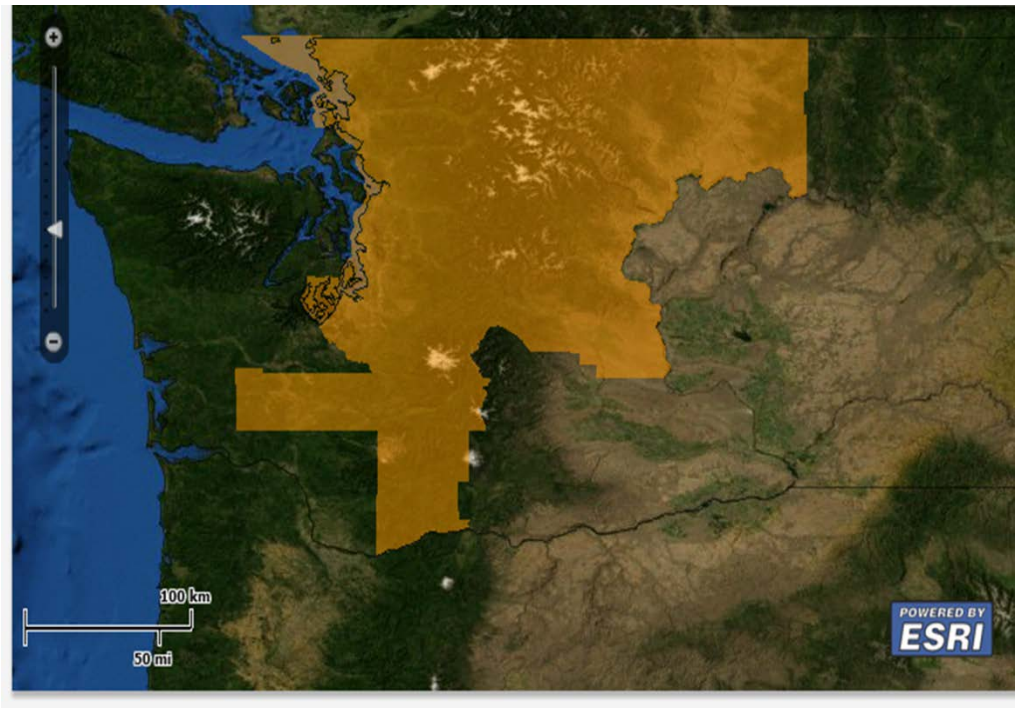

Figure 9-1. Map of the North Cascades Recovery Zone Population for Grizzly Bear (USFWS 2014c).

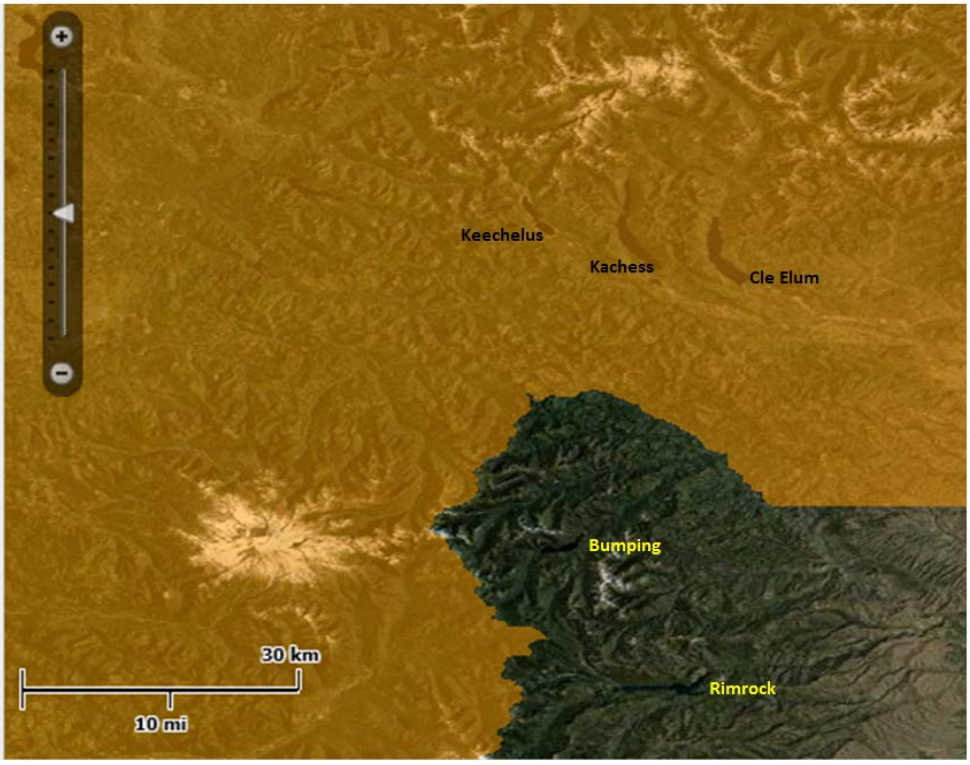

Figure 9-2. Close up of the North Cascades Ecosystem Recovery Zone Grizzly Bear Population within the Project Area (USFWS 2014c).

Grizzly bear habitat use is determined by isolation from human disturbance, food distribution, food availability, and denning security. In general, grizzly bears move seasonally, using low elevation riparian areas and meadows in the spring, higher elevations during the summer and fall months, and high isolated areas for winter denning. The Project Area near the five storage reservoirs lies within high human use areas.

Current efforts toward recovery are focusing on habitat protection through a strategy of no net loss of core habitat, information and education efforts regarding grizzly bears and their habitat, and enhanced sanitation for proper garbage and food storage in bear habitat (Interagency Grizzly Bear Committee 2014). The Okanagan-Wenatchee National Forest, which lies adjacent to the shorelines of much of the Keechelus, Kachess, and Cle Elum Reservoirs, is updating its 15-year management plan. There are 22 Bear Management Units in the Forest, the closest of which is the Cle Elum Bear Management Unit. The new long-term plan would provide for the quantity and quality of core areas to be maintained or restored, and would provide desired conditions for road densities within core areas (USFS 2011).

The USFWS conducted its 5-year status review of the grizzly bear (USFWS 2011). The uplisting from threatened to endangered status of the North Cascades bear population, along with the Cabinet-Yaak and Selkirk bear populations has a listing priority of 3 out of 6. This priority number indicates the magnitude of threat is high and those threats are imminent. However, proposed rules to reclassify threatened species to endangered are a lower priority than listing currently unprotected species (i.e., candidate species), since species currently listed as threatened are already afforded the protection of the ESA and implementing regulations.

9.2 Effects of the Proposed Action

9.2.1 Habitat Modification

No habitat modification will occur to grizzly bear habitat in the Project Area within the North Cascades bear recovery zone. No increase in roads or road densities, which are considered detrimental to grizzly bear, will result from routine O&M activities.

9.2.2 Disturbance

No grizzly bears have been observed recently in the Project Area, though two sightings were recorded for the inlets and adjacent ridge areas of Kachess and Cle Elum Reservoirs in the late 1990s (WDFW 2014c). There are no known bear denning sites in the Project Area. O&M activities occur in high human use areas of the five storage reservoirs (dam outlet works, dam faces, and shorelines adjacent to high traffic roads). Given the low likelihood of grizzly bear presence, it is not expected that bears will be disturbed by routine maintenance activities.

9.2.3 Effects Conclusion

Grizzly bear occurrence in the vicinity of Project facilities when maintenance activities occur is highly unlikely, though not impossible. No alterations to grizzly bear habitat are anticipated. Disturbance to grizzly bears from Project O&M are extremely unlikely to occur. Therefore, Reclamation concludes that the O&M of the Yakima Project, may affect, but is not likely to adversely affect grizzly bear.

Chapter 10 Marbled Murrelet

10.1 Status of the Species in the Action Area

The USFWS listed the marbled murrelet (*Brachyramphus marmoratus*) as threatened in 1992 (57 FR 45328) in Washington, Oregon, and California primarily due to declining population trends and loss of old forest nesting habitat from commercial timber harvesting. The primary objective of the Marbled Murrelet Federal Recovery Plan is to stabilize the population at or near current levels by maintaining or increasing productivity and removing or minimizing threats to survivorship (USFWS 1997). Critical habitat was designated in 1996 (61 FR 26256). On January 21, 2010, the USFWS list of U.S. counties in which the marbled murrelet is known to or is believed to occur includes Kittitas County, which encompasses part of the Project Area. Critical habitat for marbled murrelets in Washington is located in the Cascades north and west of the Project Area. No designated critical habitat is located within the Yakima basin (Figure 10-1).

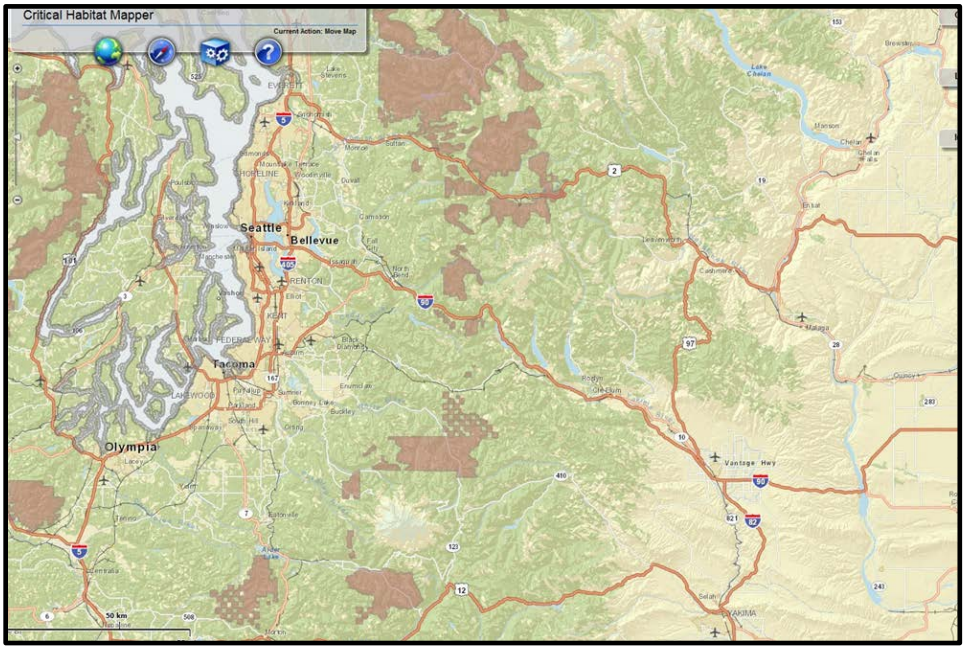

Figure 10-1. Critical habitat for Marbled Murrelet in Washington lies west of the Project Area.

Marbled murrelets have the unique behavior of foraging in marine waters and flying inland to nest in large conifer trees. Nesting behavior has been detected as far as 88 km (55 mi) from the ocean in Washington. Murrelets nest mostly on large branches or other suitable platforms in large trees (Hamer and Nelson 1995, Nelson 1997, Ralph et al. 1995), with a preference for mature and old forest in Washington, Oregon, and California (Nelson et. al 2006).

Habitat loss and fragmentation was one of the factors leading to population declines of marbled murrelets. Only 5 to 20 percent of original old-growth forests remain in Washington, Oregon, and California (USFWS 1997), most of which is in relatively small, fragmented patches or in national forest, parks, and reserves. The conservation of nesting habitat is one of the central goals of the Recovery Plan (USFWS 1997).

The amount of suitable habitat has continued to decline throughout the range of the marbled murrelet, primarily due to commercial timber harvest. The precise amount of suitable murrelet habitat within the listed range is unknown. Threats include loss of habitat, predation, gill-net fishing operations, oil spills, marine pollution, and disease. Recent reviews have concluded that the risk of predation is currently a larger threat than previously considered.

WDFW conducted a GAP analysis for marbled murrelet of suitable habitat (Figure 10-2). Suitable habitat identified by the GAP analysis indicates that the eastern-most edge of suitable marbled murrelet habitat exists within the Project Area, encompassing all of Keechelus Lake and the northern half of Kachess Lake (Figure 10-3). A possible murrelet sighting was recorded for the Snoqualmie Pass to Keechelus inlet area in 2006 (for security reasons sightings for threatened and endangered species are in township-range blocks) (Opperman et al. 2006) (Figure 10-4). The vast compilation of bird sightings in ebird (www.eBird.org) have indicated the two closest murrelet sightings to the Yakima basin occurred in 2011 just outside the northwest edge of Mount Rainier National Park and near Chester Morse Lake, both on the west side of the Cascades.

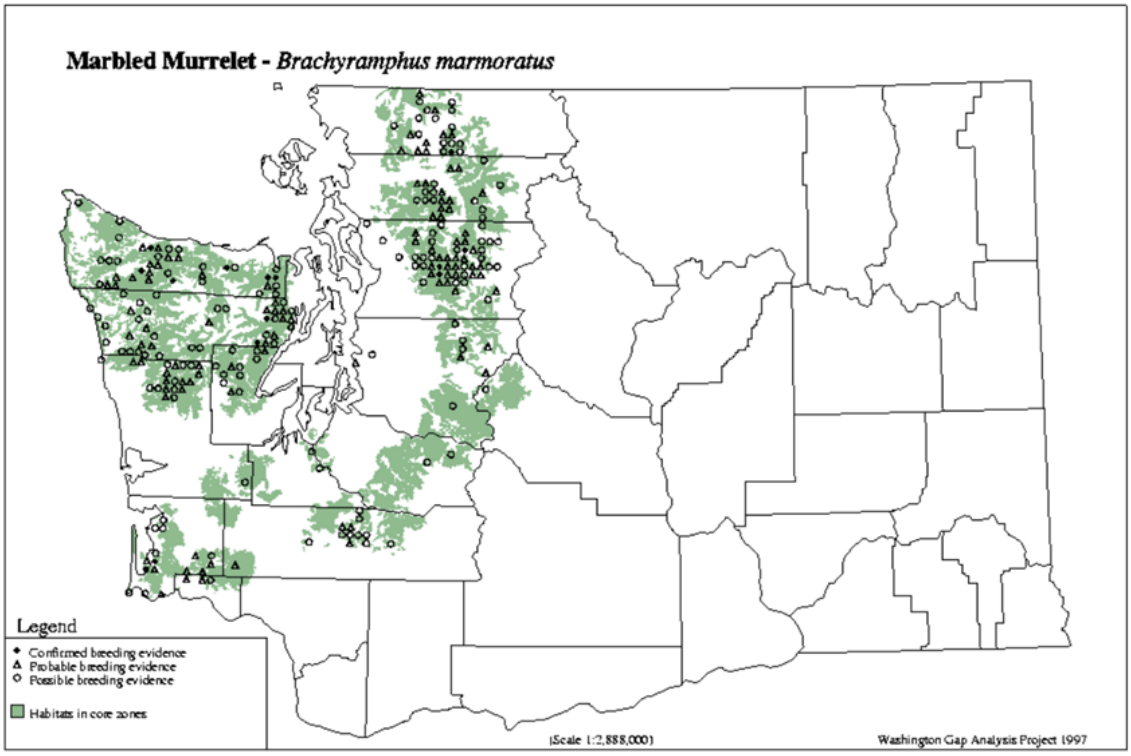

Figure 10-2. Map of suitable habitat for Marbled Murrelet from the Washington Gap Analysis Project (WDFW 1997).

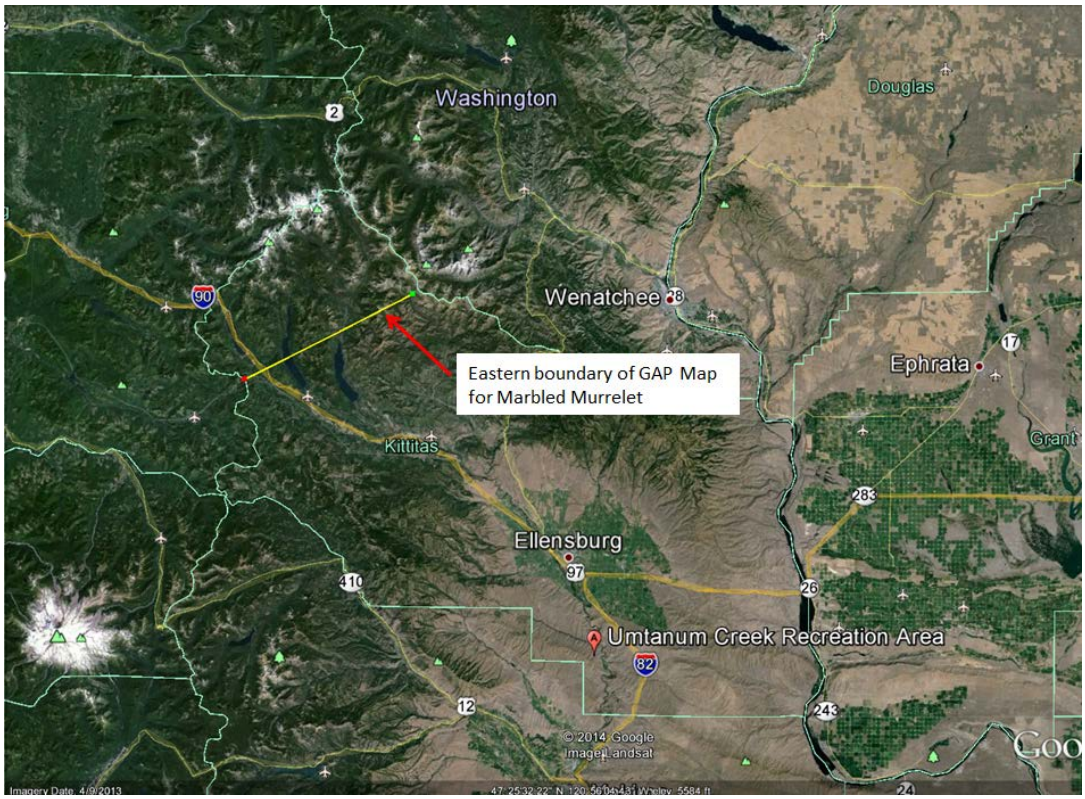

Figure 10-3. This line is the approximate eastern boundary of the GAP map for marbled murrelet in Kittitas County as mapped by WDFW (1997). Suitable habitat, as identified by GAP analysis shows suitable habitat present in the northern half of Kachess Lake and all of Keechelus Lake.

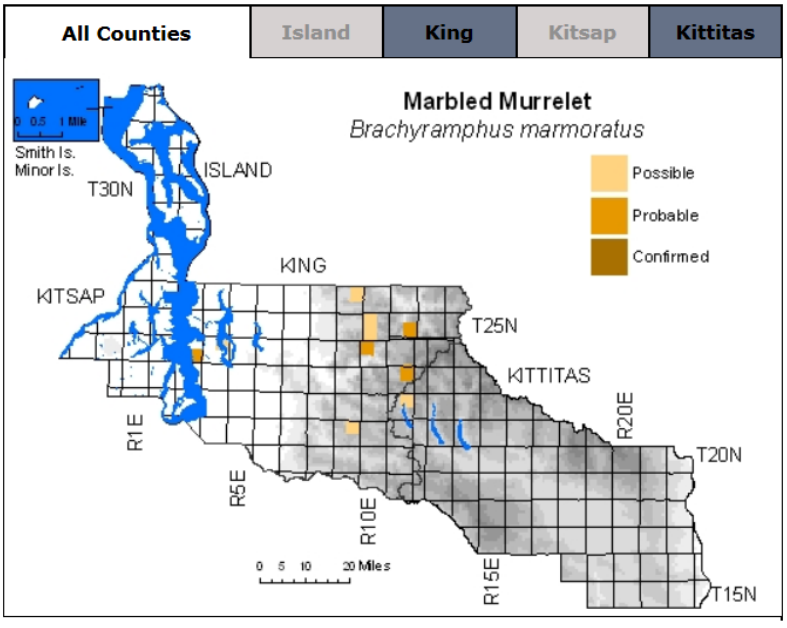

Figure 10-4. The marbled murrelet is a rare and local breeder in northeast King County in mature conifer forests. There is one record from Kittitas County near Snoqualmie summit (immediately north of Keechelus Lake) (Opperman et al. 2006).

Marbled murrelets are long-lived seabirds that spend most of their life in the marine environment, but use old-growth forests for nesting. Courtship, foraging, loafing, molting, and preening occur in near-shore marine waters. Throughout their range, marbled murrelets are opportunistic feeders and utilize prey of diverse sizes and species. They feed primarily on fish and invertebrates in near-shore marine waters although they have also been detected on rivers and inland lakes.

10.2 Effects of the Proposed Action

10.2.1 Habitat Modification

The potential for marbled murrelets nesting in the vicinity of the Project Area are extremely rare. The routine O&M actions that are associated with the five storage reservoirs would have no effect on the old forest nesting habitat required by marbled murrelets.

10.2.2 Disturbance

It is highly unlikely that routine O&M activities at the five storage reservoirs and gaging stations would result in disturbance to this elusive bird. Keechelus Lake is the most western facility and most likely to be within the marbled murrelet's nesting range. This site is also highly disturbed, since it is located adjacent to I-90.

10.2.3 Effects Conclusion

Since the potential for marbled murrelet occupancy in the Proposed Action area, particularly for nesting is unlikely, no habitat modifications to old growth nesting habitat are anticipated, and any disturbance would be short term and of low intensity, Reclamation concludes that the O&M of the Yakima Project, may affect, but is not likely to adversely affect marbled murrelet.

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Chapter 11 Northern Spotted Owl

11.1 Status of the Species in the Action Area

The northern spotted owl (*Strix occidentalis caurina*) was federally listed as threatened in 1990 (55 FR 26114). In 1994, the Northwest Forest Plan provided protections for the spotted owl and other species inhabiting late-successional forests in Washington, Oregon, and California. The first critical habitat designation for the northern spotted owl occurred in 1992, with revisions occurring in 2008. A new final rule designating critical habitat was published in December 2012.

The primary causes of spotted owl population declines are loss and adverse modification of nesting, roosting and foraging habitat due to timber harvesting, land conversions, natural disturbances such as fire, windstorms, and insect outbreaks, and competition with encroaching barred owls (USFWS 2014d). An estimated 60 percent reduction of habitat has occurred over the last 190 years. Owl numbers appear to have declined annually since 1985 when many studies began. Spotted owls are currently declining at an average rate of 2.9 percent range wide each year. The USFWS (2014d) indicates that while the listing of spotted owls as threatened and the designation of critical habitat provide some protection, past trends suggest that much of the remaining unprotected habitat could disappear in 10 to 30 years.

A long-term study has been conducted on the demography of northern spotted owls on the east slope of the Cascade Range in Washington from 1989 through 2012 (Forsman et al. 2012). This 1,787 km^2 Cle Elum Study Area Study Area encompassed three of the Yakima Project reservoirs: Keechelus, Kachess, and Cle Elum. The researchers found an 83 percent decline in the number of spotted owls detected in the study area since 1991 and a corresponding increase in the number of vacant territories. However, the team was encouraged by the fact that two territorial owls that appeared to have died during the winter of 2012 were replaced by new owls. The fact that there were a few non-territorial "floaters" within or near the study area was encouraging.

The research team found 1) strong evidence of population declines in spotted owls on 7 of 11 study areas (including the Cle Elum Study Area) and 2) barred owl presence had a generally negative effect on demographic rates of spotted owls. Spotted owl occupancy and reproduction were lower when barred owls were detected nearby. The estimated population change for the Cle Elum Study Area indicated an annual population decline of 6.3 percent. Barred owls were not detected on the Cle Elum Study Area until 2009, when a pair consisting of a male spotted owl and a female barred owl were discovered. This pair produced two hybrid young.

The Cle Elum Study (Forsman et al. 2012) also documented adverse effects to spotted owl habitat caused by a western spruce budworm (*Choristoneura occidentalis*) outbreak that started in 2000. As much as 48 percent of the entire Cle Elum Study Area has been affected. Defoliation by the budworm has the potential to reduce spotted owl habitat quality by decreasing canopy closure. Stands that are dominated by Douglas-fir (*Pseudotsuga menzesii*) and grand fir (*Abies grandis*) are particularly susceptible to defoliation. Additionally, the researchers documented 55 fires ignited by a severe lightning storm on September 8, 2012, resulting in 16,743 ha of the study area being burned. While no inhabited spotted owl territories were threatened by the fires, 38 historic territory centers were within the fire perimeter.

Spotted owls are territorial and remain on their home range throughout the year (USFWS 2008, 77 FR 71876). Home range size varies geographically, generally increasing from south to north with a corresponding geographic shift in available small mammals, which comprise most of their diet. Each home range generally contains two distinct areas: the core area and the remainder of the home range. The core area is more intensively used and tends to include the nesting area, while the remainder of the home range is used for roosting and foraging. Habitat quality in the core area is more strongly related to habitat occupancy, survival, and reproductive success than habitat quality in the larger home range (77 FR 71876). In addition to habitat requirements for resident owls, suitable habitat for dispersing owls, particularly juveniles, is important for maintaining spotted owl populations. Dispersing owls require forests that support movement to unoccupied suitable habitat.

For northern spotted owls, forest age is not as important for determining habitat suitability as the forest structure and composition, but these characteristics tend to be related to forest age. Northern interior forests typically require 150 to 200 years to attain the attributes important for nesting and roosting habitat: moderate to high canopy closure (60 to 80 percent closure); a multi-layered, multi-species canopy with large overstory trees; a high incidence of large trees with various deformities (e.g., large cavities, broken tops, mistletoe infections, and debris accumulations); large accumulations of fallen trees and other debris; and sufficient open space below the canopy for owls to fly (Thomas et al. 1990). Sometimes these forest characteristics are found in younger forests, particularly those with a significant number of remnant trees from earlier late-successional stages.

The northern spotted owl breeding season is characterized by the early nesting season and the late nesting season (Forsman et al. 1984). During the early nesting season defined as March 1 to July 15th (WSDOT 2014), nesting owls are engaging in nest site selection, egg laying, incubation, and brooding of nestlings (Forsman et al. 1984). In the late breeding season (July 16th to September 30th, WSDOT 2014), juvenile spotted owls have fledged, are able to thermoregulate, fly short distance, and are no longer completely dependent on adults for feeding (Forsman et al. 1984).

Spotted owls are strongly associated with structurally complex forest. Such forests are generally old growth, but the owls also use mature and some younger-aged forests. Sites as young as 50 years that contain remnant large-diameter trees or snags that survived, or were created by, a previous disturbance (e.g. fire, wind storm, or, in some cases, timber harvest) are sometimes used (Gutiérrez et al. 1995, Courtney et al. 2004). Forests used by spotted owls in the eastern Cascade Range tend to be younger than forests used elsewhere in Washington, and owls in those areas nest in abandoned northern goshawk (*Accipiter gentilis*) nests and branches deformed by mistletoe, rather than relying solely on snags and cavity trees (WDFW 2013).

Spotted owls use a wider array of forest types for foraging than they use for nesting, extending their foraging activities to more open and fragmented habitat. In much of the species' northern range, large, dense forests are also chosen as foraging habitat, probably because they provide relatively high densities of favored prey, the northern flying squirrel (*Glaucomys sabrinus*), as well as cover from predators. Because much of the flying squirrel's diet is fungal material, old forests provide superior foraging habitat for owls. In southern, lower-elevation portions of the owl's range, the species often forages along the edges of dense forests and in more open forests, preying on the dusky-footed woodrat (*Neotoma fuscipes*).

Although habitat that allows spotted owls to disperse may be unsuitable for nesting, roosting, and foraging, it provides an important linkage among blocks of nesting habitat both locally and over the range of the northern spotted owl. This linkage is essential to the conservation of the spotted owl. Dispersal habitat, at a minimum, consists of forest stands with adequate tree size and canopy closure to provide some degree of protection to spotted owls from avian predators and to allow the owls to forage at least occasionally. In addition to forest structure, location proximate to home range habitat is an important characteristic of dispersal habitat.

The most important habitats support all spotted owl life requisites, whereas some of them provide only certain resources, such as prey, and not others, such as nest sites. Spotted owls in Washington have the largest home ranges in the species' range (up to 27,679 acres), with substantial amounts of habitat used to hunt for prey (Forsman et al. 2005). Spotted owls primarily prey on small mammals; the most important prey species in Washington is the northern flying squirrels and various other small mammals are also taken (Forsman et al. 2001).

Occurrence and Habitat near Storage Dam Facilities (Dam Impoundments, Spillways, Outlet Works, Spilling Basins)

Among upper Yakima storage reservoirs, there are no identified northern spotted owl activity centers (active or vacant) within 0.7 miles of the storage dams and associated works (Richards 2014). One vacant northern spotted owl activity center has been identified within 1.8 miles of the Kachess impoundment. At Keechelus and Kachess Reservoirs, wet layered

mature forest is located adjacent to the dam (Table 11-1). This forest type is presumed to be suitable for nesting, roosting, and foraging. The forest type adjacent to the Cle Elum Dam infrastructure is dry, low density habitat. This forested area has stand characteristics suitable for dispersal habitat, but not nesting, roosting, and foraging (Reclamation 2010). Dry dense forest located within 0.17 miles from Cle Elum is presumed to be suitable for nesting, roosting, and foraging.

Reclamation does not have information about known northern spotted owl activity centers for either Rimrock or Clear Creek Dams, but received suitable habitat information from the USFS. Habitat suitability for nesting, roosting, foraging, and dispersal was based on aerial photography (St. Hilaire 2013). At Rimrock Reservoir, there is an approximately 120-foot buffer around the stilling basin with no continuous forest cover. Beyond this buffer, dispersal habitat is located to both the west and the east, with the eastern section on the other side of US-12. Presumed suitable nesting, roosting, and foraging habitat is located along the western shoreline of the reservoir. At Clear Creek Dam, dispersal habitat is located immediately adjacent to the spillway and dam/outlet works. The nearest mapped suitable nesting, roosting, and foraging habitat is about 500 feet from the dam.

There are no known northern spotted owl activity centers within 0.7 miles of Bumping Dam, but one activity center has been identified within 1 mile of the dam. Presumed suitable, nesting, roosting, and foraging habitat is located immediately downstream from the dam impoundment and along the western shoreline.

Table 11-1. Vegetation located within Reclamation area of influence near storage dam facilities.

Facility / Vegetation Type	Total Acres
Bumping	
Moist Layered Mature	68
Moist Single Layered	40
Cle Elum	
Dry Dense Old	6
Dry Low Density	40
Clear Creek	
Dry Partial Cut	11
Moist Layered Mature	11
Kachess	
Wet Layered Mature	72
Wet Single Layered Pole	6
Keechelus	
Meadow	15
Wet Created Opening	16

Facility / Vegetation Type	Total Acres
Wet Forest. Blowdown Opening	3
Wet Layered Mature	299
Wet Parkland	31
Wet Single Layered Pole	8
Tieton	
Dry Dense Old	25
Grassland; Shrubland	13
Moist Layered Mature	13

Occurrence and Habitat near Reservoir Areas

Reclamation storage facilities are surrounded by national forest land. A general mosaic of mapped suitable nesting, roosting, foraging, and dispersal habitat surrounds these reservoirs. Known northern spotted owl activity centers are documented within 1.8 miles of several project reservoirs, though many of these are currently vacant (Richards 2014; St. Hilaire 2013). Spotted owl presence throughout the forested areas surrounding the reservoirs, and nesting in suitable nesting, roosting, and foraging habitat is possible.

11.2 Critical Habitat

The critical habitat analyses in this BA focus on areas where an action area overlaps with designated critical habitat. There are five storage reservoirs that overlap with critical habitat for the northern spotted owl. These include Cle Elum, Kachess, Keechelus, Bumping, and Rimrock Reservoirs. Clear Creek Dam, a Reclamation facility, also overlaps with critical habitat.

The USFWS first proposed critical habitat for the northern spotted owl on May 6, 1991 (56 FR 20816) and designated 6,887,000 acres of federal lands in California, Oregon, and Washington on January 1, 1992 (57 FR 1796). In 2007, the USFWS proposed revisions to critical habitat (72 FR 32450) that were adopted as final on August 13, 2008 (73 FR 47326).

The 2008 designation was challenged in court, and in July 2009, the Federal Government requested voluntary remand of the 2008 revised critical habitat. On March 8, 2012, the USFWS proposed revised critical habitat designation (77 FR 14062). On December 4, 2012, a final rule for revised designated critical habitat was published (77 FR 71876).

The 2008 revisions resulted in a 23 percent decrease in designated critical habitat to 5,312,300 acres (77 FR 71876). The 2012 designations increased designated habitat to 9,577,969 acres. In the 1992 and 2008 designations, only federal lands were designated as critical habitat. In 2012, federal lands comprised the majority of designated critical habitat, but some lands under state ownership and in California some private lands were designated as well.

The final rule designating revised critical habitat identifies PCEs, the physical and biological features of a landscape that a species needs to survive and reproduce. These PCEs include:

1) Forest types that may be in early-, mid-, or late-seral stages and that support the northern spotted owl across its geographical range;

2) Habitat that provides for nesting and roosting. In many cases, the same habitat also provides for foraging (PCE 3). Nesting and roosting habitat provides structural features for nesting, protection from adverse weather conditions, and cover to reduce predation risks for adults and young;

3) Habitat that provides for foraging, which varies widely across the northern spotted owl‘s range, in accordance with ecological conditions and disturbance regimes that influence vegetation structure and prey species distributions; and

4) Habitat to support the transience and colonization phases of dispersal, which in all cases would optimally be composed of nesting, roosting, and foraging habitat (PCEs [2] or [3]), but which may also be composed of other forest types that occur between larger blocks of nesting, roosting, and foraging habitat.

There are two subunits within the Project Area: 1) East Cascade North Unit, Subunit 4 that encompasses Keechelus, Kachess, and Cle Elum Reservoirs; and 2) East Cascade North Unit, Subunit 5 which encompasses all of Rimrock and Clear Lake and a portion of Bumping Reservoir.

East Cascade North (ECN)-4 consists of approximately 222,818 acres in Kittitas County, Washington. Threats in this subunit include current and past timber harvest, competition with barred owls, and removal or modification of habitat by forest fires, insects, and diseases. This subunit is expected to provide demographic support of the overall population. ECN-4 is located primarily in the upper Yakima River watershed. The evaluation of sites known to be occupied at the time of listing indicated that approximately 78 percent of the area of ECN-4 was covered by verified northern spotted owl home ranges. When combined with likely occupancy of suitable habitat and occupancy of nonterritorial owls and dispersing subadults, this subunit was considered to have been largely occupied at the time of listing. In addition, there may be some smaller areas of younger forest within the habitat mosaic of this subunit that were occupied at the time of listing. USFWS determined that all of the occupied and likely occupied areas in this subunit are essential for the conservation of the species to meet the recovery criterion that call for the continued maintenance and recruitment of northern spotted owl habitat (77 FR 71876).

Critical habitat for northern spotted owl for ECN-4 lies immediately adjacent to dam structures, outlet works, stilling basins at Keechelus, Kachess, and Cle Elum Dams (Figure 11-1, Table 11-2).

East Cascade North (ESN)-5 consists of approximately 201,108 acres in Kittitas and Yakima counties, Washington. Threats in this subunit include current and past timber harvest, competition with barred owls, and removal or modification of habitat by forest fires, insects, and diseases. This subunit is expected to provide demographic support of the overall population. ECN-5 is located primarily in the watershed of the Naches River. The evaluation of sites known to be occupied at the time of listing indicated that approximately 85 percent of the area of ECN-5 was covered by verified northern spotted owl home ranges. When combined with likely occupancy of suitable habitat and occupancy of nonterritorial owls and dispersing subadults, this subunit was considered to have been largely occupied at the time of listing. In addition, there may be some smaller areas of younger forest within the habitat mosaic of this subunit that were occupied at the time of listing. USFWS determined that all of the occupied and likely occupied areas in this subunit are essential for the conservation of the species to meet the recovery criterion that call for the continued maintenance and recruitment of northern spotted owl habitat (77 FR 71876).

The Yakima Project Action Area within this critical habitat unit include the northern-most third of Bumping Lake, a small portion of the inlet areas, as well as the dam structure and the Bumping River. Critical habitat encompasses the entire Rimrock Lake and Dam structure; the Clear Lake and Dam, as well as much of the Tieton River, and adjacent ridges (Figure 11-2, Table 11-2).

Table 11-2. Total acreage of designated critical habitat within Reclamation's general area of influence at storage dams.

Site	Acres
Bumping	107
Cle Elum	56
Clear Creek	22
Kachess	80
Keechelus	365
Tieton	69

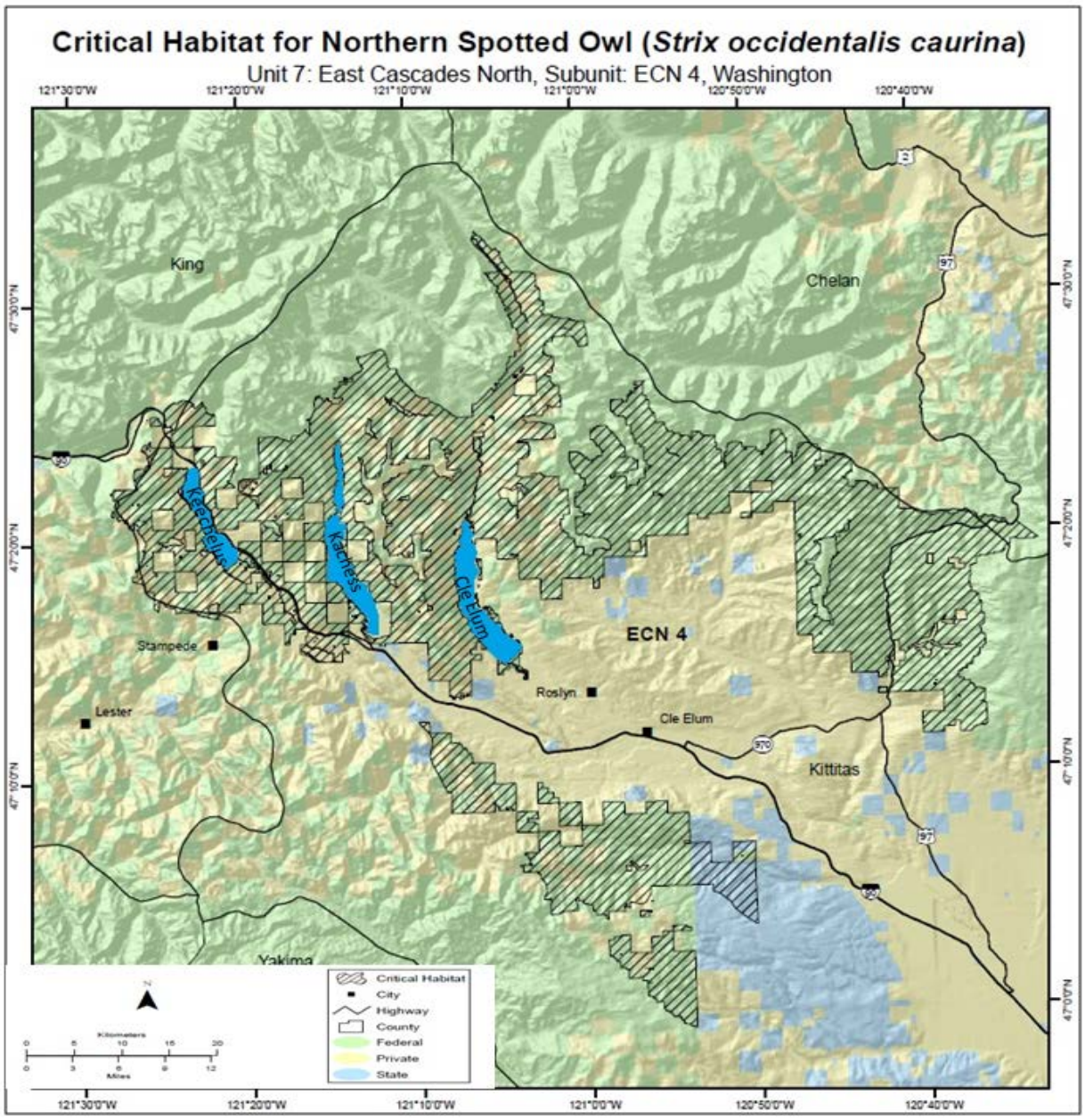

Figure 11-1. Northern spotted owl critical habitat adjacent to Keechelus, Kachess, and Cle Elum Dams (ECN-4).

Northern spotted owl occurrence has been documented in the area of Bumping Dam and both occurrence and breeding sites have been documented for the north and south sides of Bumping Lake (WDFW 2014c). Occurrence and breeding has been documented in the general vicinity of Rimrock Lake and adjacent ridges.

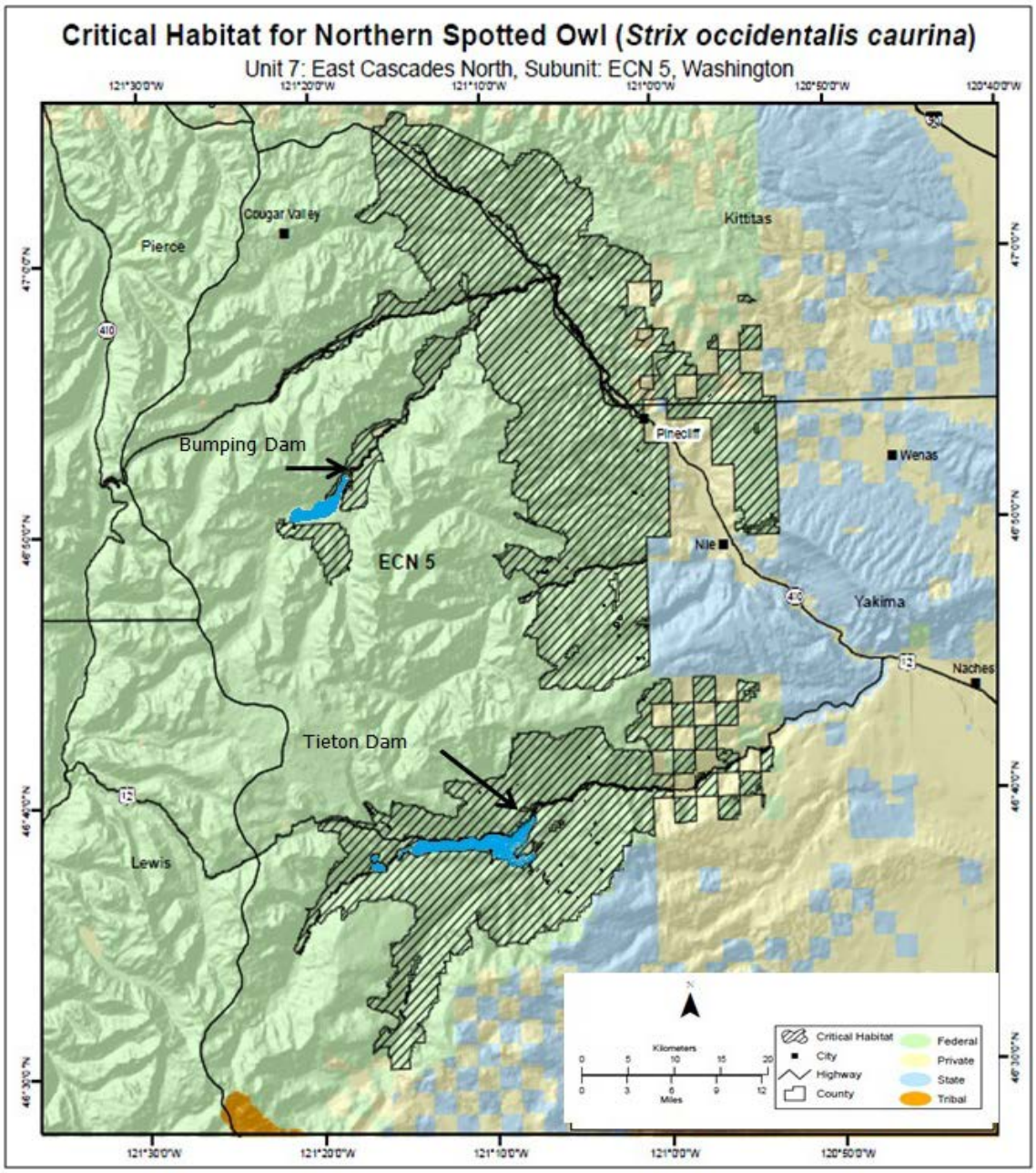

Figure 11-2. Northern spotted owl critical habitat adjacent to Bumping and Tieton Dams (ECN-5).

11.3 Effects of the Proposed Action

11.3.1 Direct Effects

Noise Impacts

Noise from large machinery and other heavy tools may disturb or harm any northern spotted owl individuals located within the vicinity. Noise generating activities are only expected with maintenance activities requiring heavy equipment or chainsaws (Section 3.2). The approach developed by the USFWS for a Biological Opinion for the Olympic National Forest program of activities (USFWS 2003) is used to analyze potential effects associated with noise. Decibel levels above 92dBA are expected to cause direct injury to spotted owls. Decibel levels between 70 dBA and 92 dBA are expected to result in disturbance to spotted owl. Injury is defined as when actual injury occurs, such as an adult flushing from the nest or the young missing a feeding. Disturbance is defined as where the owl may show avoidance of the sound by hiding, defending itself, moving the wings or body, or postponing a feeding. The effects from disturbance are not expected to reach the level of injury.

Heavy equipment operation (including chain saws) – guidance produced by WSDOT (2014, p. 7-29) concludes that for construction noise to warrant a may affect determination, this activity must be conducted during the breeding season (March 1 – September 30th) and be within 0.25 miles from suitable or known occupied stands. Construction activities that are between 111 yards and 0.25 miles from suitable habitat and occur during the breeding season may affect, but are not likely to adversely affect northern spotted owls. Construction noise may rise to the level of harm if it occurs during the early nesting period (March 1 – July 15) and is within 111 yards of suitable or occupied habitat. The 111 yard standard provides enough distance for construction noise with an average maximum noise level at 50 feet of 90 dBA to attenuate to the 70 dBA threshold. Reclamation determines that this guidance is suitable for Reclamation maintenance activities as well, based on information about average maximum noise levels for common construction equipment and decibel addition rules (WSDOT 2014, p .7.11, 7.16). Depending on the exact location of the maintenance, heavy machinery operations at Keechelus, Kachess, Bumping, and Rimrock may be close enough to suitable nesting, roosting, and foraging habitat to affect northern spotted owls, since nesting, roosting, and foraging habitat is located with 111 yards of dam facilities at these locations. This is a somewhat conservative assessment, as Keechelus and Rimrock both experience higher ambient noise due to their proximity to I-90 and US-12 and motorized recreational boats use all of these reservoirs.

In order to minimize potential effects to northern spotted owls for heavy machinery noise, the following timing considerations will be in place at the different storage dams:

- Maintenance activities can occur at all storage dams between October 1 and February 29;
- Maintenance activities can occur year round at Cle Elum and Clear Lake;
- Maintenance activities can occur during the late nesting period at Keechelus, Kachess, Bumping, and Rimrock (July 16 – September 30);
- In order for maintenance activities to occur at Keechelus, Kachess, Bumping, and Rimrock during the early nesting period (March 1 – July 15), a variance must be requested and granted (Section 3.2.1). The variance request will include specific information about the location of the activity and the distance to suitable nesting, roosting, and foraging habitat, or a more detailed noise assessment for the specific tools that will be used for the analysis. Reclamation therefor concludes that noise associated with maintenance activities may affect, but is not likely to adversely affect northern spotted owl.

Habitat Impacts

Reservoir fluctuations that routinely occur as part of standard operations will not affect owls as the nesting, roosting, and foraging habitats for the owls are above the maximum high-water line. Since northern spotted owls do not prey on aquatic species, reservoir drawdowns do not affect their prey base, nor are the owls attracted to reservoirs. In addition, owls do not rely on vegetation and woody debris that are routinely cleared from the dam faces, so removal of this debris will not directly affect northern spotted owls or their habitat. Therefore, Reclamation concludes that there will be no effect to spotted owl from habitat effects associated with project operations.

Some minor vegetation clearing to maintain site access is included in the Proposed Action. Minor vegetation clearing will be restricted to trees less than 19 inches DBH, with the exception of single hazard tree removal. This vegetation removal will typically consist of edge habitat adjacent to access roads and areas already cleared for existing facilities. Vegetation clearing may occur within dispersal habitat year round and within suitable nesting, roosting, and foraging habitat during the late breeding or non-breeding period (July 16 – February 29), unless a variance is requested and obtained. Hazard tree removal in nesting, roosting, and foraging habitat will only be conducted outside the nesting period, unless a variance is requested and obtained. Understory vegetation cleared in any year is expected to be less than 1 acre. Since vegetation removal will be limited to a small footprint, target smaller vegetation, and timed to avoid impacts to suitable habitat during sensitive nesting periods, potential effects to northern spotted owl are expected to be of small enough

scale that harm will not occur. Reclamation concludes that Project maintenance activities may affect, but are not likely to adversely affect northern spotted habitat through habitat alterations.

11.3.2 Indirect Effects

Minor vegetation clearing, especially in dispersal habitat could affect habitat for prey species. An insignificant amount of habitat is anticipated to be affected through Project O&M. Herbicides will be applied in all of the reservoir project areas to control noxious and invasive terrestrial weeds. This could have some effect on prey species that are occasionally taken by spotted owls: rabbits and mice, by eliminating some weed cover. However, native vegetation will not be targeted. Herbicide BMPs will prevent accidental spraying of native plant species. Therefore, Reclamation concludes that potential indirect effects associated with vegetation clearing and herbicide application may affect, but are not likely to adversely affect northern spotted owl.

11.3.3 Effects to Designated Critical Habitat

Reclamation storage dam facilities are located within areas designated as critical habitat for northern spotted owl (Table 11-1). Critical habitat includes areas with suitable nesting, roosting, foraging, and dispersal habitat that are necessary for the conservation of the species. PCEs for spotted owl critical habitat include roost sites, nesting grounds, rainfall, canopy cover, and soil type.

Since the reservoir area and range of fluctuation will increase compared to existing conditions, Reclamation concludes that Project operations will have no effect on designated critical habitat. Vegetation clearing for maintenance purposes will be directed to maintaining existing facilities and access areas, and is thus limited in scope and scale of disturbance to areas designated as critical habitat. A total of 1 acre understory habitat may be removed per year. This vegetation clearing will be targeted at smaller understory vegetation (less than 14 inches dbh) and limited hazard tree removal. Therefore, there will be a minor impact to the forest canopy structure. While this alteration occurs in areas designated as critical habitat, the PCEs will not be fundamentally altered by the Proposed Action. Because of these factors, Reclamation has determined that the Project may affect, but is not likely to adversely affect critical habitat for northern spotted owl in the Project Action Area.

11.3.4 Effects Conclusion

Reclamation has determined that Yakima Project O&M may affect but is not likely to adversely affect northern spotted owl or its designated critical habitat.

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Appendices

Appendix A

Yakima Project Individual Water Contracts

Entity	Annual Quantity (ac-ft)	Instantaneous Rate (cfs)	Period of Use	Diversion	Fish Screen?
Cascade Irrigation District	16,800	150	Year round	LB Yakima River, SW1/4NW1/4 Sec. 18, T18N, R18E	Y - Ph II / WDFW
Union Gap Irrigation Flood Water	1,200	37 (March) 13 (April - May)	March 15 - May 31	Union Gap Canal	Y - Phase II / WDFW
Union Gap Irrigation District Warren Act	4,222	13	April 1 - October 31	Union Gap Canal	Y - Phase II / WDFW
UGID/Tuck	30	0.1	April 1 - October 31	Union Gap Canal	Y - Phase II / WDFW
City of Ellensburg	6,000	23.33	April 20 - October 15	Town Dam	Y - Phase I
City of Yakima NRWTP	3,583	29	Storage control - October 15	LB Naches River SW1/4SW1/4 Sec. 31, T14N, R17E 13N, R18E	Y
City of Yakima Nelson	1,500	6.2	Storage control - October 15	Nelson Dam	Y - Phase I
Yakima Valley Canal Co. Flood Water	1,100	33 (March) 4 (April - June)	March 1 - June 30	Congdon Ditch	Y - Phase II / WDFW
Yakima Valley Canal Co. Warren Act	4,300	64 (July - Aug.) 41.5 (Sep.)	July 1 - September 30	Congdon Ditch	Y - Phase II / WDFW
Naches-Selah Irrigation District	4,486	36.5 max	April 1 - October 31	Naches-Selah	Y - Phase II / WDFW
Broadway Irrigation District	700	4 max	April 1 - October 31	Wide Hollow Creek, 600 ft west of east 1/4 corner section 35-13-18	Not Applicable (Decommissioned Diversion)
West Side Irrigating Co.	8,200	25	April 20 - September 30	RB, Yakima River - NE1/4SE1/4 Sect 33 R19E, T17N	Y - Phase I
Terrace Heights Irrigation District	1,354.2	4.62 max	April 1 - September 30	Roza canal	Y - Roza Phase I Screens
Selah - Moxee Irrigation District Flood Water	1,107	58	March 15 - March 31	Selah Moxee Canal	Y - Phase II / WDFW

Entity	Annual Quantity (ac-ft)	Instantaneous Rate (cfs)	Period of Use	Diversion	Fish Screen?
Selah - Moxee Irrigation District Warren Act (Pomona)	4,757	14.6 max	April 1 - September 30	Selah Moxee Canal	Y - Phase II / WDFW
Moxee Ditch Co. - Sub A / Rest Haven	959.4	3.1	April 1 - October 31	Moxee-Hubbard ditch - pumped from Roza wasteway	Y
Gangle Warren Act	30	0.1 max	April 1 - October 15	Union Gap Canal	Y - Phase II / WDFW
Carlson Warren Act	230	0.73 max	April 1 - October 15	Union Gap Canal	Y - Phase II / WDFW
Bradberry Warren Act	54	0.15 max	April 1 - September 30	Union Gap Canal	Y - Phase II / WDFW
McAllister Warren Act	76	0.25 max	April 1 - September 30	Union Gap Canal	Y - Phase II / WDFW
U.S. Forest Service Warren Act (Naches Ranger Station)	17.8	0.1	July 1 - September 30	Emerick Ditch	Y
Muoth Warren Act	10	0.23	April 1 - October 31	Cowiche Creek - 490 ft east and 1,170 ft north of the west quarter of section16, T 13N, R E WM	Y
Payne Warren Act Contract	160	0.4	April 1 - October 31	Fogarty Ditch	Y - Phase II / WDFW
City of Cle Elum	593	3	January 1 - December 31	Cle Elum River	Y

Appendix B

Reclamation Maintenance Programmatic Consultation
Project Notification Form

Request Date: _____ Reclamation Contact:_____
Lat/Long:_____
6th Field HUC:_____ HUC Name: _____
Project Start Date: _____ End Date: _____

- Does the project require near and/or in-water construction? Yes □ No □
- Will the project occur at Keechelus, Kachess, Bumping or Rimrock dams during the NSO early nesting period? Yes □ No □
- Does the project require a variance? Yes □ No □

Project Category (select all that apply)

□ Activity 1a – Site Access
□ Activity 1b – Worksite Isolation
□ Activity 1c – Fish Salvage
□ Activity 3c – Repairs to Rock Armoring (Storage)
□ Activity 4b – Gaging Station Repair
□ Activity 4c – Staff Gage Replacement
□ Activity 5b - Diversion Dam Debris Relocation
□ Activity 6c – Fish Facility Sediment Removal
□ Activity 6d - Fish Facility Repairs

Federal ESA Species/Critical Habitat Present in Action Area

- Middle Columbia River steelhead? □ Critical Habitat? □
- Bull Trout? □ Critical Habitat? □
- Northern spotted owl? □ Critical Habitat? □

Project Description

Attach a description of project activities and the intended results(s); tell when the project is to occur, describe how each of the activities will be implemented; provide any other pertinent information.

Variance Request / Justification

Describe how the effects of the requested variance fall within the range of effects described for the proposed activities in the Yakima Project Operations and Maintenance Biological Opinion, by addressing the following:

1. *BMP described in the BA which is proposed for modification.*
2. *Environmental conditions anticipated at the time of the proposed work (flow and weather conditions), as relevant.*
3. *Biological justification as to why a variance is necessary and a brief rational for why the variance will not cause additional adverse effects beyond the scope of the Opinion.*

Appendix C

Fish and Wildlife Sensitive Period Calendars

Fish Species

State Waters within the Action Area (Water Resource Inventory Area)	Times when spawning or incubating salmonids are least likely to be present
Yakima River (37.0002/38.0002/39.0002) - Mouth to Roza Dam	June 1 - September 15
Ahtanum Creek (37.1382)	June 16 - September 30
Yakima River (39.0002) - Roza Dam to Teanaway River	August 1 - August 31
Yakima River (39.0002) - Teanaway River to Easton Dam	August 1 - August 31
Yakima River (39.0002) - Upstream of Easton Dam	August 1 - August 31
Cle Elum River (39.1434) - Mouth to Dam	July 16 - August 31
Kachess River (39.1739) - Below Dam	July 16 - August 15
Taneum Creek (39.1081) - Mouth to I-90	July 16 - August 31
Taneum Creek (39.1157) - Upstream of I-90	July 16 - September 30
Naches River (38.0003) - Mouth to Tieton River	July 1 - October 15
Naches River (38.0003) - Tieton River to Bumping River	July 1 - August 15
Bumping River (38.0998)	July 16 - August 15
Tieton River (38.0166) - Mouth to Rimrock Dam	July 1 - August 31

Source: WDFW 2010

Terrestrial Species

Gray cells show sensitive periods

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Gray Wolf Mating/ Denning		-	-	-	-	-	-	-				
Gray Wolf Rendezvous							-	-	-	-	-	
Grizzly Bear Hibernation/ Denning	-	-	-	30th							15th	-
Marbled Murrelet Pre-alternate molt (retain flight)*		15th	-	-	15th							
Marbled Murrelet Nesting												
N.Spotted Owl Nesting Early			1st	-	-	-	15th					
N.Spotted Owl Nesting Late							16th		30th			

Source: WSDOT 2014

Appendix D

Facility Status - Ladders

Facility	SOP Date	SOP Author	Operational Flows	Documented Issue	Issue Schedule to be Resolved
Wanawish RB and LB Ladders	1992	NMFS/USBR	All flows < 4,000 cfs	Abundant water star grass and other debris in reach clogges auxilary water intake. This issue is addressed by visiting the site more frequently when this is an issue.	N/A
Prosser Dam Fish Ladders	1992	NMFS/USBR	250 cfs for extreme low flow operations. No maximum flow is identified.	SOP requirements for low configuration is not clear. Fish Passage group is working with SOAC to address. The indicator for the attraction flow gate is broken. The attraction flow can still be adjusted to maintain ladder to criteria.	Underway
Sunnyside Fish Ladders	1992	NMFS/USBR	Critical low water ladder operations when flows are less than 400 cfs. No max. cfs identified.	The Right Bank and Center Ladder's jet flow pipe has been rocked-in since 1996. With this deficiency, can still set ladders to meet criteria most of the time. A bent stem on the high flow gate prevents operation of this gate and is currently set to low flow configuration. This is a recent problem (only bent during low flow period/no need yet to adjust). SOP needs to be updated to reflect that gate automation has been removed and gates are operated manually.	2015
Wapato Dam Fish Ladders	1992	NMFS/USBR	All flows	Due to planned channel reconfiguration downstream of dam, ladder downstream entrances are now indundated. SOP required revision to access. Sediment accumlation is axillary rakes, but does not negatively affect ability to keep ladder in criteria.	Not scheduled
Marion Drain Fish Ladder	1992	NMFS/USBR	Whenever wasteway gate is lowered into the flow	None noted	
Toppenish-Satus Fish Ladder	1990	NMFS	Fish ladder operates when the gate is lowered during irrigation season, as well as when it is up during the non-irrigation season.	The ladder may operate better during the irrigation season than during the non-irrigation season due to the loss of a constant water elevation created by the diversion gate. When flows are inadequate for ladder, screen bypass, and irrigation entitlement, YN makes determination about operations.	
Nelson Dam Fish Ladder	1992	NMFS/USBR	Not identified. SOP does not establish criteria for low and high flow operating ranges	SOP placed special emphasis on fishway exit trashrack and auxillary water intake trashrack cleaning to provide adequate flow	
Wapatox Fish Ladder	Not avail.	N/A	N/A	Only minor problems with debris and sediment. Observations of fish falsely attracted to bypass water has not been observed since the 1980s	
YTID Fish Ladder	Not avail.	N/A	N/A		
Roza Dam Fish Ladder	1992	WDF/USBR	All flows - settings based on forebay elevation	SOP needs to be revised to reflect the current operations without using the differs in the lower ladder pools. The auxilary water valves were disconnected at least 25 years ago. A diffuser gate was added to address false attraction created by bypass pumps. This upgrade has been effective	
Town Dam Fish Ladder				Only minor problems with debris and sediment. Sediment accumulation flush downstream during high flow events	

Facility	SOP Date	SOP Author	Operational Flows	Documented Issue	Issue Schedule to be Resolved
Easton Dam Fish Ladder				Sediment that has accumulated near the auxillary rack needs to be removed. With current conditions, are still able to operate ladder to criteria. The upper section of the ladder has large sumburged ports but no weirs. An emphesis will be placed on the daily/weekly inspections to look for an abnormal head differential in a pool step that would indicate a blocked port. During the annual ladder inspection when the ladder is dewatered these ports will all be visually inspected and cleaned of debris as necessary.	

Facility	Primary O&M Responsibility	Associated Dam Diverts Contract Water	Mesh Size or Type if not Woven Wire	Scheduled to Upgrade to 3/23 mesh	Documented Issue
Sunnyside	Reclamation	Yes	1/8		
Wapato	Reclamation	Yes[1]	1/8		
Toppensish - Satus	Reclamation	Yes[1]	1/8		Star grass rolls onto screens and then into bypasses. Regular inspections check for clogging. No adjustments are made, maintenance consists of inspecting ladder and removing debris.
Richland Canal	Reclamation	Yes	1/8		
Columbia Canal	Reclamation	Yes	1/8		Submegence is often at the low end, but operators are able to keep site within criteria using check boards located downstream of the screens.
Chandler Canal	Reclamation	Yes	1/8		High sediment loads in some years cause drums to stop due to load. Address problem by allocating extra personnel to maintain site / remove silt during irrigation season using compressed air.
Toppenish Creek	Reclamation	No	1/8	Yes (2015)	It is difficult to maintain proper submergence when small amounts of water are diverted. Consider modifying structure with check structure and re-examining SOP
Roza Canal	Reclamation	Yes	1/8		
Westside Canal	Reclamation	Yes	3/32		
Easton	Reclamation	Yes	1/8	Yes (2015 - 2020)	
Taneum Canal Company	Reclamation	Yes	3/32		In water short years, ID shut off bypass flow if they are not receiving entitlement. KRD provides water down the drop, easing this problem
Knudson	Reclamation	No	1/8	Yes (2015)	
Bachelor-Hatton	Reclamation	No	1/8		
JohnCox	Reclamation	No	1/8		
Toppenish Pump	Reclamation	Yes[1]	1/8		BPA declined funding request to rebuild the screens at this time.
WIP Lower	Reclamation	No	1/8		
WIP Upper	Reclamation	No	1/8		Due a low head differential from the fish bypass entrance to the exit, flow through the bypass pipe can be less than optimal, especially at high flows, which then backs up into the pipe.
Yakima Tieton	Reclamation	Yes	Flat Plate		
Bull	WDFW	No	1/8		
Bull/Wilson	WDFW	No	1/8		
Clark	WDFW	No	1/8		
Congdon	WDFW	No	1/8		
Ellensburg Mill	WDFW	No	1/8		
Fogarty	WDFW	Yes	1/8		

Facility	Primary O&M Responsibility	Associated Dam Diverts Contract Water	Mesh Size or Type if not Woven Wire	Scheduled to Upgrade to 3/23 mesh	Documented Issue
Fruitvale	WDFW	No	Flat Plate		
Gleed	WDFW	No	Belt Screen		The stakeholders are currently evaluating feasibility of consolidating the Gleed diversion with City of Yakima's M&I diversion at the Wapatox power canal outfall. A decision should be made by the end of 2014.
Kelley-Lowry	WDFW	No	1/8		
Lindsey	WDFW	No	1/8		
Naches/Selah	WDFW	Yes	Flat Plate		
Naches-Cowiche	WDFW	Yes	1/8		
New Cascade	WDFW	Yes	1/8		
Old Union	WDFW	No	1/8		
Packwood	WDFW	No	1/8		
Powell/LaFortune	WDFW	No	1/8		
Selah Moxee	WDFW	Yes	Flat Plate		
Sniles-Allen	WDFW	No	1/8		
Taylor	WDFW	No	1/8		
Union Gap	WDFW	Yes	1/8		
Younger	WDFW	No	1/8		

[1] Water diverted for use by the Wapato Irrigation Project in not included as part of the Proposed Action (See Section 1.2). Some of the WIP facilities are using or diverting return flows from the Federal Project

Appendix E

Ladder Operations

Sunnyside Diversion Dam		Q = Discharge at Yakima River @ Parker (PARW)						Comment
Center Fish Ladder								
Gate Number	Fish Ladder Feature	**300** <= Q < 350	**350** <= Q < 400	**400** <= Q < 450	**450** <= Q < 500	**500** <= Q < 6000	Q >= **6000**	
11, 13	Low Flow Entrance Gates	Open	Open	Open	Open	Open	Closed	
12, 14	High Flow Entrance Gates	Closed	Closed	Closed	Closed	Closed	Open	
6, 9	Jet Attraction Pipes	Closed	Closed	Closed	Closed	Closed	Open	
8	Junction Pool Aux. Water Supply	Closed	Closed	Closed	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1.5' drop	
5, 10	Aux. Attraction Water	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1.5' drop	
7	Water Exchange Pipe	Open	Open	Open	Open	Open	Open	
Left Fish Ladder								
Gate Number	Fish Ladder Feature							
17	Low Flow Entrance Gate	Closed	Open	Open	Open	Open	Closed	
18	High Flow Entrance Gate	Closed	Closed	Closed	Closed	Closed	Open	
15	Jet Attraction Pipes	Closed	Closed	Closed	Closed	Closed	Open	
16	Aux. Attraction Water	Closed	Closed	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1.5' drop	
Right Fish Ladder								
Gate Number	Fish Ladder Feature							
3	Low Flow Entrance Gate	Closed	Open	Open	Open	Open	Closed	
4	High Flow Entrance Gate	Closed	Closed	Closed	Closed	Closed	Open	
1	Jet Attraction Pipes	Closed	Closed	Closed	Closed	Closed	Open	
2	Aux. Attraction Water	Closed	Closed	Adj. for 1' drop*	Adj. for 1' drop*	Adj. for 1' drop*	Adj. for 1.5' drop*	*silt only allows for .5' drop
Exceptions:								
1. high flow entrance opening depends on conditions at dam and their influence on the whitewater								
2. attraction water often shut off in fall when debris (leaves) are frequent - too difficult to maintain trash racks when attraction water is on								
3. attraction water turned off at high flows (~7 K) to minimize debris problems, note that fish ladder is not designed for flows above 12K								

Source: November 2008, Skline and TLeonard

Prosser Diversion Dam		Q = Discharge at Yakima River @ Prosser (YRPW)							
Center Fish Ladder									Operating criteria dated 6/94
Gate Number	Fish Ladder Feature	**300** <= Q < 350	**350** <= Q < 400	**400** <= Q < 450	**450** <= Q < 500	**500** <= Q < 2500	**2500** <= Q < 4000	Q >= **4000**	
G-1	Low Flow Entrance Gate (right)	Closed	Closed	Open	Open	Open	Closed	Closed	60 cfs
G-2	High Flow Entrance Gate (right)	Closed	Closed	Closed	Closed	Closed	Open	Open	
G-3	Low Flow Entrance Gate (left)	Closed	Open	Open	Open	Open	Closed	Closed	76 cfs
G-4	High Flow Entrance Gate (left)	Closed	Closed	Closed	Closed	Closed	Open	Open	
G-5	Crossover/balance water	Closed	Closed	Open	Open	Open	Open	Open	
A-1	Junction Pool Aux. Water Supply	Closed	Closed	Adj. for 1' drop	Adj. for 1' drop	Open	Open	Open	adjusted for 4' differential between junction pool and tailwater
A-2	Aux. Attraction Water (left)	Closed	Closed	Adj. for 1' drop	Adj. for pool	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	
A-3	Aux. Attraction Water (right)	Closed	Closed	Adj. for pool	Adj. for pool	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	68 cfs low/120 cfs high
Left Fish Ladder									Operating criteria dated 6/94
Gate Number	Fish Ladder Feature								
G-1	Low Flow Entrance Gate	Open	Open	Open	Open	Open	Open	Closed	39 cfs
G-2	Medium Flow Entrance Gate	Closed	Closed	Closed	Closed	Open	Open	Closed	44 cfs
G-3,4	High Flow Entrance Gate(s)	Closed	Closed	Closed	Closed	Closed	Closed	Open	53 cfs
G-5,6	Aux. Attraction Water	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	28 cfs low/109 cfs med/93 cfs high
Right Fish Ladder									Operating criteria dated 10/87
Gate Number	Fish Ladder Feature								
G-1	Low Flow Entrance	Open	Open	Open	Open	Open	Open	Open	poor access for fish at low flows
G-2	High Flow Entrance Gate	Closed	Closed	Closed	Closed	Closed	Closed	Open	
G-3	Low & High Flow Entrance Gate	Closed	Open	Open	Open	Open	Open	Open	
G-4	Aux. Attraction Water	Closed	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1' drop	Adj. for 1.5' drop	
G-5	Junction Pool Aux. Water Supply	Closed	Open	Adj. for 1' drop	Adj. for 1' drop	Open	Open	Open	adjusted for 5' differential between junction pool and tailwater
Exceptions:									
1. timing of high flow entrance opening depends on conditions at dam and their influence on the whitewater									
2. attraction water often shut off in fall when debris (leaves) are frequent - too difficult to maintain trash racks when attraction water is on									
3. attraction water turned off at high flows (~7 K cfs) to minimize debris problems, note that fish ladders are not designed for flows above 12K									
4. fish exit gates closed at high flows (>7K cfs) to reduce debris inundation potential									

Source: November 2008, Skline and TLeonard

Appendix F

Appendix F

Bumping Reservoir Storage Max, Min, Model vs. Historic 1981-2009

	Maximum Storage (af)						Minimum Storage (af)					
CAL YR	Model AF	Date range		Historic AF	Date Range		Model AF	Date range		Historic AF	Date Range	
1981	33970	5/19	7/8	34456	4/30		11442	11/16		3870	11/9	11/12
1982	38416	6/23		35261	6/13		13318	12/1		3843	1/20	1/22
1983	36505	6/1		34181	6/2		12731	11/1		2795	12/19	
1984	33970	6/29	7/17	33802	5/31	6/16	6303	12/31		3826	12/30	12/31
1985	37767	6/8		35498	6/7		1792	3/17		3820	3/24	4/6
1986	37342	6/2		34620	6/1		8087	1/17		3150	10/25	
1987	36737	5/12		34690	5/9		1538	11/29		3280	11/30	
1988	33970	6/23	7/8	34542	6/17		1998	1/11		2990	11/2	
1989	33970	6/24	7/8	33970	6/5		8839	11/8		6520	11/3	
1990	33970	6/26	7/11	34295	6/4	6/5	14740	1/4		10016	3/6	
1991	33970	6/25	7/13	34607	6/20		8575	11/11		2630	10/22	
1992	33970	5/7	6/17	35260	5/25		1751	12/31		3260	10/30	
1993	34089	5/21		30981	6/1		1453	11/29		2480	11/14	12/1
1994	33970	5/11	7/3	29960	6/13	6/14	1747	1/1		3074	1/1	
1995	35183	12/1		35794	11/30		14302	11/6		7778	3/19	
1996	33970	6/25	7/8	35755	6/5		13179	11/9		5840	12/30	12/31
1997	39257	6/18		36181	6/16		15000	3/14	3/18	5000	3/15	
1998	33970	6/27	7/8	35755	6/10		8670	11/12		7488	10/6	10/7
1999	34485	7/13		35433	6/18		14209	3/22		5305	4/15	4/16
2000	33970	6/26	7/10	34620	6/6		4411	12/31		3814	12/31	
2001	33970	5/30	6/30	34373	6/28		1670	3/6		2863	3/7	
2002	34938	6/17		34334	6/29		2611	12/31		5382	12/12	
2003	34037	5/31		34568	5/28		2568	1/1		5547	1/1	
2004	33970	6/8	7/8	34634	5/28		12544	1/14		8880	1/14	
2005	33970	5/18	6/19	34256	5/10		6713	12/21		5736	12/20	
2006	34821	6/14		35485	6/6		11482	11/2		8720	11/2	
2007	34236	6/4		34607	6/3		10854	11/11		7600	11/11	
2008	34147	6/30		34542	7/1		7801	4/13		4278	4/12	
2009	35675	6/6		35020	6/5		11145	4/8		8535	4/9	4/11

Cle Elum Reservoir Storage Max, Min, Model vs. Historic 1981-2009												
	Maximum Storage (af)						Minimum Storage (af)					
CAL YR	Model AF	Date range		Historic AF	Date Range		Model AF	Date range		Historic AF	Date Range	
1981	391474	6/6	6/7	436613	6/1		55594	9/16		32269	10/28	10/30
1982	436950	6/29	7/7	434550	6/28		94775	1/14		40627	1/14	
1983	436950	6/28	6/30	436086	5/30		187481	10/31		142670	10/19	
1984	436950	6/29	7/8	438340	6/16		200368	10/10		139038	10/12	
1985	436929	6/20		418293	6/18		70960	10/18		43080	10/13	
1986	420228	6/11		413113	6/8		44308	10/26		35472	10/25	
1987	349224	6/1		364340	5/21	5/22	9889	11/12		11340	10/26	
1988	318308	6/23		362470	6/24		16548	2/6		28600	1/1	
1989	419477	6/15		438150	6/10		47680	11/3		46798	10/12	
1990	436950	6/25	7/1	440175	6/17		141761	10/2		128022	10/2	
1991	436950	6/24	7/5	438246	7/3		170220	11/3		156257	10/22	10/23
1992	436950	5/8	5/11	433964	5/11		24182	9/22		15930	9/23	
1993	315784	6/12		345100	6/10		12888	11/30		11150	10/24	
1994	258849	6/14		277543	5/31		13510	1/1		12860	10/19	
1995	436950	6/27		438488	6/26		82088	1/1		84918	1/1	
1996	436831	6/17		438390	6/16		125186	10/13		105310	10/14	
1997	436950	6/29	7/14	437669	6/26		184887	1/1		182630	1/1	
1998	436703	6/18		439744	5/24		86403	11/12		73200	11/12	
1999	436950	6/29	7/29	437958	7/12		154053	1/1		146930	1/1	
2000	436950	6/26	6/30	441434	6/6		127977	9/9		90120	9/9	
2001	276415	6/3		243574	6/3	6/4	28465	10/12		24700	10/9	
2002	436950	6/30	7/3	437620	6/22		111410	1/1		114846	1/1	
2003	436950	6/13	6/22	435798	6/13		70483	10/10		43550	10/11	
2004	421117	6/8		422600	6/17		47572	9/10		59780	9/11	
2005	354287	5/23		370500	5/26		18136	9/28		13970	9/28	
2006	436950	6/29	7/1	436566	6/25		68167	1/1		65540	1/1	
2007	436859	6/13	6/13	436758	6/16		69245	10/18		76731	10/1	
2008	436950	7/2	7/8	436614	7/4		129896	1/1		131119	1/1	
2009	436678	6/22		436566	6/20		104445	9/30	12/31	79691	10/16	10/17

Kachess Reservoir Storage Max, Min, Model vs. Historic 1981-2009												
	Maximum Storage (af)						Minimum Storage (af)					
CAL YR	Model AF	Date range		Historic AF	Date Range		Model AF	Date range		Historic AF	Date Range	
1981	482124	5/4		240391	4/30		300649	10/1		106662	10/5	
1982	486342	6/30		239127	5/17		322850	12/31		129629	1/1	
1983	473445	6/19		238633	6/1		328520	10/26		116980	11/1	
1984	486791	6/28		238212	6/1	6/2	345571	10/16		119733	10/14	
1985	461550	6/25		237665	6/20		270925	10/17		52190	10/7	
1986	409767	6/11		219489	6/7		272177	10/25		21060	10/25	
1987	400779	6/16		171986	6/11		250366	11/20		21700	10/14	10/18
1988	368602	6/27		166492	6/30	7/1	253478	10/13		23280	10/14	
1989	413514	6/21		196213	6/6	6/7	280695	10/9		63190	10/18	
1990	471872	7/1		241342	6/10		324587	12/31		110608	1/1	
1991	486550	6/13		237755	5/24	5/25	330311	10/20		89260	10/20	
1992	453555	5/20		221750	5/22		255513	10/21		24030	10/20	10/22
1993	367317	6/12		136910	5/22		251502	11/28		19360	10/31	11/1
1994	348888	6/23		106040	5/13		254359	12/31		18920	10/18	
1995	416443	6/17		220640	8/2		290839	10/10		62420	1/1	
1996	486342	6/8		235945	2/12		329086	10/14		29750	9/25	
1997	486980	6/29	7/10	239935	7/10		368432	12/31		76320	1/1	
1998	486064	6/8		240754	5/25		307966	10/22		77902	10/22	
1999	486980	6/29	7/10	239567	8/4	8/7	350715	12/31		124661	1/1	
2000	486980	6/22		238935	7/11		331217	10/15		105120	10/18	
2001	403740	6/16		168009	5/27		262088	10/13		19355	10/10	
2002	474902	7/7		240295	7/7		304374	12/31		62150	1/1	
2003	438388	6/21		237710	6/18	6/19	297910	10/7		46396	10/16	
2004	429058	6/14		163570	6/23		266536	10/4		48646	10/16	
2005	374566	5/23		166330	5/25		261769	10/4		24788	9/30	
2006	407501	6/30		178380	7/22	7/23	266779	10/19		53138	1/1	
2007	452913	6/24		239070	6/19	6/21	282184	10/18		105760	10/15	
2008	432104	7/10		238620	7/4		309897	12/31		134334	1/1	
2009	486843	6/18		238620	6/20	6/22	353694	9/30	12/30	98840	10/16	

Keechelus Reservoir Storage Max, Min, Model vs. Historic 1981-2009										
	Maximum Storage (af)					Minimum Storage (af)				
CAL YR	Model AF	Date range		Historic AF	Date Range	Model AF	Date range		Historic AF	Date Range
1981	142866	5/3		160060	5/4	22168	9/26		34774	10/5
1982	155458	6/25		157795	5/17	45682	1/6		42336	10/15
1983	132551	6/1		157514	6/10 6/11	47636	10/31		64897	1/4
1984	155088	7/5		157617	6/16 6/17	65562	10/9		61150	10/15
1985	143172	6/8		158540	6/7	17494	9/4		10110	10/9 10/10
1986	129964	6/2		131436	4/27	9751	9/22		12010	9/28
1987	130255	5/17		151000	5/15	5012	11/19		8790	10/26 10/30
1988	103994	6/4		126179	5/29	8801	10/12		10310	10/13
1989	130849	5/18		156318	6/27	9429	11/1		10820	10/22 10/25
1990	146336	6/16		159518	6/1	42009	10/2		53995	10/1
1991	157045	6/3		158332	6/20	54718	11/3		37182	11/3
1992	157770	4/21	5/1	135566	4/8	14819	10/16		10590	10/5
1993	105685	5/22		156575	7/5	7350	11/1		7320	10/14
1994	86634	5/29		126915	7/8	10915	10/20		7220	10/13
1995	131504	5/31		145165	5/19	12164	9/29		20560	9/26 9/28
1996	151969	6/8		159648	5/27	56873	9/14		37452	10/15
1997	157770	6/29	7/10	157978	6/25	75311	9/15		69960	8/29
1998	152806	6/8		158130	6/3	44187	11/3		22086	10/12 11/8
1999	157770	6/29	7/10	138980	7/12	94285	1/1		56210	10/6 10/7
2000	157755	6/22		140122	6/15	54304	9/7		24768	9/8
2001	115454	5/28		93000	6/14	12974	10/12		9956	10/9
2002	157563	6/29		139735	6/28	54190	11/11		15661	11/11
2003	139890	6/1		93140	5/5	11221	10/7		9680	10/11
2004	114459	6/3		134073	6/4	11233	8/23		19346	9/2
2005	119979	4/30		116166	4/27	9354	9/28		9580	9/28
2006	113006	6/8		158280	6/12	11218	10/28		17396	10/26
2007	144085	6/6		157620	6/4	27904	10/17		30218	9/29
2008	127260	7/3		158514	6/26	39129	11/2		55330	11/2 11/4
2009	157589	6/17		158055	6/11	46686	9/30	12/31	36622	10/16

Rimrock Reservoir Storage Max, Min, Model vs. Historic 1981-2009											
	Maximum Storage (af)					Minimum Storage (af)				
CAL YR	Model AF	Date range		Historic AF	Date Range	Model AF	Date range		Historic AF	Date Range
1981	198000	5/19	7/5	199518	5/1	51178	10/5		47806	10/5
1982	198000	6/29	7/15	198683	6/18	33011	10/20		94902	1/1
1983	198000	6/28	7/7	198505	6/28	50683	10/19		122960	10/30
1984	198000	6/29	7/17	198961	6/4	54511	10/20		92124	11/1
1985	186335	7/17		198400	7/6	20000	10/15	10/19	84232	2/28
1986	198000	6/16	7/2	198880	6/15	44127	1/1		72282	10/25
1987	194158	7/7		197844	5/15	10000	10/8	10/16	9730	10/15
1988	148325	7/15		198480	6/20	10000	10/7	10/14	22000	10/16
1989	175973	7/21		198425	6/13	34885	10/11		42540	10/16
1990	198000	6/25	7/10	198828	6/20	24364	10/17		38440	10/14
1991	198000	6/24	7/13	198530	7/3	20000	10/13	10/20	28370	10/19
1992	147662	6/29		173556	6/22	6/23	10000	10/1	10/16	19506	10/3
1993	101894	6/28		182328	7/1	7/2	10000	9/29	10/16	10594	10/12
1994	79137	7/9		141706	7/12	7/13	10000	10/15	10/16	10692	10/12
1995	198000	6/27	7/7	198750	6/18		50095	1/1		56444	10/11
1996	198000	6/25	7/7	199135	7/4	7/5	39274	10/17		51819	10/15
1997	198000	6/29	7/23	198700	7/4		75259	1/1		93372	1/1
1998	198000	6/26	7/7	199010	5/25		20000	10/14	10/18	36552	10/14
1999	198000	6/29	8/4	197792	7/21		64406	1/1		61744	10/21
2000	198000	6/26	7/9	198450	5/23		41117	10/18		79520	10/24
2001	76019	7/6		158548	7/2		10000	9/27	10/16	16850	10/17
2002	198000	6/30	7/12	198025	6/29		20000	10/16	10/20	53762	10/18
2003	198000	6/18	7/7	198525	6/18		21214	10/14		42640	10/17
2004	183068	7/21		198480	6/8		44120	10/11		69835	1/1
2005	152720	6/6		198150	5/21		14175	10/16		37340	10/16
2006	198000	6/29	7/9	198700	6/13		20000	10/6	10/19	32120	10/20
2007	198000	6/23	7/7	198225	6/15		20000	10/5	10/18	52696	10/15
2008	198000	6/29	7/17	198199	6/29		50072	10/14		56712	10/29
2009	198000	6/28	7/7	198500	6/27	6/28	57913	9/30	12/31	43079	10/15

Appendix G

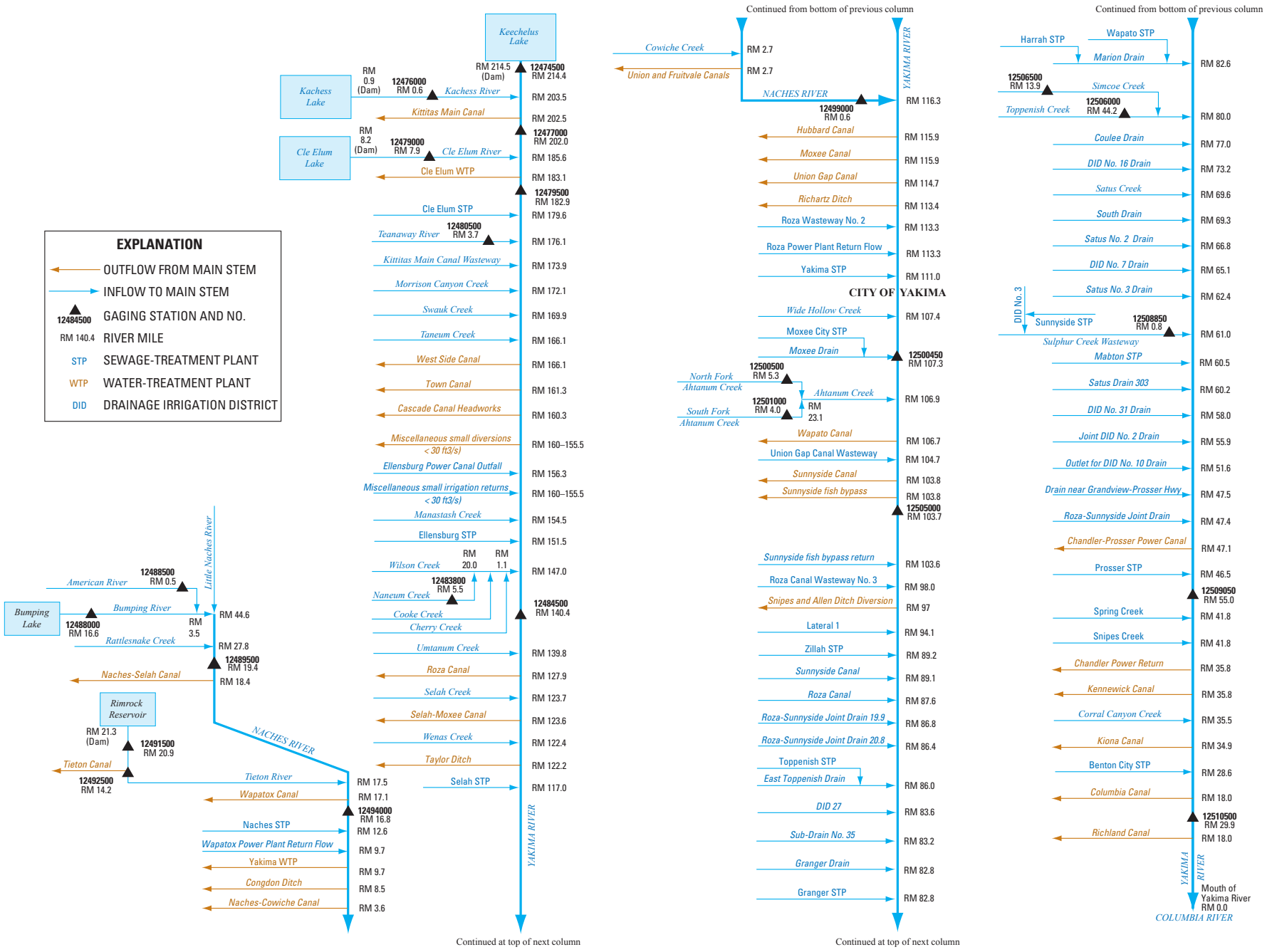


Figure 1. Selected tributaries, diversion canals, return flows, and streamflow-gaging stations, Yakima River basin, Washington.

Appendix H

Appendix H

Geomorphic Analysis for 10 Yakima Basin Gaging Stations

This appendix provides the full results for geomorphic analysis conducted for the Biological Assessment. Please see Section 4.4.1 for a description of analytical method used and discussion of results. The "Historic (to Status Quo)" scenario compares the number of days and magnitude of high flows using the Historic condition as the baseline. "Status Quo (to Proposed Action)" is similar but uses Status Quo as the baseline against which to compare the Proposed Action changes. A comparison between Historic and Proposed Action was not calculated. Percent changes of time and discharge less than 10 percent are considered insignificant to non-existent and are indicated in italics.

Bumping Reservoir

		Average Annual Days of Q >= $Q_{1.5}$ baseline			% Change	
Scenario	**$Q_{1.5}$ (CFS)**	**Historic**	**Status Quo**	**Proposed Action**	**Time**	**$Q_{1.5}$**
Historic (to Status Quo)	1,130	5.6	5.7	--	*1.9%*	*-2.4%*
Status Quo (to Proposed Action)	1,103	--	6.9	6.9	*0.0%*	*0.0%*
Proposed Action	1,103	--	--	--	--	--

CleElum Reservoir

		Average Annual Days of Q >= $Q_{1.5}$ baseline			% Change	
Scenario	**$Q_{1.5}$ (CFS)**	**Historic**	**Status Quo**	**Proposed Action**	**Time**	**$Q_{1.5}$**
Historic (to Status Quo)	3,663	6.2	1.3	--	-79.4%	*-5.6%*
Status Quo (to Proposed Action)	3,459	--	4.9	5.8	19.1%	*0.1%*
Proposed Action	3,463	--	--	--	--	--

Kachess Reservoir

		Average Annual Days of Q >= $Q_{1.5}$ baseline			% Change	
Scenario	**$Q_{1.5}$ (CFS)**	**Historic**	**Status Quo**	**Proposed Action**	**Time**	**$Q_{1.5}$**
Historic (to Status Quo)	1,266	15.0	8.4	--	-43.8%	*7.3%*
Status Quo (to Proposed Action)	1,359	--	2.9	2.8	*-3.5%*	*-2.3%*
Proposed Action	1,327	--	--	--	--	--

Keechelus Reservoir

		Average Annual Days of Q >= $Q_{1.5}$ baseline			% Change	
Scenario	**$Q_{1.5}$ (CFS)**	**Historic**	**Status Quo**	**Proposed Action**	**Time**	**$Q_{1.5}$**
Historic (to Status Quo)	1,186	14.3	4.3	--	-69.9%	*-8.0%*
Status Quo (to Proposed Action)	1,092	--	10.1	9.1	*-9.6%*	*2.1%*
Proposed Action	1,115	--	--	--	--	--

Naches 16_8 at Naches NACW

		Average Annual Days of Q >= $Q_{1.5}$ baseline			% Change	
Scenario	**$Q_{1.5}$ (CFS)**	**Historic**	**Status Quo**	**Proposed Action**	**Time**	**$Q_{1.5}$**
Historic (to Status Quo)	5,584	7.4	6.8	--	*-7.9%*	*-12.4%*
Status Quo (to Proposed Action)	4,893	--	11.0	10.9	*-0.9%*	*1.6%*
Proposed Action	4,970	--	--	--	--	--

Rimrock Reservoir

		Average Annual Days of Q >= $Q_{1.5}$ baseline			% Change	
Scenario	**$Q_{1.5}$ (CFS)**	**Historic**	**Status Quo**	**Proposed Action**	**Time**	**$Q_{1.5}$**
Historic (to Status Quo)	2,061	9.8	11.7	--	19.8%	*5.3%*
Status Quo (to Proposed Action)	2,170	--	8.7	7.3	-16.3%	*-2.9%*
Proposed Action	2,106	--	--	--	--	--

Tieton 14_2 below YTID Diversion Dam

		Average Annual Days of Q >= $Q_{1.5}$ baseline			% Change	
Scenario	**$Q_{1.5}$ (CFS)**	**Historic**	**Status Quo**	**Proposed Action**	**Time**	**$Q_{1.5}$**
Historic (to Status Quo)	1,900	8.2	9.5	--	15.5%	*7.3%*
Status Quo (to Proposed Action)	2,039	--	5.6	4.8	-14.7%	*-9.5%*
Proposed Action	1,845	--	--	--	--	--

Yakima 202_0 at Easton EASW

		Average Annual Days of Q >= $Q_{1.5}$ baseline			% Change	
Scenario	**$Q_{1.5}$ (CFS)**	**Historic**	**Status Quo**	**Proposed Action**	**Time**	**$Q_{1.5}$**
Historic (to Status Quo)	1,787	7.7	4.8	--	-37.8%	-31.9%
Status Quo (to Proposed Action)	1,217	--	13.7	13.2	*-3.5%*	*4.4%*
Proposed Action	1,272	--	--	--	--	--

Yakima River at Parker PARW

		Average Annual Days of Q >= $Q_{1.5}$ baseline			% Change	
Scenario	**$Q_{1.5}$ (CFS)**	**Historic**	**Status Quo**	**Proposed Action**	**Time**	**$Q_{1.5}$**
Historic (to Status Quo)	8,444	13.3	12.0	--	-10.3%	-20.3%
Status Quo (to Proposed Action)	6,734	--	20.4	19.7	*-3.1%*	18.0%
Proposed Action	7,943	--	--	--	--	--

Yakima River from Prosser to Kiona

		Average Annual Days of Q >= $Q_{1.5}$ baseline			% Change	
Scenario	**$Q_{1.5}$ (CFS)**	**Historic**	**Status Quo**	**Proposed Action**	**Time**	**$Q_{1.5}$**
Historic (to Status Quo)	7,030	19.8	19.3	--	*-2.3%*	-10.4%
Status Quo (to Proposed Action)	6,300	--	24.3	24.1	*-0.7%*	13.0%
Proposed Action	7,119	--	--	--	--	--

Appendix I

Appendix I
Steelhead Critical Habitat Reach Delineations

Upper Yakima Subbasin (17030001)

The Upper Yakima River is divided into four stream reaches for the purpose of this analysis: 1) the Keechelus to Easton Reach, from Keechelus Dam to Easton Diversion Dam; 2) the Easton Reach, from Easton Diversion Dam to the confluence of the Cle Elum River; 3) the Cle Elum River, from Cle Elum Dam to the confluence with the Yakima River; and 4) the mainstem Yakima Reach from the confluence of the Cle Elum and Yakima Rivers to the confluence of the Naches River (see Figure AI-1 for designated stream reaches affected by Yakima Project operations in the Upper Yakima River).

The Keechelus to Easton Reach (RM 214.5 to RM 202.5) is approximately 12 miles long. The Yakima River from Easton Diversion Dam to the confluence with the Cle Elum River (RM 202.5 to RM 185.6) is approximately 17 miles long. The Cle Elum reach is approximately 8.2 miles long and begins at Cle Elum Dam and ends at the confluence of the Yakima River at RM 185.6. There is no passage at Cle Elum Dam so steelhead cannot pass upstream beyond this point. The mainstem reach of the Yakima River from the confluence with the Cle Elum River at RM 185.6 to RM 116.3 where the Naches River joins the Yakima River is approximately 69.3 miles long.

Naches Subbasin (17030002)

The Naches River is separated into four stream reaches for the purposes of this analysis: 1) the Bumping River, from the outlet of Bumping Dam to the confluence with the Little Naches River; 2) the Upper Naches, from the Bumping River and Little Naches River confluence to the confluence of the Tieton River; 3) the Tieton River, from Tieton Dam to the confluence of the Naches River; and 4) the Lower Naches, from the confluence of the Tieton River to its confluence with the Yakima River (see Figure AI-2 for designated stream reaches affected by Yakima Project operations in the Naches Subbasin).

The Bumping River reach is 16.6 miles long. The Upper Naches reach is 27.1 miles long. The Tieton River is 21.3 miles long, with the Tieton Diversion Dam at RM 14.2. Similar to the Upper Naches and Bumping River Reaches, all of this reach has been designated as steelhead critical habitat (see reference map for areas designated as critical habitat in the Tieton reach). The Lower Naches reach is 17.5 miles long from the confluence of the Tieton River to its confluence with the Yakima River.

Lower Yakima Subbasin (17030003)

The Lower Yakima Subbasin is separated into three stream reaches for the purposes of this analysis: 1) the Union Gap reach, from the confluence of the Yakima and Naches Rivers to Sunnyside Dam; 2) the Wapato reach, from Sunnyside Dam to Prosser Dam, and; 3) the Lower Yakima reach, from Prosser Dam to the confluence with the Columbia River. This subbasin also contains a few tributary and irrigation drains that are influenced by the operation of the

Yakima Project, including; small portions of the Sulphur Wasteway, Spring/Snipes Creek Wasteways, and Corral Creek (see Figure AI-3 for designated stream reaches affected by Yakima Project operations in the Lower Yakima Subbasin).

The Union Gap Reach is 12.5 miles long. This reach begins at the confluence of the Naches River at RM 116.3 and borders the city of Yakima before flowing through Union Gap into the lower Yakima Valley. The Wapato reach, is 56.7 miles long and located between the Sunnyside Diversion Dam (RM 103.8) and Prosser Dam (RM 47.1). Satus and Toppenish Creeks enter in this reach, along with significant inflow from groundwater and return flow drains such as Sulphur Creek at RM 61.0. The Lower Yakima Reach is 47.1 miles long and includes all mainstem river segments downstream of Prosser Dam to the confluence with the Columbia River

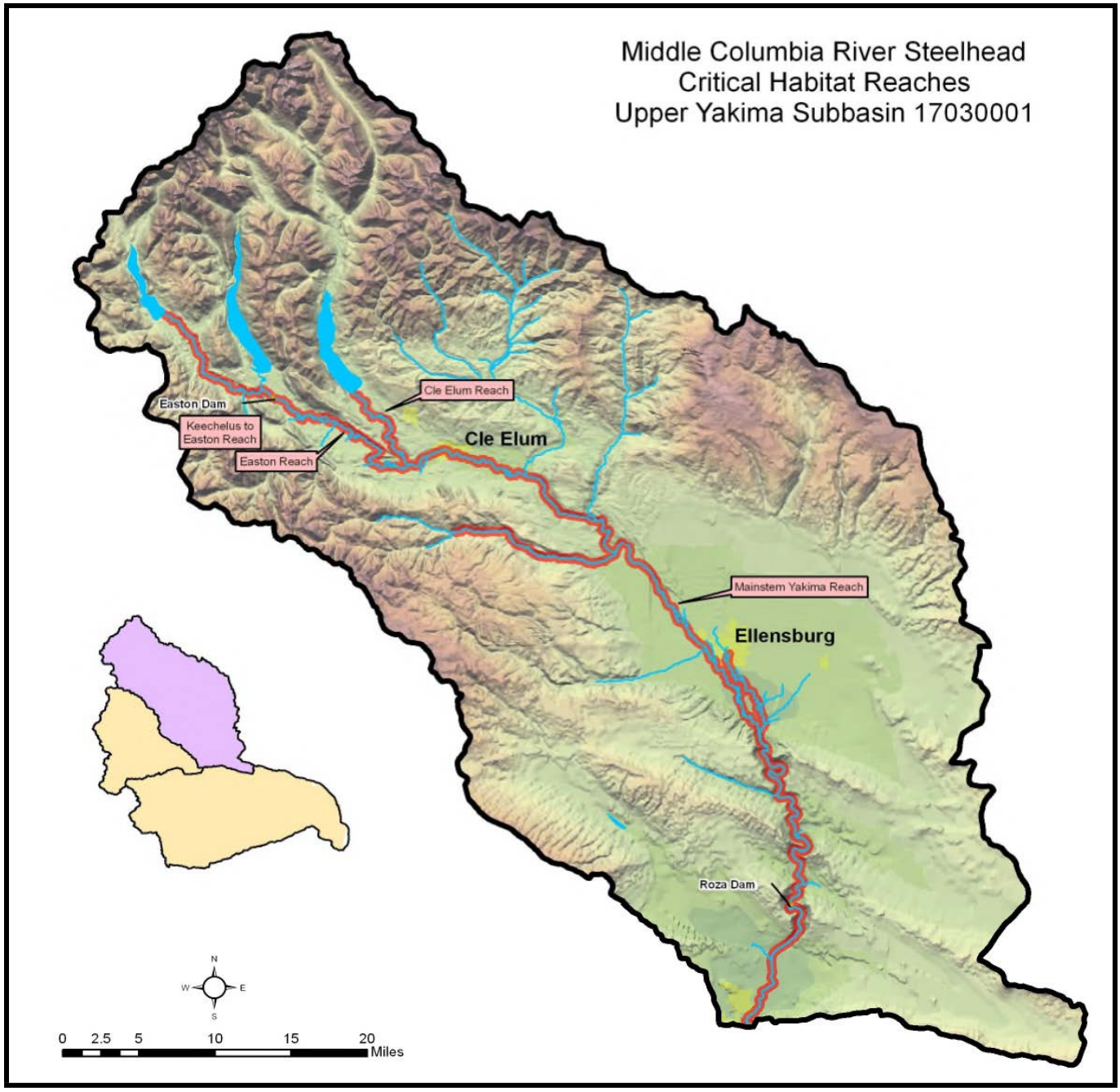


Figure AI-1. Reference map of the Upper Yakima Subbasin (#17030001) of the MCR Steelhead DPS. River reaches highlighted in red are designated critical habitat areas affected by the proposed action.

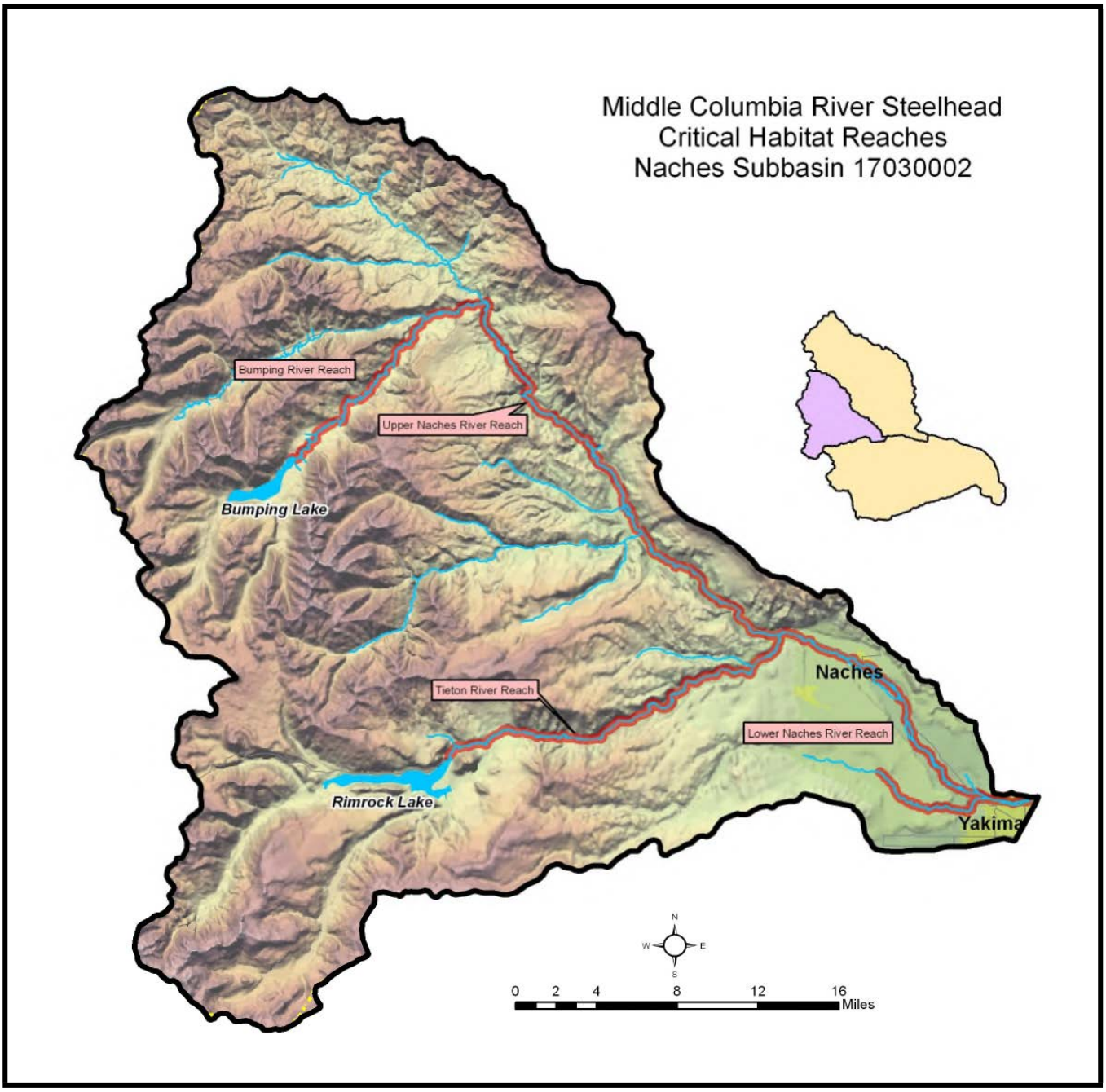


Figure AI-2. Reference map of the Naches Subbasin (#17030002) of the MCR Steelhead DPS. River reaches highlighted in red are designated critical habitat areas affected by the proposed action.

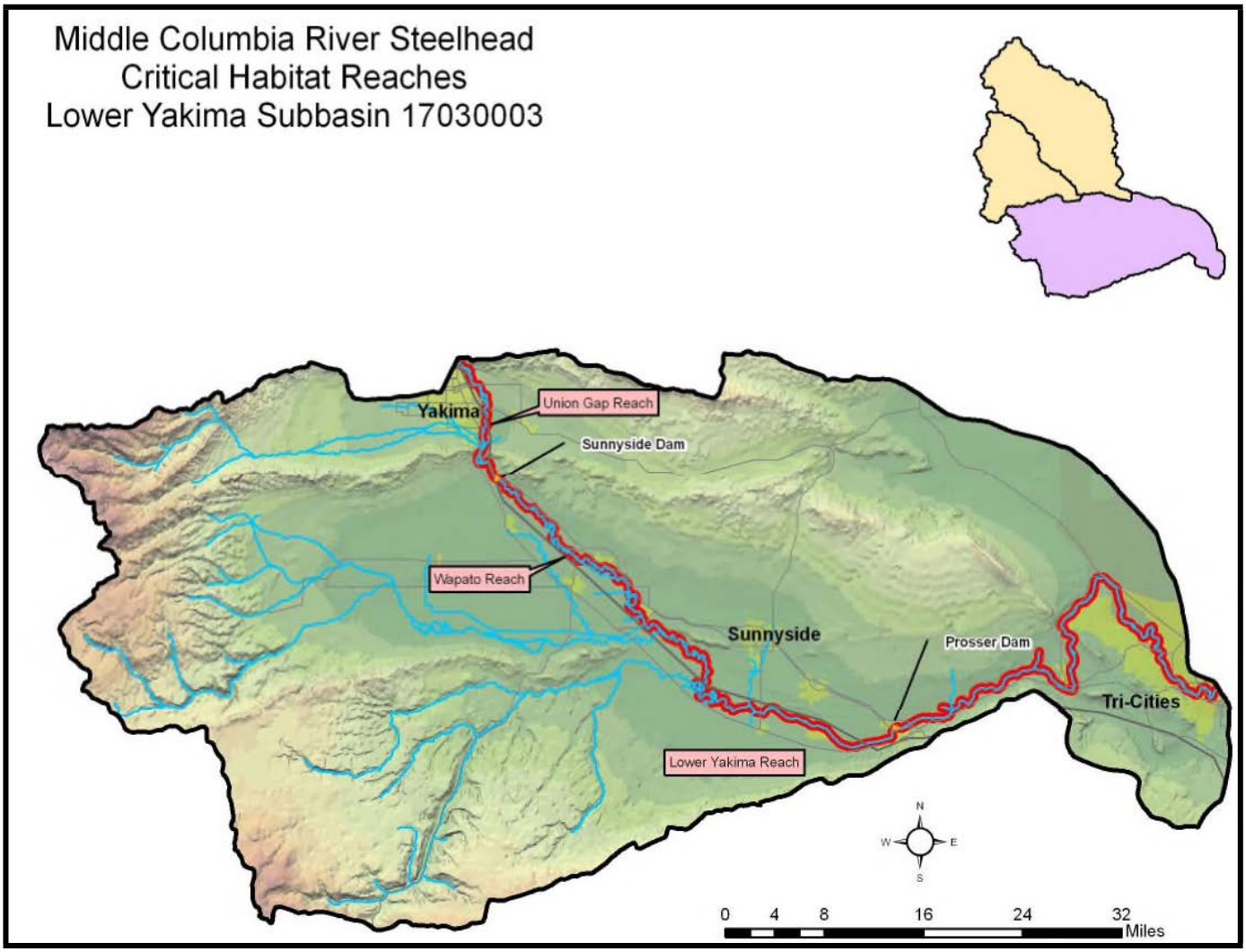


Figure AI-3. Reference map of the Lower Yakima Subbasin (#17030003) of the MCR Steelhead DPS. River reaches highlighted in red are designated critical habitat areas affected by the proposed action.

Appendix J

REACH	METHOD	RECOMMENDED INSTREAM FLOW/ FLOW OBJECTIVES (cfs)											
		Spring				Summer				Winter			
		March	April	May	June	July	August	September	October	November	December	January	February
Keechelus Dam to Lk. Easton	IFTAG Recommended (1984)	125	125	125	100	100	100	125	125	100	100	100	125
	IFTAG Optimal (1984)	150	125	125	75	75	75	125	125	100	100	75	150
	USFWS (1981)(abv. Kachess R.)	175	425	750	640	150	150	170	260	135	125	150	175
	Interim Operating Plan (2002) (Keechelus Outflow to Crystal Springs)							60 - 100 cfs, Sept. 1 - Oct. 20					
	Interim Operating Plan (2002) (Keechelus Outflow to Crystal Springs)	15 - 100							15 - 100 cfs, Oct. 21 - March 31				
	Interim Operating Plan (2002) (Crystal Springs to Lk. Easton)							60 - 100 cfs, Sept. 1 - Oct. 20					
	Interim Operating Plan (2002) (Crystal Springs to Lk. Easton)	30 - 100							30 - 100 cfs, Oct. 21 - March 31				
	U.S. Bureau of Reclamation (2008)	No recommended flows for this reach.											
	Hubble White Paper (2010)	No recommended flows for this reach.											
Kachess River		Not summarized as reach is lesser priority											
Easton Reach	IFTAG Recommended (1984) (Easton Dam to Cle Elum R)	275	275	275	225	225	225	400	400	350	350	275	275
	IFTAG Optimal (1984)	250	250	250	225	225	250	250	400	250	250	250	250
	USFWS (1981)(blw. Easton Dam)	275	845	1465	1215	250	250	220	375	375	375	300	275
	Interim Operating Plan (2002)							150 - 300 cfs, Sept. 10 - Oct. 20					
	Interim Operating Plan (2002)	80 - 300							80 - 300 cfs, Oct. 21 - March 31				
	U.S. Bureau of Reclamation (2008)	722	1166	1400	787	450	375	375	375	425	450	450	450
	Hubble White Paper (2010)	600	970	1165	665	450	375	375	375	425	450	450	450
Cle Elum River	IFTAG Recommended (1984)	250	225	225	150	150	150	250	250	250	250	250	250
	IFTAG Optimal (1984)	250	200	200	150	150	150	150	150	150	150	150	250
	USFWS (1981) (at mouth)	250	1235	2570	2375	150	150	150	250	200	200	200	250
	Interim Operating Plan (2002)							150 - 650 cfs, Sept. 10 - Oct. 20					
	Interim Operating Plan (2002)	60 - 300							60 - 300 cfs, Oct. 21 - March 31				
	U.S. Bureau of Reclamation (2008)	511	954	1500	1301	589	400	400	400	425	425	425	425
	Hubble White Paper (2010)	430	805	1265	1095	495	400	400	400	425	425	425	425
Cle Elum to Teanaway River	IFTAG Recommended (1984)	500	500	500	600	600	600	650	650	600	600	525	525
	IFTAG Optimal (1984)	600	800	800	800	800	800	600	550	800	800	800	600
	USFWS (1981) (abv. Teanaway River)	740	2450	4385	3780	450	470	550	550	600	675	700	700
	Interim Operating Plan (2002)							400 - 800 cfs, Sept. 10 - Oct. 20					
	Interim Operating Plan (2002)	200 - 325							200 - 325 cfs, Oct. 21 - March 31				
	U.S. Bureau of Reclamation (2008)	No recommended flows for this reach.											
	Hubble White Paper (2010)	No recommended flows for this reach.											
Teanaway River	USFWS (1981) (at mouth)	150	785	1,800	485	65	65	30	60	150	150	100	150
Teanaway to Roza Dam	IFTAG Recommended (1984) (Wilson Crk to Roza Dam)	900	750	750	750	750	750	750	1000	1000	750	750	900
	IFTAG Optimal (1984)	900	750	750	750	750	750	750	900	900	750	750	900
	USFWS (1981) (abv. Roza Dam)	1000	4100	7000	5400	1000	900	825	950	950	1000	1000	1000
	Interim Operating Plan (2002)	No recommended flows for this reach.											
	U.S. Bureau of Reclamation (2008) (used Ellensburg Reach recommended flows)	1982	2424	3700	2586	2000	1000	1000	1000	980	1016	1257	1459
	Hubble White Paper (2010) (used Ellensburg Reach recommended flows)	1980	2425	3700	2590	2000	1000	1000	1000	980	1015	1255	1460
Manastash Creek	USFWS (1981) (at mouth)	43	135	240	215	55	25	20	20	25	35	30	35
Roza - Naches	IFTAG Recommended (1984)	900	1000	1000	1300	1300	1300	1000	800	800	1000	1000	900
	IFTAG Optimal (1984)	1100	1200	1200	1300	1300	1300	1200	800	800	1200	1200	800
	USFWS (1981) (abv. Naches)	900	4100	7000	5400	1000	865	785	900	900	1000	1000	900
	Interim Operating Plan (2002)					200 - 300 cfs, July 1 - Oct. 20							
	Interim Operating Plan (2002)	300 - 400							300 - 400 cfs, Oct. 21 - March 31				
	Interim Operating Plan (2002)	300 - 600							300 - 600 cfs, Oct. 21 - March 15				
	U.S. Bureau of Reclamation (2008)	No recommended flows for this reach.											
	Hubble White Paper (2010)	No recommended flows for this reach.											
Wenas Creek	USFWS (1981) (at mouth)	16	50	85	75	20	9	8	7	9	12	11	13
Bumping Dam - Lower Naches	IFTAG Recommended (1984) (Bumping River)	200	200	200	100	100	150	150	150	150	150	150	150
	IFTAG Optimal (1984)	150	100	100	100	100	100	100	100	100	100	100	150
	USFWS (1981) (blw. Bumping Dam)	200	300	730	795	100	90	75	115	195	200	150	200
	Interim Operating Plan (2002) (Dam to American River)	50 - 120							50 - 120 cfs, Oct. 21 - March 31				
	U.S. Bureau of Reclamation (2008)	No recommended flows for this reach.											
	Hubble White Paper (2010)	No recommended flows for this reach.											

REACH	METHOD	RECOMMENDED INSTREAM FLOW/ FLOW OBJECTIVES (cfs)											
		Spring				Summer				Winter			
		March	April	May	June	July	August	September	October	November	December	January	February
Tieton River	IFTAG Recommended (1984) (Lower Tieton River)	125	125	125	200	200	150	150	200	200	200	200	125
	IFTAG Optimal (1984) (Lower Tieton River)	125	125	125	275	275	175	125	275	275	275	275	125
	USFWS (1981) (at mouth)	150	725	1230	1240	200	125	250	250	200	200	200	150
	Interim Operating Plan (2002)	15 - 50							15 - 50 cfs, Oct. 21 - March 31				
	U.S. Bureau of Reclamation (2008)	No recommended flows for this reach.											
	Hubble White Paper (2010)	No recommended flows for this reach.											
Lower Naches River	IFTAG Recommended (1984) IFTAG Optimal (1984)	No recommended flows for this reach.											
	USFWS (1981) (at mouth)	400	2065	3790	3655	400	400	500	500	400	400	400	400
	Interim Operating Plan (2002)	Recommended IOP flows no longer applicable - were for Wapatox Powerplant.											
	U.S. Bureau of Reclamation (2008)	1265	1802	2297	2291	988	550	550	550	500	576	691	720
	Hubble White Paper (2010)	1265	1800	2295	2290	990	550	550	550	500	575	690	720
Yakima River from Naches River to Parker	IFTAG Recommended (1984) IFTAG Optimal (1984)	No recommended flows for this reach.											
	USFWS (1981) (abv. Sunnyside Dam)	820	5900	11150	8510	955	955	965	1455	1420	920	920	820
	Interim Operating Plan (2002)	No recommended flows for this reach.											
	U.S. Bureau of Reclamation (2008)	No recommended flows for this reach.											
	Hubble White Paper (2010)	No recommended flows for this reach.											
Ahtanum Creek	USFWS (1981) (at mouth)	50	215	355	300	20	20	20	20	20	20	20	50
Yakima River from Parker to Toppenish Creek (Wapato Reach)	IFTAG Recommended (1984) (Sunnyside Dam - Marion Drain)	700	800	800	800	800	800	800	700	700	700	700	600
	IFTAG Optimal (1984)	800	800	800	900	900	900	900	800	800	900	900	600
	USFWS (1981) (avb. Toppenish)	820	5900	11150	8510	955	955	965	1455	1429	920	920	820
	Interim Operating Plan (2002)	-	Title XII Legislative Target Flows, varies between 300 and 600 cfs depending on the total water supply available (TWSA), Apr. 1 - Oct. 31.							-	-	-	-
	U.S. Bureau of Reclamation (2008)	3109	2794	3500	2655	1300	1300	1300	1300	1758	1854	2163	2460
	Hubble White Paper (2010)	3110	2795	3500	2655	1300	1300	1300	1300	1760	1855	2165	2460
Yakima River between Toppenish Creek and Prosser Dam	IFTAG Recommended (1984) IFTAG Optimal (1984)	No recommended flows for this reach.											
	USFWS (1981) (abv. Prosser)	1000	5900	11700	8750	1000	1000	1000	1500	1500	1000	1000	1000
	Interim Operating Plan (2002)	–	Title XII Legislative Target Flows, varies between 300 and 600 cfs depending on the total water supply available (TWSA), Apr. 1 - Oct. 31.							–	–	–	–
	U.S. Bureau of Reclamation (2008)(Wapato Reach)	3109	2794	3500	2655	1300	1300	1300	1300	1758	1854	2163	2460
	Hubble White Paper (2010)	No recommended flows for this reach.											
Yakima River - Chandler Reach	IFTAG Recommended (1984) (Prosser Dam - Chandler PH)	800	700	700	800	800	800	800	1000	1000	800	800	800
	IFTAG Optimal (1984)	1400	750	750	750	750	750	750	1000	1000	1400	1400	1400
	USFWS (1981) (abv. Kiona Canal)	1000	5800	9800	7900	1000	1000	1000	1500	1500	1000	1000	1000
	Interim Operating Plan (2002)		1000 cfs, Apr. 1 - June 30			Subordination flows of 450 cfs or Title XII flows, whichever is greater, July 1 - Oct. 31							
	U.S. Bureau of Reclamation (2008)	No recommended flows for this reach.											
	Hubble White Paper (2010)	No recommended flows for this reach.											
Lower Yakima River (Chandler Powerplant to mouth)	IFTAG Recommended (1984) (blw. Horn Rapids Dam)	900	800	800	800	800	800	900	1300	1300	900	900	900
	IFTAG Optimal (1984)	1000	1000	1000	1000	1000	1000	1000	1500	1500	1000	1000	1000
	USFWS (1981) (at mouth)	1000	5800	9800	7900	1000	1000	1000	1400	1400	1000	1000	1000
	Interim Operating Plan (2002)	No recommended flows for this reach.											
	U.S. Bureau of Reclamation (2008)	No recommended flows for this reach.											
	Hubble White Paper (2010)	No recommended flows for this reach.											

Sources: Instream Flow Technical Advisory Group (IFTAG) 1984
U.S. Fish & Wildlife Service (Simmons, 1981)
Interim Comprehensive Operating Plan for the Yakima Project Washington. U.S. Department of Interior, U.S. Bureau of Reclamation, November, 2002
Planning Report/EIS Yakima River Basin Water Storage Feasibility Study Yakima Project Washington, U.S Bureau of Reclamation January 2008
Discussion on Biologically Based Flows For The Determination Of Average Water Year Instream Flow Demand For The Yakima River Basin Study, Hubble, U.S. Bureau of Reclamation, Undated (Received April 2010)

Appendix K

Flip-Flop Technical Memorandum

By Chris Lynch
September 23, 2014

Subject: Question regarding the BA: How will the more gradual Flip-flop ramp down differ from the "normal" ramp down?

The Interim Operating Plan states that the "The flow reduction process starts September 1st and is ramped down over a 10-day period. The flow in the upper Yakima River is reduced by approximately 3,000 cfs, with the majority of the cutback taking place in the Cle Elum River, which is normally reduced to 200 cfs and then reviewed by SOAC for acceptability." The average ramp down rate under this scenario is -280 cfs/day whereas the actual ramp down rate varies from day to day and has often been much larger on a given day. Tables K-1 and K-2 show how the maximum drop in flow has changed through the decades.

	Without drought years (w/o those <80% prorationing)			
Period is Sep 1- 10	**1981-2014**	**1981-1990**	**1991-2000**	**2002-2014**
Average avg-annual ramp rate, cfs	**-163**	**-151**	**-200**	**-151**
Average max-annual ramp rate, cfs	**-477**	**-779**	**-488**	**-244**

Table K-1. Ramp rate analysis, Sep 1-10, without drought years.

	With all years, including drought years.			
Period is Sep 1- 10	**1981-2014**	**1981-1990**	**1991-2000**	**2001-2014**
Average avg-annual ramp rate, cfs	**-149**	**-143**	**-160**	**-145**
Average max-annual ramp rate, cfs	**-423**	**-715**	**-396**	**-233**

Table K-2. Ramp rate analysis, Sep 1-10, with all years including drought years.

Note that the ramping rate has generally declined through the decades and that the lowest overall average and lowest average for the Maximum annual ramp rate occurred in the most recent era.

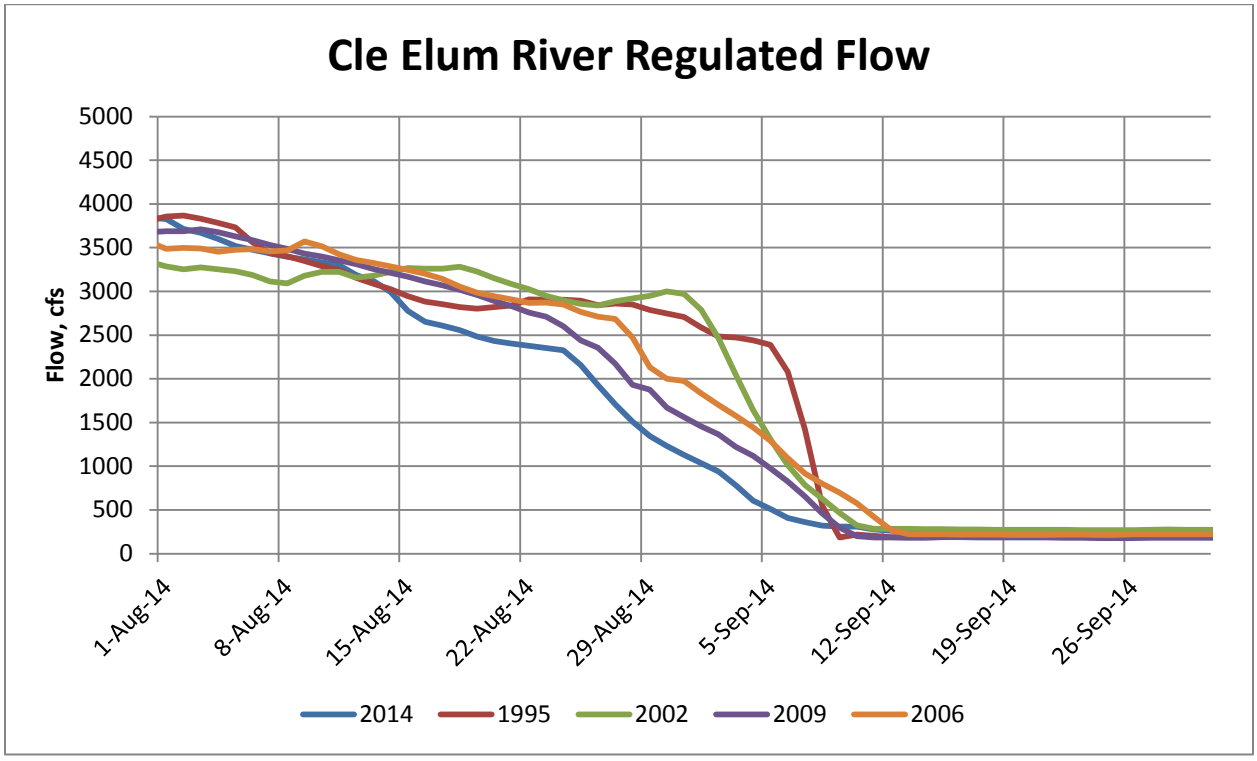
	Without drought years (w/o those <80% prorationing)			
Period	**1981-2014**	**1981-1990**	**1991-2000**	**2002-2014**
Aug 15-20 average Max-annual ramp rate, cfs	**-86**	**-103**	**-47**	**-95**
Aug 21-26 average Max-annual ramp rate, cfs	**-148**	**-161**	**-156**	**-134**
Aug 27-Sep 2 average Max-annual ramp rate, cfs	**-271**	**-212**	**-378**	**-252**
Sep 3-Sep 12 average Max-annual ramp rate, cfs	**-494**	**-855**	**-488**	**-228**

Table K-3. Ramping rate analysis, Maximum annual ramping rate for different periods of record.

Note in Table K-3 that the maximum annual ramping rate is the smallest in the 2001-2014 era for all periods listed except for Aug 15-20. It appears upon examination of the hydrographs that it is primarily due to the hydrology (precipitation, available flows and demands) of the sample years but it would be necessary to have higher ramping rates during this period in order to have lower ramping rates throughout the whole period (see 2014 in the graph below).

Diversion entitlements, and consequently actual diversions, have a significant drop between August and September which leads to the biggest reductions in flow from Cle Elum happening around the 1st of September or closely thereafter, i.e. after the Labor Day weekend. This accounts for the largest ramping rate values being observed in the Aug 27 – Sept 2 and Sep 3- Sep 12 periods. To keep Cle Elum's ramping rate to no greater than a 250 cfs drop the YFO must leave extra water in the river at Parker or manipulate the outflow from other reservoirs, namely Rimrock.

The ramping rates can also be kept smaller by extending the total time taken to ramp Cle Elum flows, i.e. weeks instead of days. The YFO has been trying to implement this more gradual ramping rate in the recent era in response to the request from SOAC and NMFS. Cle Elum flows have been ramped down earlier in August when possible. Generally the earlier the date of storage control the longer the period in which Cle Elum water can be used to meet demands and therefore the more gradual the ramping rate can be. In years with a late storage control date the reservoir has less time to use up its share of the storage and it also has greater hydraulic capacity later into August so that it is possible to release higher flows.



The graph shows five different years, each with a different ramp down pattern. The gradual ramp down that the YFO would target in the future would look much like that shown in 2006, 2009 or 2014. The YFO would try to avoid ramp downs like 1995 but may, on occasion, particularly in wet years with a late storage control date need to ramp down as in 2002. The YFO would try to keep the daily rate equal to or less than a drop of 250 to 300 cfs per day, particularly later in the transition period, after September 1. The ramping rate on any given day can be influenced by weather and/or demands. Trying to keep the ramping rate at or below 250 cfs per day may leave excess flow in the river below the Parker control point unless flows are reduced from another System reservoir like Rimrock. In years like 2002 the ramping rate may need to go as high as 400 cfs per day at times. In drought years the ramping rate usually does not go much above 200 cfs per day and incidentally begins earlier in August.

Appendix L

Kachess and Keechelus Entrainment Study Technical Memorandum

Study Goals

The Bureau of Reclamation (Reclamation) conducted a fish entrainment investigation with the aims of quantifying entrainment rate, timing, and species composition at Keechulus and Kachess Dams. A screw trap was used to sampling downstream of the outlet works at both of these dams. Supplemental hydroacoustics and fyke-net monitoring was conducted downstream of Keechelus and Kachess reservoirs, respectively. This memo documents methods and results from two seasons of investigation at Keechulus Dam (2010) and Kachess Dam (2011). A full report is also available for the 2010 entrainment monitoring at Keechelus Dam) (Reclamation, 2011).

Background

In the Yakima River Basin, Reclamation operates a dam and reservoir system to meet irrigation, hydropower, flood control, fish and wildlife management, industrial water supply, and recreation goals. Original project authorization in 1905 approved irrigation development and the investigation of storage sites. Five Yakima Project storage reservoirs were later constructed between 1909 and 1935: Bumping, Cle Elum, Kachess, Keechulus, and Rimrock. With the exception of Rimrock Reservoir on the Tieton River, these storage reservoirs were historically natural lakes. While Clear Lake is a reservoir in the Yakima Project, it is normally managed at full pool year round and not considered a storage reservoir for water supply. These impoundments provide water supply to help meet irrigation entitlements by storing and regulating a portion of the flow of the Yakima River and its tributaries.

Within the Yakima Project, none of the five storage dams' outlet structures are screened to prevent fish entrainment from water releases, nor were fish passage facilities constructed for migratory fish. Previous investigations of Tieton Dam at Rimrock Reservoir have shown that the number of fish entrained can be substantial during periods of high release flows (Hiebert at al. 2003, Hiebert at al. 2004, James 2002). Furthermore, these studies have shown that a variety of highly valued species are being entrained, including bull trout (*Salvelinus confluentus*), which was listed as threatened under the Endangered Species Act in 1998 (FR 63 31647). Although fish entrainment is likely occurring at other Yakima Project storage dams, the extent or magnitude of fish entrainment is not known. Applying entrainment rates observed at Tieton Dam at other storage reservoirs would be inappropriate, as outlet work configuration and water release patterns are significantly different. An important consideration for the outlet work configuration is that Rimrock Reservoir is not constructed over a natural lake, in contrast to the four other storage reservoirs in the basin.

In the upper Yakima Basin, Keechulus and Kachess Reservoirs support bull trout populations, but the amount of bull trout entrainment at these dams is unknown. Monitoring over 2 irrigation seasons in 2010 (Keechelus) and 2011 (Kachess) was conducted to provide dam-specific entrainment information.

Keechulus and Kachess Dam Operations

Keechulus and Kachess dams are both earthfill structures constructed on natural lakes in the Upper Yakima arm of the Yakima Basin. In the early 1900s, settlers erected timber crib dams at these sites. As part of the Federal Yakima Irrigation Project, Reclamation constructed dams at Kachess in 1912 and at Keechulus in 1917. These facilities are operated to meet irrigation demands, flood control, and instream flows for fish.

The Keechelus Dam outlet works emerge from a gated penstock. Water released from the dam flows through a single 8.5-foot-square hydraulically operated slide gate and through a concrete chute and stilling basin (165 feet long by 18 feet wide by up to 28 feet deep). The outlet channel then transitions to rip-rap bank armoring and then into a more natural stream channel with riparian vegetation. A 22-inch-diameter pipe in the outlet conduit bypasses minimum flows to benefit fish and other aquatic organisms when the outlet gates are closed.

Kachess Dam is equipped with a gated spillway consisting of 1 radial gate (50' x 8') with an 8.0 foot maximum gate opening capable of releasing 3,690 cfs at full lake elevation. These gates have a minimum gate opening of 0.17 foot and are the main release points when spawning and incubation flows are released in the Yakima River. Located in the same outlet works is an 18-inch butterfly valve at invert elevation of 2195.92 feet, which at 25 foot of head and 100 percent gate opening, bypasses approximately 35 cfs into the outlet conduit, through the valve installed in the outlet works downstream of the main gates. When the main outlet gate is closed, and the auxiliary low flow bypass valve is being used, it is only capable of providing minimum flows for fishery and stream enhancement in the Kachess River. The Kachess outlet works has poor hydraulic capacity resulting large volume of storage relative to the low head outlet works.

Kachess and Keechelus Reservoir storage is primarily used to meet upper Yakima Basin irrigation demands and provides carryover storage in normal water years (Reclamation 2002). The prime flood control season extends from mid-November through mid-June. Irrigation demands are met by releases from Keechelus dam either through bypassed reservoir inflows beginning in mid-March or stored water releases that typically start in mid-April to mid-June, depending on the water year. In addition to irrigation demands and flood storage needs, Keechulus operations are shaped by spring Chinook spawning requirements in the Upper Yakima River. Instead of balanced water releases from the five storage reservoirs throughout the summer, water supply "flip-flops" between reservoirs in the Yakima and Naches arms of the basin. Releases from the Yakima arm predominate in the late spring and summer, and then flips so that releases are primarily from the Naches arm when spring Chinook spawning commences in September in the upper Yakima River. This managed hydrologic regime encourages spring Chinook to spawn in areas of the stream channel that will remain wetted throughout the incubation period (February – March) when reservoir releases are minimized so that the reservoirs can refill. In addition to the large scale basin-wide "flip-flop", a smaller scale "mini flip-flop" occurs in most years between Keechelus and Kachess Reservoirs. Under this scheme, operations are geared towards maintaining appropriate spring Chinook spawning flows in the Yakima River beneath Keechelus dam by making heavier releases from Keechelus during June, July, and August and delaying releases from Kachess until September and October so that releases can then be cut at Keechelus to suitable spawning flows (Figure L-1).

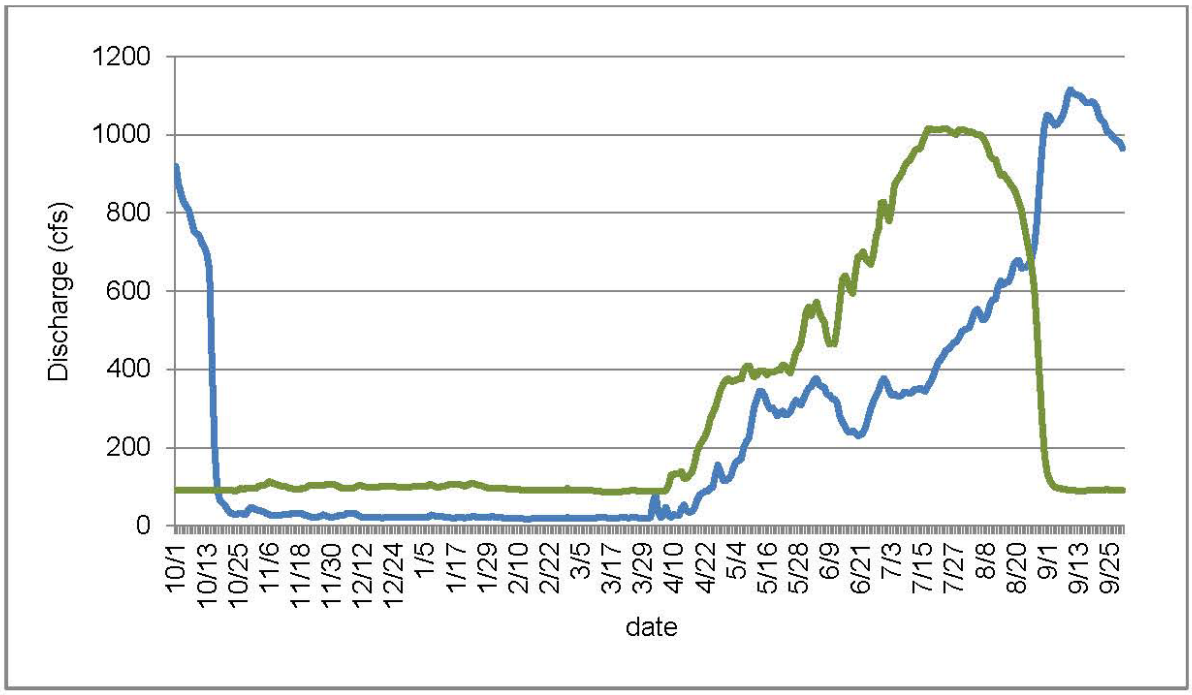


Figure L-1. Average daily releases out of Kachess (blue line) and Keechelus (green line) Reservoirs during the 2001 – 2010 water years.

Methods

Screw Trap

A rotary screw trap was operated at downstream of the Keechelus Outlet works in 2010 and the Kachess outlet works in 2011. The 8-foot diameter rotary drum screw trap was operated from May 14, 2010 to September 1, 2010 at Keechelus and from June 20, 2011 to October 11, 2011 at Kachess. The sampling time period encompassed the main rising limb period, peak flow, and rescinding limb of the hydrograph as well as the period with the highest and lowest annual water surface elevations at each reservoir. The screw trap was not operational for brief periods in May and July at Keechelus (approximately 16.5 hours total) and September at Kachess (approximately 12 hours total). Additionally, from September 8th to 16th, a strong back-eddy prevented the screw trap from spinning continuously at Kachess. The screw trap is estimated to have been operated for approximately 2,622 hours at Keechelus in 2010 and 2,698 hours at Kachess in 2011, though this estimate does not take into account the time period when the trap cone was not continuously spinning at Kachess.

The screw trap was checked at least every Monday, Wednesday, and Friday during the period it was operated. During each trap check, biologist first visually scanned the trap live box for bull trout, dip-netted all captured fish out of the trap box and placed them in an aerated 5-gallon bucket. Had bull trout been observed, they would have been placed in a separate, covered, aerated 5-gallon bucket. Captured fish were anesthetized using 50 to 100 mg/l buffered MS-222

that was administered based on fish responsiveness. Each fish was identified to species, fork length was measured to the nearest mm, and condition was noted as live, injured, or dead. All fish data was recorded on field data sheets. All fish captured of appropriate size were marked using either fin clips or pigment dyes. Fish were also checked for marks indicating that the fish had been previously captured.

Recaptured and unmarked fish were placed downstream of the screw trap after processing, and fish that were marked for recapture efficiency tests were placed upstream.

Each time the screw was sampled, cone revolutions-per-minute and any irregularities in screw trap operations were recorded. Immediately after collecting all fish from the trap box, debris was cleaned from the cone and trap box.

Fyke Net

In the second season of the study at Kachess Reservoir, hydroacoustic investigation (see Reclamation 2010 for additional details) was not conducted, and a modified fyke net was deployed in order to fish an area lower in the water column. The funnel-shaped fyke was made of heavy duty 1/8 inch woven mesh fabric, had an upstream trap opening measuring 5 feet wide by 6 feet deep. The fyke net was 12 feet long and tapered to a narrow horizontally-oriented slot measuring 2 inches high by 22 inches wide at the live box. Heavy duty PVC fabric sewn to the tapered end of the fyke net was attached to an aluminum trap box with an aluminum flange at the terminus of the net. The PVC fabric extended approximately 6 inches into the trap box, creating a "minnow trap" style capture fyke. The fyke net and live box were mounted on a 14 foot long by 8 foot wide aluminum frame which was floated by 16 foot long inflatable cataraft pontoons. A rigging system was mounted to the deck of the floating trap barge to raise and lower the fyke net with a system of cables and hand crank winch. Downrigger balls and a bridle system connected to the anchor cable kept the bottom of the fyke net entrance submerged to design depth. The fyke net opening fished from the surface to a depth of about 6 feet during the trapping period (about 2 feet deeper than the screw trap sampling zone). The fyke net was operated immediately adjacent to the screw trap throughout the majority of the sampling period. After the screw trap was moved to the downstream end of the outlet pool, the fyke net was moved to the north bank of the outlet pool to collect fish caught in the strong back-eddy. The fyke net was operated for approximately 12 weeks, from July 13, 2011 to October 11, 2011.

Results

More fish were detected by screw trap monitoring conducted downstream of Kachess Dam than Keechelus Dam (Table L-1). At both locations, spring Chinook juveniles were detected, indicating that a portion of the fish detected were of downstream origin. At Keechelus, kokanee dominated the sample, while at Kachess whitefish were most commonly observed, followed closely by red-sided shiner and sculpin. At both reservoirs, the proportion of live and dead fish varied by species. The size of detected fish followed a normal distribution at Keechelus reservoir, with the majority of detected fish ranging from 40-59 mm fork length (Figure L-2). At Kachess, the catch was dominated by relatively small fish in the 20-39 mm fork length category. The second most abundant size category was 60-79 mm.

At Kachess Reservoir, a higher proportion of the fish detected were sampled by the screw trap than the fyke net (Table L-2). A number of species were detected solely by screw-trap operations. Burbot, however, were detected in nearly equal numbers through fyke-net and screw trap sampling.

Entrainment patterns were related to dam operations by characterizing dam discharge and reservoir elevation during the sampling period as: a) low discharge at the onset of the monitoring period when the reservoir was still filling and irrigation demands were low, b) a ramp up period when discharge increased rapidly to meet irrigation demands, c) sustained peak discharge to meet irrigation demands, and d) the ramp down (Figures L-3 through L-6). Fish were captured throughout the entire sampling period at both reservoirs, but patterns across the sampling period varied between reservoirs (Figures L-4 and L-6). At Keechelus Reservoir, entrainment rates peaked in July, at the end of the ramp up period (b) and the beginning of the sustained discharge period (c) (Figure L-4). In contrast, there was not a single peak in the number of fish detected downstream of Kachess Dam. Relatively high numbers of fish were periodically detected in the low discharge period (a), while discharge ramped up (period b), and at the beginning of the sustained high discharge period (c), when forebay elevation was still relatively high (Figure L-6).

Table L-1. Screw trap fish capture summary for the 2010 and 2011 monitoring season. Fish are listed in descending order of percent total catch. Recaptures are not included in counts.

	Keechelus (2010)				Kachess (2011)			
Species	**Count**	**Catch/Hr**	**Live (%)**	**Dead (%)**	**Count**	**Catch/Hr**	**Live (%)**	**Dead (%)**
Whitefish < 50 mm[1]	30 (28/2)	0.011	20	80	615 (36/0)	0.228	6	94
Whitefish, pygmy ≥ 50 mm	98	0.037	7	93	137	0.051	31	69
Whitefish, mountain ≥ 50 mm	3	0.001	100	0	7	0.003	29	71
Sculpin	7	0.003	71	29	572	0.212	81	19
Red sided shiner[2]	2	0.001	100	0	574	0.213	97	3
Chinook[3]	48	0.018	100	0	243	0.090	97	3
Mountain sucker	---		---	---	70	0.026	94	6
Burbot	5	0.002	60	40	19	0.007	84	16
Northern pikeminnow	3	0.001	100	0	14	0.005	100	0
Unknown non-salmonid	6	0.002	83	17	10	0.004	80	20
Kokanee	318	0.121	71	29	6	0.002	33	67
Brook Trout	---		---	---	2	0.001	100	0
Cutthroat	---		---	---	1	0.000	100	0
Longnose dace	1	0.000	100	0	1	0.000	100	0
Oncorhynchus spp.	3	0.001	67	33	1	0.000	0	100
Total	**526**	**0.201**			**2272**	**0.842**		

[1] parentheses show field identified species (pygmy whitefish / mountain whitefish)

[2]Included small minnows presumed to be red sided shiners in Kachess sample

[3] Known to be of downstream origin

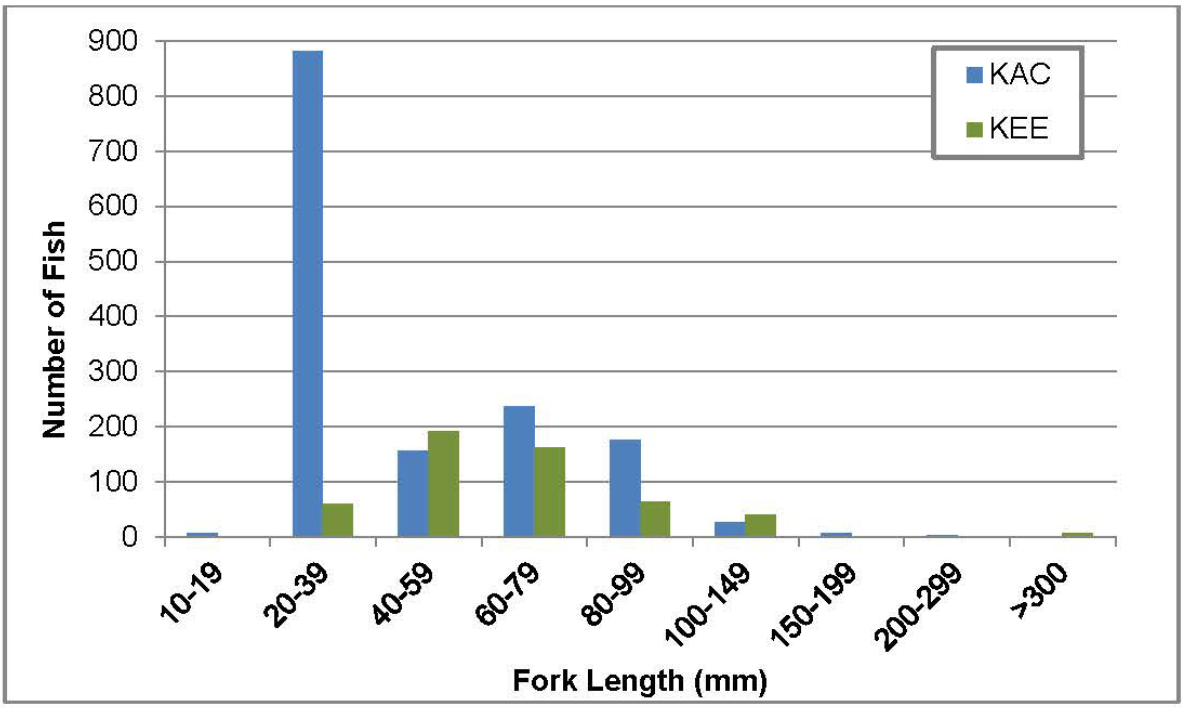


Figure L-2. Size (fork length) distribution by fish species at each reservoir using the rotary screw trap.

Table L-2. Comparison of species caught using the 2 methods (screw trap and fyke net) utilized in 2011 at Kachess. Fish are listed in descending order based on percentage caught by fyke net. Recaptures are not included in counts.

Species	Count	% Fyke net	% Screw trap
Burbot	40	53	48
Unidentified whitefish	932	36	64
Kokanee	7	14	86
Unidentified non-salmonid	11	9	91
Sculpin	623	8	92
Pygmy whitefish	165	5	95
Red-sided shiner	66	2	98
Chinook	245	1	99
Unidentified minnow	510	0	100
Mountain sucker	70	0	100
Northern pikeminnow	14	0	100
Mountain whitefish	7	0	100
Brook Trout	2	0	100
Cutthroat trout	1	0	100
Longnose dace	1	0	100
Unidentified salmonid	1	0	100
Grand Total	**2695**	**24**	**76**

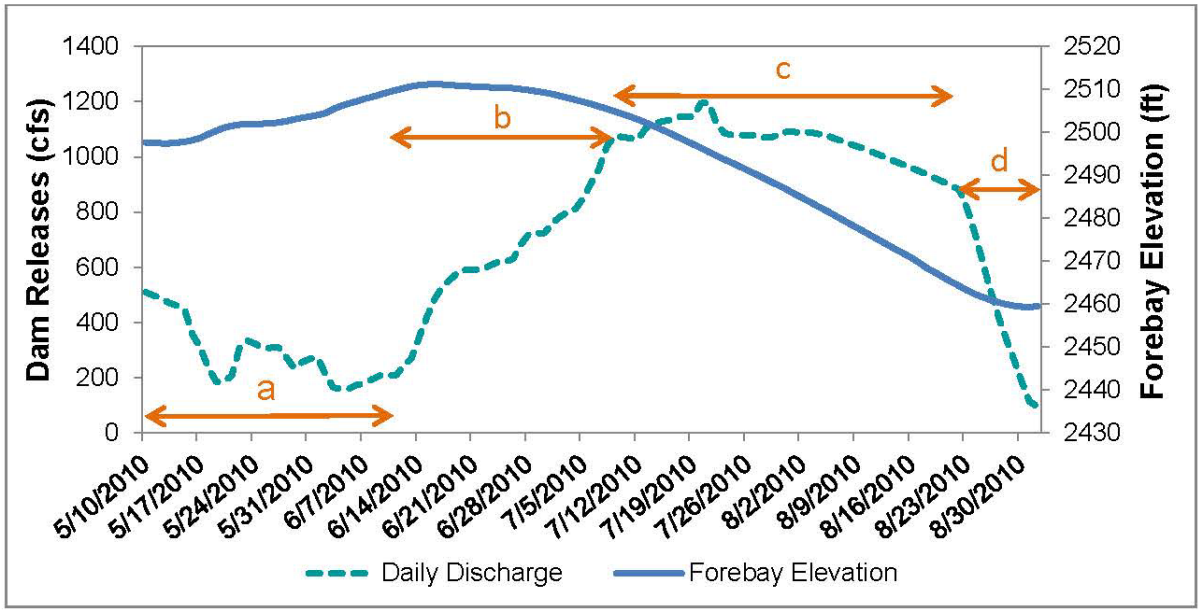


Figure L-3. Daily Keechelus discharge and forebay elevations during the monitoring period, with 4 distinct operational periods identified: a) low discharge, b) discharge ramp-up, c) sustained peak discharge, and d) discharge ramp-down.

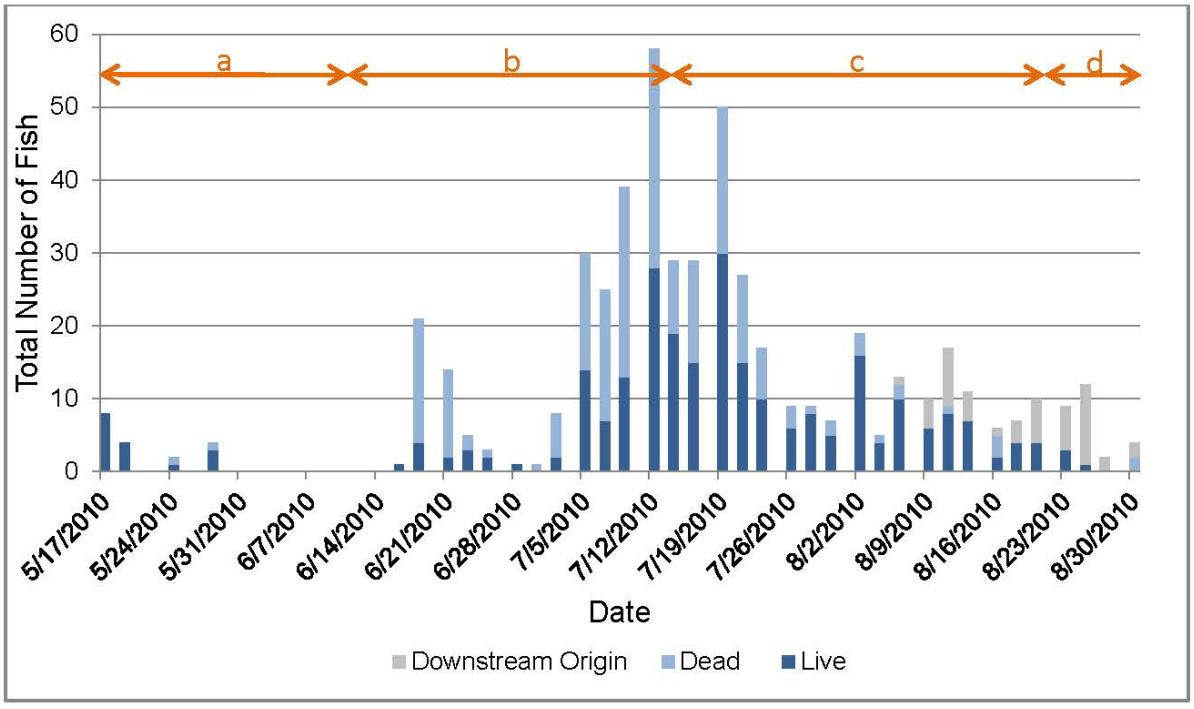


Figure L-4. Number of fish captured per screw trap check over the course of the monitoring period at Keechelus Reservoir, with 4 distinct operational periods identified above. Downstream-origin fish are Chinook salmon, which are not present in the reservoir.

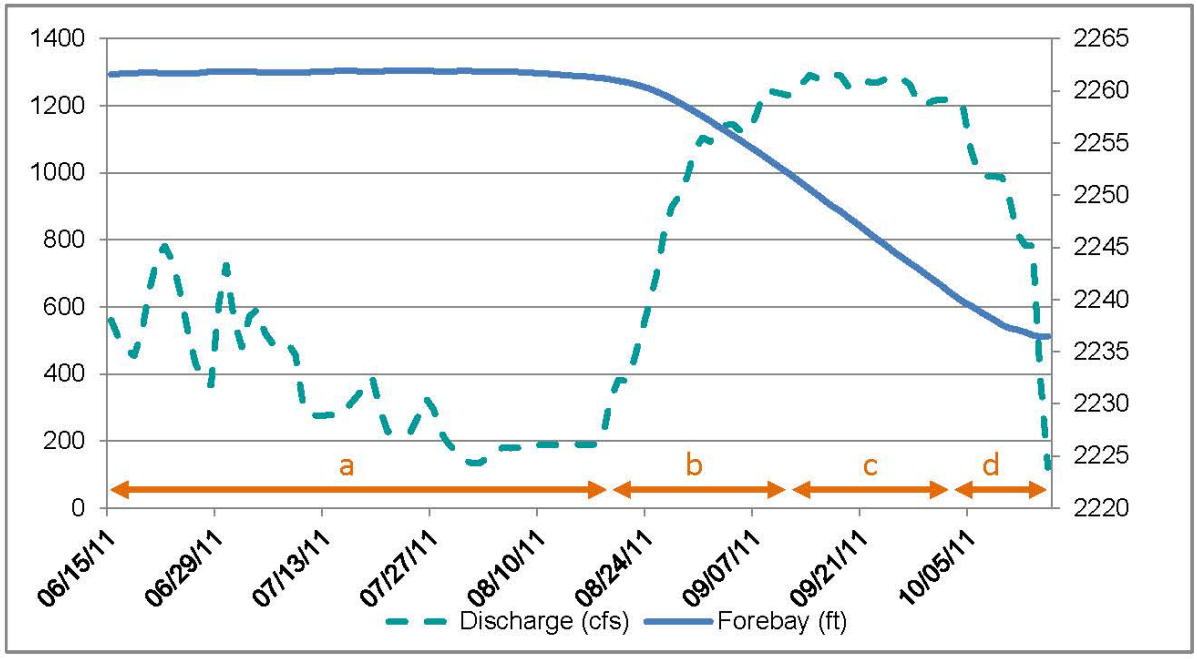


Figure L-5. Daily Kachess discharge and forebay elevations during the monitoring period, with 4 distinct operational periods identified: a) low discharge, b) discharge ramp-up, c) sustained peak discharge, and d) discharge ramp-down.

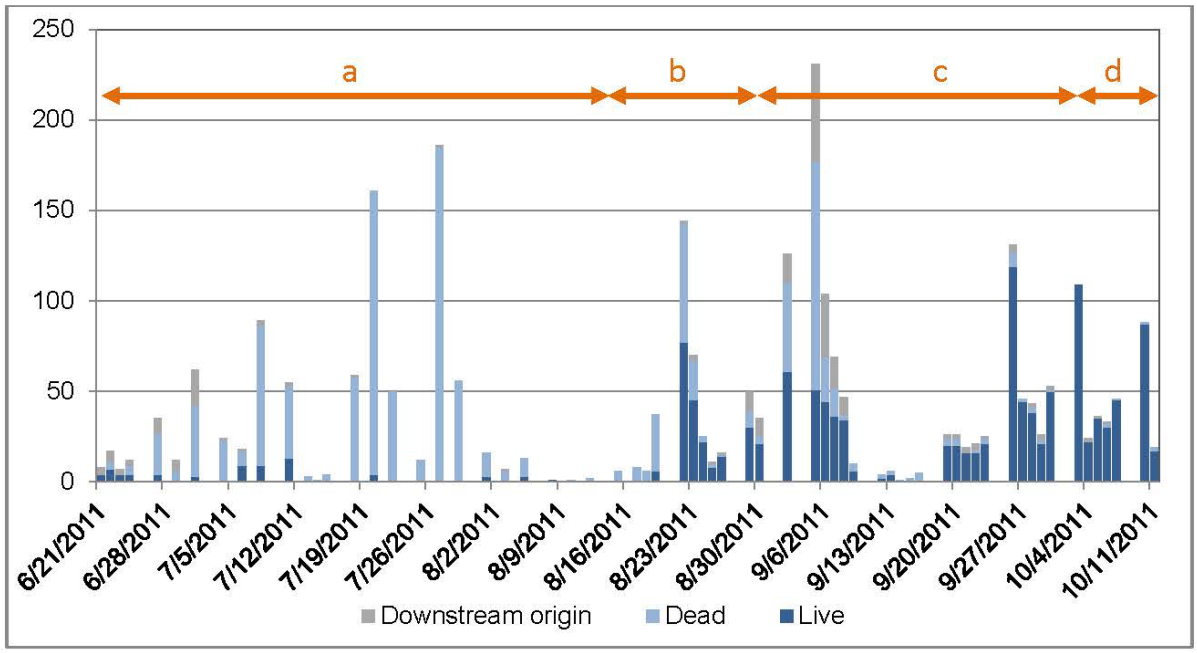


Figure L-6. Number of fish captured per screw trap check over the course of the monitoring period at Kachess Reservoir, with 4 distinct operational periods identified: a) low discharge, b) discharge ramp-up, c) sustained peak discharge, and d) discharge ramp-down. Downstream-origin fish are Chinook salmon, which are not present in the reservoir.

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