Leavenworth National Fish Hatchery Surface Water Intake Fish Screens and Fish Passage Project Environmental Impact Statement

Biological Assessment

US Department of the Interior
Bureau of Reclamation
Columbia-Pacific Northwest Regional Office
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Mission Statements

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Acronyms and Abbreviations

Acronym	Full Phrase
BA	biological assessment
BMP	best management practice
Boulder Field Project	Icicle Creek Boulder Field Fish Passage Project
ºC	degrees Celsius
CFR	Code of Federal Regulations
cfs	cubic feet per second
CHU	critical habitat unit
CHSU	critical habitat subunit
CIPP	cure-in-place pipe
COIC	Cascade Orchards Irrigation Company
CUA	contractor use area
dBA	A-weighted decibel
Ecology	Washington Department of Ecology
EIS	environmental impact statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973
ºF	degrees Fahrenheit
	foraging, migrating, and overwintering
FPRP	ESA Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Washington State Fish Passage and Habitat Enhancement Restoration Programmatic
IO&MA	intake operations and maintenance area
IPID	Icicle and Peshastin Irrigation District
LNFH, Hatchery	Leavenworth National Fish Hatchery
Mid-C RU	Mid-Columbia recovery unit
MPI	USFWS Matrix of Pathways and Indicators
NMFS	National Marine Fisheries Service
NPDES	National Pollution Discharge Elimination System
NTU	nephelometric turbidity unit
O&M	operations and maintenance
OHWM	ordinary high water mark
PCE	primary constituent element
pH	potential of hydrogen
PISMA	pipeline intake and sediment management area

Reclamation	Bureau of Reclamation
RM	river mile
SR	spawning and rearing
SWISP	Surface Water Intake Fish Screens and Fish Passage
TMDL	total maximum daily load
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife

Chapter 1. Introduction

1.1 Purpose and Background

The purpose of this biological assessment (BA) is to determine the effects of the Leavenworth National Fish Hatchery (hereafter, LNFH or Hatchery) Surface Water Intake Fish Screens and Fish Passage (SWISP) Project (the Proposed Action) on species that are federally protected under the Endangered Species Act of 1973 (ESA), as amended. The BA is intended to fulfill Section 7(c) of the ESA and is intended to ensure the Proposed Action would not likely jeopardize the continued existence of federally listed species, nor result in the destruction or adverse modification of designated critical habitat, as defined in the Endangered Species Consultation Handbook (USFWS and NMFS 1998).

The Bureau of Reclamation (Reclamation) is proposing to rehabilitate, replace, and modernize the LNFH surface water intake and delivery system on Icicle Creek near Leavenworth, Washington. This would be done by constructing new headworks[1] and a creek-width roughened channel, and replacing and lining the surface water conveyance pipeline to the LNFH. Additional details and a description of the Proposed Action can be found in **Chapter 3**, Proposed Action.

The LNFH was designed and constructed in the late 1930s as mitigation for the construction and operation of Grand Coulee Dam. The Hatchery, which is owned and operated by the US Fish and Wildlife Service (USFWS) and funded by Reclamation and Bonneville Power Administration, raises and releases 1.2 million Spring Chinook Salmon (*Oncorhynchus tshawytscha*) smolts annually into Icicle Creek. The LNFH's primary point of diversion and water delivery system on Icicle Creek is nearly 80 years old and is reaching or exceeding its operational life. Further, at this time the intake facility does not comply with current National Marine Fisheries Service[2] (NMFS) criteria for anadromous salmonids (NMFS 2011), and it can result in entrainment of ESA-listed fish. The NMFS biological opinion for LNFH operations (NMFS 2017a; consultation WCR-2017-7345) requires the LNFH to have a surface water intake and delivery system that complies with NMFS current screening and fish passage criteria for anadromous fish passage facilities in place and operating by May 2023.[3]

In 2008, the NMFS and USFWS prepared the *Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Washington State Fish Passage and Habitat Enhancement Restoration Programmatic* (FPRP; NMFS and USFWS 2008). The FPRP provided ESA coverage by both the NMFS and USFWS for the US Army Corps of Engineers (USACE) nationwide permit program for such projects, which would include the Proposed Action. This combined agency programmatic biological opinion expired on December

[1] Headworks means any dam, weir, barrage, or reservoir and all works appurtenant thereto, used for or in connection with the storage, control, conveyance, or distribution of water. For the SWISP Project, the headworks includes the combined intake structure elements.
[2] This agency is also known as National Oceanic and Atmospheric Administration Fisheries
[3] The NMFS biological opinion for consultation WCR-2017-7345 contains a detailed consultation history up to the issuance of that biological opinion.

31, 2013. The USACE and NMFS reinitiated consultation, and the NMFS has issued subsequent biological opinions for the nationwide permit program. However, the USACE has been operating under consultation extensions from the USFWS, with the most recent extension expiring December 31, 2020. The USACE has reinitiated consultation with the USFWS; however, a biological opinion covering the nationwide permit program has not been completed. Therefore, to comply with ESA Section 7(a)(2) and 50 Code of Federal Regulations (CFR) 402, Reclamation has prepared a BA to determine the potential impacts of the Proposed Action on the threatened bull trout (*Salvelinus confluentus*) and its designated critical habitat, and the endangered gray wolf (*Canis lupus*).

1.2 Project Area

The Project Area is on and near the LNFH, near the City of Leavenworth in Chelan County, Washington. The Project Area includes the LNFH's surface water intake and primary point of diversion on Icicle Creek, and the conveyance pipeline to the Hatchery. The surface water intake is on USFWS property, while the pipeline crosses several private parcels before reentering USFWS property. The Project Area also includes approximately 1.25 miles of Icicle Creek Road, from the surface water intake to a Forest Service kiosk to the west, as well as access roads and staging areas on USFWS property. An overview of the Project Area is depicted on **Map A-1** in **Appendix A**.

1.3 Action Area

The Action Area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the Action Area, Reclamation evaluated the farthest-reaching physical, chemical, and biotic effects of the action on the environment. The Action Area is depicted on **Map A-2** in **Appendix A**.

The Action Area is the area within the ordinary high water mark of Icicle Creek, from 230 feet upstream of the surface water intake at river mile (RM) 4.5, to the Washington Department of Ecology (Ecology) compliance monitoring location at RM 2.3, downstream of the Hatchery. Reclamation does not expect effects on ESA-listed fish and critical habitat in Icicle Creek from construction of the Proposed Action to extend beyond these limits.

The Action Area also includes a 0.25-mile buffer around the Project Area (see **Section 1.2**) to evaluate noise and other potential disturbance effects on listed terrestrial wildlife species. Reclamation does not anticipate perceptible effects from construction and operation of the Proposed Action to extend farther than 0.25 miles from the Project Area. This is because the baseline amount of existing human-caused disturbance in the Project Area vicinity is moderate to high. This is due to recreational use, vehicle and traffic noise, and existing residential, commercial, and other development in the Action Area.

1.4 Listed Species and Critical Habitats

There are 10 threatened or endangered species, and one candidate species in the Action Area vicinity as identified by the USFWS's Information for Planning and Consultation (**Appendix B**). Listed species and critical habitat with potential to be affected by the Proposed Action are analyzed in detail in this BA and are summarized in **Table 1**.

Table 1
Listed Species and Critical Habitats

Species or Critical Habitat	Status	Effect Determination[1]
Bull trout (*Salvelinus confluentus*)	Threatened	May affect, likely to adversely affect
Bull trout critical habitat	N/A	May affect, likely to adversely affect
Gray wolf (*Canis lupus*)	Endangered	May affect, not likely to adversely affect

Notes:
[1] See **Chapter 5** for effects analysis, and **Chapter 6** for effect determination summaries.

Reclamation determined that the Proposed Action will not affect the following species: Canada lynx (*Lynx canadensis*, threatened), grizzly bear (*Ursus arctos horribilis*, threatened), North American wolverine (*Gulo gulo luscus*, proposed threatened), northern spotted owl (*Strix occidentalis caurina*, threatened), marbled murrelet (*Brachyramphus marmoratus*, threatened), yellow-billed cuckoo (*Coccyzus americanus*, threatened), showy stickseed (*Hackelia venusta*, endangered), Wenatchee Mountains checkermallow (*Sidalcea oregana* var. *calva*, endangered), and whitebark pine (*Pinus albicaulis*, candidate). These species are either not present in or near the Action Area, or suitable habitat is not present there.

Reclamation also determined that the Proposed Action will not affect the following critical habitats because they are not present in or near the Action Area: Canada lynx designated critical habitat, grizzly bear proposed critical habitat, marbled murrelet designated critical habitat, Northern spotted owl designated critical habitat, yellow-billed cuckoo proposed critical habitat, and Wenatchee Mountains checkermallow designated critical habitat.

These species and their critical habitats are not addressed further in this BA.

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Chapter 2. Foreseeable Future Actions

2.1 Foreseeable Future Actions in the Action Area

The Icicle Creek Boulder Field Fish Passage Project (Boulder Field Project) assessed fish passage and geomorphic conditions for the natural barrier at RM 5.6, also known as the boulder field, to document the extent of anthropogenic impact on fish passage and to identify fish passage alternatives for bull trout and Steelhead (*Onchorhynchus mykiss*). This project has four elements:

1) improve fish passage at RM 5.6,

2) relocate and replace the City of Leavenworth water supply pipeline and fish screen,

3) replace and relocate the Icicle and Peshastin Irrigation District's (IPID) fish screens, and

4) improve fish passage at the IPID and City of Leavenworth diversion dam.

Construction work initiated in summer 2020, with a projected completion in October 2020, for the first two elements. Elements three and four will occur at a later time because they need longer review periods and possibly different permit considerations. The overall purpose of the project is to remove fish barriers and increase fish passage to more than 20 miles of potential, undisturbed fish habitat above the boulder field in Icicle Creek. The boulder field is located at RM 5.6, upstream of the Action Area (Dominguez et al. 2013). Elements one and two will remove boulders, create four step pools along the right bank for fish passage, and install a new fish screen on the City of Leavenworth's water line (Trout Unlimited 2018).

For the third element, IPID is working with the Washington Department of Fish and Wildlife (WDFW) to bring the screens up to current state and federal criteria, and will relocate and replace IPID's fish screen and screen house to the banks of Snow Creek. Fish are believed to be at high risk of impingement if entrained. The fish bypass releases fish via a 15-foot drop onto a boulder that is not submerged for most of the irrigation season. Access of heavy machinery to this site will require modification to the existing bridge over Icicle Creek at RM 5.5, or construction of a new bridge. The existing bridge is part of the Snow Lakes Trail and is owned by the Forest Service.

Finally, fish passage improvements are proposed at the diversion dam that diverts water for withdrawal from Icicle Creek by the IPID and City of Leavenworth (at approximately RM 6.0) for the last element (Trout Unlimited 2018). This element will be informed by the first element and subsequent monitoring of fish migration upstream.

The IPID Irrigation Efficiencies Project includes traditional irrigation efficiency upgrades, such as canal lining or piping of irrigation ditches. A water savings of approximately 10.1 cubic feet per second (cfs), or 3,000 acre-feet annually, could be achieved in lower Icicle Creek, including the Action Area, from implementing efficiency upgrades that will be identified in the IPID Comprehensive Water Conservation Plan (Chelan County and Ecology 2019).

The Cascade Orchards Irrigation Company (COIC) Irrigation Efficiencies Project consists of installing a piped and pressurized system, and replacing the current gravity-fed point of diversion with a pump station downstream on the Wenatchee River or Icicle Creek near their confluence. Improvements also would include replacement of the open ditch system with a closed-pipe canal and laterals to improve efficiency. The COIC project would restore 11.9 cfs (3,640 acre-feet annually) to lower Icicle Creek, including the Action Area. The COIC recently completed an alternatives analysis to explore various conservation project options (Chelan County and Ecology 2019).

The Domestic Conservation Project (Chelan County and Ecology 2019) focuses on implementing conservation for domestic users within the City of Leavenworth and rural areas of the Icicle Creek subbasin. Anticipated water savings are approximately 0.5 cfs and 400 acre-feet annually, all of which would go toward domestic supply. Because these water savings would go toward domestic water supply, they would not affect instream conditions in the Action Area.

Chapter 3. Proposed Action

3.1 Proposed Action

The Proposed Action is construction of Reclamation's Alternative C, analyzed in the LNFH SWISP Project Draft Environmental Impact Statement (EIS). The Proposed Action includes construction of the SWISP Project only. It does not include associated operations and maintenance (O&M), such as sediment management or management of the proposed fish screens during icing conditions. O&M activities will be covered in a separate ESA Section 7 consultation.[4]

Reclamation proposes to rehabilitate the LNFH surface water intake and delivery system on Icicle Creek by constructing new headworks and a creek-width roughened channel, and replacing and lining the surface water conveyance pipeline to the Hatchery. In addition, the current access road would be modified and extended to provide better entry to an expanded intake operations and maintenance area (IO&MA). The Proposed Action is depicted on **Map A-3** and **Map A-4** in **Appendix A**. A conceptual drawing of the proposed intake facilities is included as **Map A-5** in **Appendix A**. Reclamation shared final engineered drawings of the Proposed Action with the USFWS.

General descriptions of the Proposed Action components are included in the following sections. Following the general descriptions, additional information on Proposed Action phasing, timing, and other details is included in *Construction Phases, Timing, and Additional Detail.*

Intake and Fish Passage

The existing low-head diversion dam and fish ladder/sediment sluice will be partially demolished and removed. The headworks and creek-width roughened channel will be constructed over the remaining, undemolished portions of these features. Concrete surfaced areas would be limited to the IO&MA pad and the intake structure perimeter, on the creek side. The remaining surfaces would be natural or gravel covered. Two self-cleaning, cylindrical screens will be installed at the intake headworks to provide NMFS-compliant fish screening, provide redundancy in case of screen maintenance, and facilitate the Hatchery's ability to meet future water conservation goals. A low-flow boulder weir fishway will be integrated into the roughened channel to provide NMFS-compliant fish passage during typical low flows.

A portion of the roughened channel will be extended upstream of the diversion dam to facilitate fish passage overall and at higher flows in particular. The intake trashrack structure will be removed, and a new intake pipeline will be placed in the intake channel to connect the headworks to the conveyance pipeline. The intake channel will be filled to cover the pipeline and create the IO&MA to enable Hatchery personnel to safely and efficiently access, operate, and maintain the intake facilities. The existing stairway from the access road to the intake channel will be removed as this

[4] Email from C. Raekes, USFWS, to M. Cappellini, USFWS; J. Sutter, Reclamation; E. Heether, Reclamation; S. Hoefer, Reclamation; and S. Franks, USFWS, on October 7, 2020, Subject: Re: Follow up on our call this morning.

area would become part of the IO&MA. Additional detail on intake and fish passage construction during Phase I is included in *Construction Phases, Timing, and Additional Detail*, below.

Sediment Management

Multiple design elements are proposed to manage sediment accumulated at the intake. These are a ramp on the upstream side of the roughened channel to help mobilize sediment over the feature. This element will facilitate passive sediment mobilization by Icicle Creek flows over the roughened channel on a continuous basis, and during higher flows in particular. The slope of the ramp is 2 horizontal to 1 vertical.

Another element to manage sediment is a vertical access pipe incorporated into the IO&MA behind the screens. This will enable a submersible pump to draw in screened water and force it through a hose and nozzle to mobilize sediment through propulsion. Additional elements are a series of pipes, valves, and an outlet channel at the pipeline intake and sediment management area (PISMA) to flush sediment through the intake pipeline back to Icicle Creek. Components of the PISMA will be placed at the former gatehouse location; additional construction detail is included below. While construction of these additional elements is included in this consultation, sediment management using them is considered to be O&M, which are not included under this consultation.

Conveyance Pipeline

The conveyance pipeline will be replaced using cut and cover trenching on USFWS property at the Hatchery grounds and lined with cure-in-place pipe (CIPP) on USFWS property at the surface water intake and on private parcels. Construction of several temporary access points (contractor use areas [CUAs]) along the existing conveyance pipeline alignment will provide ingress and egress for pipe lining on private lands. These areas will be restored to preconstruction conditions following lining activities.

The lower section of pipeline on USFWS property will be constructed parallel to the existing pipeline. The current control valve system at the sand settling basin on USFWS property will be replaced with a new control valve vault to allow safe pipe filling operations. After control valve connections are made, the existing pipeline will be decommissioned and abandoned in place.

All rehabilitation, replacement, and modernization of the LNFH intake and delivery facilities will conclude at the control valve system; the sand settling basin and inside and outside screen chambers will remain unaltered. Additional detail on conveyance pipeline construction during Phase II is included in *Construction Phases, Timing, and Additional Detail*, below.

Temporary Hatchery Water Supply

Temporary Hatchery water will primarily be supplied by a gravity-fed diversion. A 40-cfs water supply to the LNFH will be maintained during Phase I construction. Temporary pumping from the spillway pool will supply water while the gravity bypass pipeline and outlet are installed and connected to the existing conveyance pipeline approximately 200–300 feet below the intake construction area. This will be over an approximately 1 week period. It is likely that multiple pumps will be needed to supply this water.

A 20-cfs water supply to the LNFH will be maintained during Phase II construction between April 17 and May 20. This will be needed when lining the pipeline with CIPP, and pipeline interconnections are underway. This water supply to the LNFH will be through pumping from the spillway pool adjacent to the LNFH as needed.

Additional detail on the temporary Hatchery water supply during Phase I and Phase II of construction is included in *Construction Phases, Timing, and Additional Detail*, below.

Access and Staging

Staging and storage sites for construction equipment and materials, and construction staff administration and vehicle parking will be located at various locations on LNFH grounds. Trucks hauling construction equipment and containing construction materials will be required to turn around approximately 1.25 miles above the intake access road, at the Forest Service and Alpine Lakes Wilderness Area kiosks on Icicle Creek Road. Construction access to the conveyance pipeline will use existing roads, temporary access routes, and the pipeline right-of-way. Additional detail on access and staging during Phase I and Phase II of construction is included in *Construction Phases, Timing, and Additional Detail*, below.

Best Management Practices

Reclamation will implement acceptable practices to protect the water quality and other resources during construction. Best management practices (BMPs) will be implemented to reduce project impacts on resources and resource uses, including, but not limited to, fisheries and aquatic resources, Tribal interests, public health and safety, and recreation. The comprehensive list of BMPs is included in **Appendix D**.

Construction Phases, Timing, and Additional Detail

Construction of the SWISP Project will occur in three phases. Phase I includes construction of the intake access road and rehabilitation of the intake structures and facilities (e.g., fish screens and fish passage). Phase I includes all proposed in-water work. The in-water work window is between July 1 and November 15 each year; construction will be done over 2 years, including two in-water work windows (2022 and 2023). Phase I construction activities could occur up to 24 hours per day and up to 7 days per week.

Phase II includes replacement and lining of the conveyance pipeline. Phase II construction activities will be limited to 7:00 a.m. to 10:00 p.m., up to 6 days per week (Monday through Saturday). There will likely be temporary overlap between parts of Phase I and Phase II construction. For instance, in July 2022 it is likely that construction of the proposed intake facilities may overlap with pipeline replacement on the Hatchery grounds.

Phase III includes revegetation of upland and riparian areas that are proposed to be disturbed during earlier phases of construction.

Additional detail for each construction phase is provided in the following sections.

Phase I

Mobilization and site preparation for Phase I construction will begin in March 2022, and finish by mid-April. Site preparation in the intake construction area will begin with installation of erosion control measures such as silt fencing (see **Appendix D**) at the boundary of the intake construction area, and clearing and grubbing within the intake construction area. A total of approximately 0.89 acres of surface disturbance and vegetation removal will occur. Erosion control measures would be maintained in working order for the duration of the project.

The intake access road will be graded to facilitate intake construction area access. Intake access road construction will include breaking rocks and bedrock, removing boulders, and excavating and filling to the design grade to widen and extend the existing access road. A vehicle guardrail will also be installed on the creek side of the road. A crane will be used to unload construction materials from delivery trucks and move them to required construction areas. Access to the existing gatehouse/proposed PISMA location would also be graded. This construction will be done outside of and up to the Icicle Creek ordinary high water mark.

Following site preparation, cofferdam A will be installed. Three temporary cofferdam arrangements are proposed over the two in-water work window seasons, as shown in **Figure 1**. In the figure, Cofferdam Phase 1 is the same as cofferdam A in this BA, Cofferdam Phase 2 is cofferdam B, and Cofferdam Phase 3 is cofferdam C.

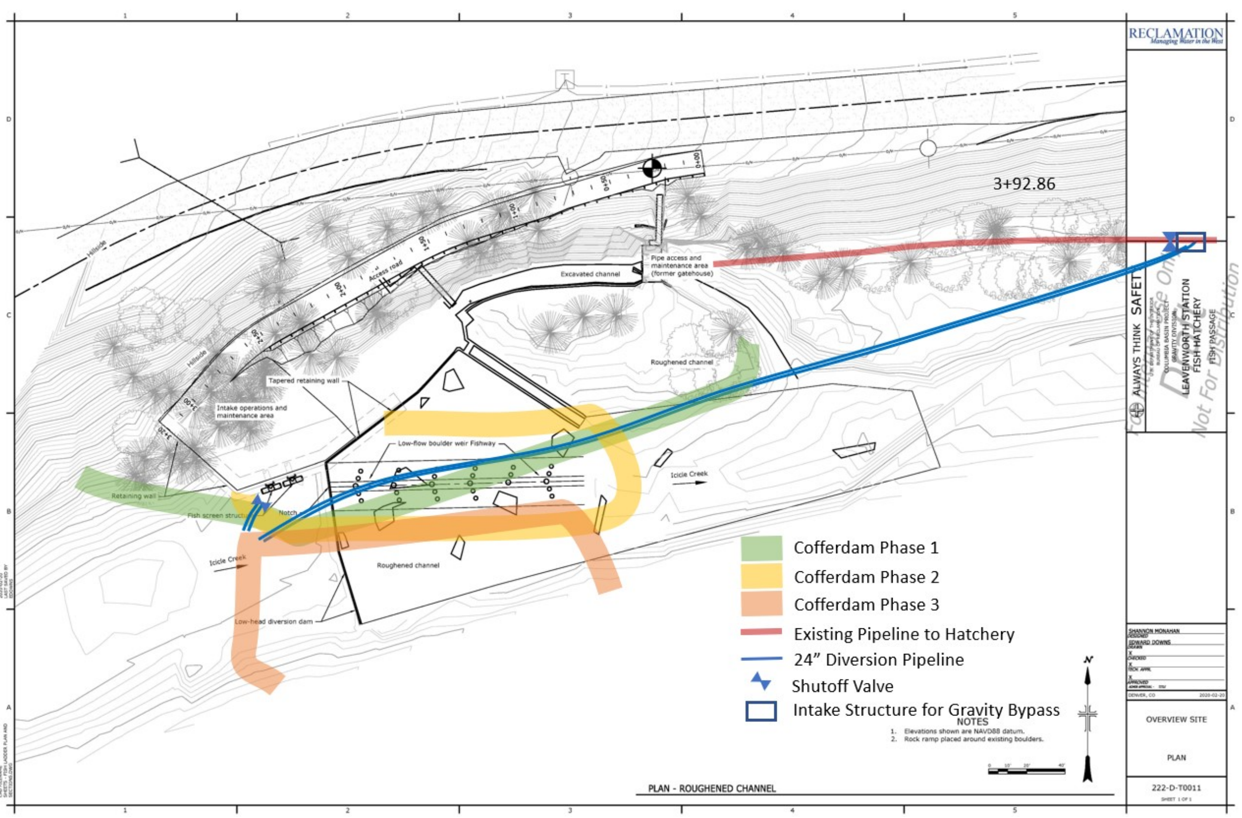

Figure 1. Rendering of Temporary Cofferdam Locations

Cofferdam A installation will begin in early July 2022, at the beginning of the in-water work window; cofferdam A will be fully installed by late July. It will be removed no later than November 15, 2022. Cofferdams B and C will be installed in sequence during the second in-water work window, in 2023. They will be removed no later than November 15, 2023. Cofferdam durations, dewatered work areas, and purpose are summarized in **Table 2**.

Table 2
Temporary Cofferdam Phasing and Details

Cofferdam	Duration Installed	Approximate Dewatered Work Area[1]	Fish Salvage Required?	Purpose
A	Early July 2022 to mid-November 2022	0.4 acres	Yes	Partial demolition of low-head diversion dam and fish ladder/sediment sluice; construction and installation of headworks
B	Early July 2023 to late August 2023	0.3 acres	Yes	Construction and installation of creek-width roughened channel (north half) and low-flow boulder weir fishway; fracture and removal of boulder; preparation of cofferdam C area
C	Late August 2023 to early October 2023	0.3 acres	Yes	Construction and installation of creek-width roughened channel (south half)
PISMA sluiceway work area isolation[2]	Late July 2022 to mid-August 2022	0.1 acre	Yes	Construction of the PISMA sluiceway

Notes:
[1] Cofferdam dewatered work area estimates are approximate. Estimates are for the dewatered area within the Icicle Creek ordinary high water mark.
[2] This work area is typically dry during the work period, so this cofferdam is unlikely to be necessary.

During construction of Phase I while cofferdams are in place, existing fish passage will be maintained over the greatest stream width as possible, while maintaining a minimum depth of water at 0.8 feet (see BMPs in **Appendix D**). During cofferdam installation and removal no wet crossings or heavy equipment use will occur in Icicle Creek live water. Use of a long-reach excavator or crane will be used for constructing and removing the cofferdams, either from outside of the Icicle Creek ordinary high water mark, or from within a temporarily dewatered work area isolated from Icicle Creek by another cofferdam. Machinery and equipment will be removed from the dewatered work areas when not in active use, and during higher-flow conditions.

Temporary cofferdams will likely consist of geo-bags filled with sand and gravel,[5] stacked side-by-side and one atop another to achieve necessary dimensions. Once placed, the cofferdam will be wrapped with Visqueen[6] or a similar material, eliminating interstitial spaces between the geo-bags to prevent impingement or entrapment of fish and reduce or prevent leakage. The cofferdam design is estimated to be approximately 12 feet wide at the base with a tapered width as it rises to approximately 9 feet. Due to the uneven, cobbly to rocky nature of the Icicle Creek streambed in the intake construction area, an excavator working from adjacent uplands (or for cofferdam C, within the dewatered work area of cofferdam B) will be used to level the streambed in the cofferdam footprint area. If use of a jackhammer is necessary to fracture rocks within the stream, it will be used in the dewatered cofferdam area after the cofferdam is installed. Some of the streambed materials removed will be hauled to a staging area (see **Map A-1**) and stockpiled for later use in construction of the roughened channel, and material that cannot be reused will be removed and properly disposed of in a landfill. Once the streambed is prepared, cofferdam geo-bags will be placed by a crane or excavator operating from adjacent uplands (or from within a dewatered work area). Additional details on the amount and type of fills and removals associated with temporary cofferdams is included in **Table 3**.

During streambed preparation and cofferdam installation, water quality monitoring will occur to ensure turbidity downstream of the construction does not exceed allowable levels, in compliance with Conservation Measure 3 (see **Section 3.2**, Conservation Measures). Should observed turbidity exceed allowable levels at the point of compliance specified in the conservation measure, in-water construction will temporarily stop until turbidity has cleared. In-water construction could then recommence at a slower rate to minimize generated turbidity. Monitoring and additional temporary work stoppages would occur as needed in accordance with the conservation measure.

Prior to cofferdam installation, block nets (seine and dip nets) will be used to remove fish from, and prevent fish from entering, the cofferdam footprint area. All fish salvage activities, including netting, would be conducted by the USFWS Mid-Columbia Fish & Wildlife Conservation Office. Transfer measures for ESA-listed fish would include using a sanctuary net that holds water during transfer to prevent the added stress of an out-of-water transfer when necessary and minimal handling of fish. Once cofferdams are installed, the area behind the cofferdam will be temporarily dewatered using one or more sump pumps, and the USFWS Mid-Columbia Fish & Wildlife Conservation Office would salvage any fish inadvertently trapped within the area to be dewatered. During dewatering, Reclamation will adhere to the USFWS (2012) Recommended Fish Exclusion, Capture, Handling, and Electroshocking Protocols and Standards for bull trout (**Appendix E**). Pumps used to temporarily bypass water or to dewater work areas will be screened to prevent aquatic life from entering the intake. Fish screens or guards will comply with the most recent fish screening guidelines for anadromous salmonids prescribed by the NMFS (see **Appendix D**, Best Management Practices).

All exterior (stream-facing) walls of cofferdams will be smooth and free of joints to reduce impingement or entrapment of ESA-listed fish species, or other fish, present in Icicle Creek. The

[5] Geo-bags, or non-woven geotextile bags, are large bags made of synthetic materials, such as polyester, polypropylene, or polyethylene, which are filled with sand, rock, or other material. They are fastened shut and used to protect structures or riverbanks from erosion or scour.

[6] Visqueen is a brand of low-density polyethylene plastic sheeting.

construction contractor will conduct visual inspections of the cofferdams on a regular basis to ensure they are maintained in functioning condition. During visual inspections, and fish observed impinged or entrapped in the cofferdam structure of other associated appurtenances (e.g., guywires) will be reported immediately to the on-site inspector, who will immediately contact the USFWS Mid-Columbia Fish & Wildlife Conservation Office. The contractor will not handle or remove fish (live or dead). Staff from the Mid-Columbia Fish & Wildlife Conservation Office will investigate the impingement or entrapment and record pertinent information (such as data on species, size, likely reason for impingement, and other environmental conditions assumed to contribute to impingement) and will share information with USFWS Ecological Services. The contractor will implement any mitigation measures developed by USFWS Ecological Services, in consultation with Reclamation, to reduce or prevent further impingement or entrapment.

Partial demolition of the low-head diversion dam and fish ladder/sediment sluice, and notching of the low-head diversion dam where the low-flow fishway would be built in the 2023 in-water work window, will be done using 30-pound pneumatic tools (i.e., jackhammers). Jackhammers would likely be an attachment to the excavator, but, for smaller rocks, a hand-held jackhammer could be used. Such tools typically generate sound levels of approximately 85 A-weighted decibels (dBA), measured 50 feet from the tool (Federal Highway Administration 2006); however, noise levels will be higher closer to the tool. For instance, a 35-pound pneumatic breaker tool is listed as generating 106 dBA, though the distance from the tool is not specified (Ingersoll Rand 2014).

Demolition will be done from outside of the Icicle Creek ordinary high water mark, or in dewatered work areas, behind a temporary cofferdam. Demolished materials will be removed to an upland location for disposal in a landfill.

Similarly, construction of the headworks and retaining wall will be conducted in dewatered work areas behind a temporary cofferdam. The proposed dimensions of the intake headworks fish screen are approximately 50 feet wide, by 165 feet long, by 20 feet high. Fill for the headworks would consist of approximately 1,733 cubic yards of earthen material and 410 cubic yards of reinforced concrete (see **Table 3**, Fills and Removals Within and Adjacent to Icicle Creek). A foundational base would be first poured to form stem walls, and the base will be placed with rebar extending upwards to help anchor the wall to the base. Over-excavation of a minimum of 3 feet into the Icicle Creek streambed will be done with an excavator working in the dewatered work area, with structural compacted backfill replaced in this area to support the stem walls.

Demolition would begin in late July 2022 and last approximately 1 month; formwork, reinforcing, and pouring concrete for the headworks and retaining walls will begin in August 2022 and last approximately 2 months. Concrete will be left to cure for a minimum of 4 days before cofferdams are removed (**Appendix D**). Approximately 0.15 acres of Icicle Creek below the ordinary high water mark will be permanently lost due to construction of the proposed intake facilities.

Following construction of the intake structure, Reclamation will install two 30-inch diameter self-cleaning, cylindrical fish screens that meet current NMFS criteria for anadromous salmonids (NMFS 2011), as required by the NMFS biological opinion for LNFH operations (NMFS 2017a). Per the construction specifications, screens will have a design approach velocity that will not exceed 0.4 feet per second at the maximum design flow measured at 3 inches from the screen. The working deck at a minimum of 1 foot above the 100-year floodwater surface elevation will be constructed as part of the intake headworks structure then the fish screens will be placed in the guide-channels integrated into the structure. The mechanics to raise and lower the fish screens will be located on the working deck. The fish screen structure will be oriented such that the screens will be as close to parallel with the direction of streamflow as possible, to provide NMFS-compliant sweeping velocities. Screens will be installed in late October to early November 2022. An excavator will lift the screens into place from the working deck and would not require equipment in the water.

Demolition of the existing gatehouse and construction of the PISMA will take approximately 3 weeks, from late July 2022 to mid-August 2022. These could occur concurrently with cofferdam placement, however, it is likely that cofferdam placement will be prioritized to occur before gatehouse demolition and PISMA construction due to construction area size constraints and equipment access considerations. The construction area will be mostly contained within the existing gatehouse footprint. This area is located approximately 20 feet from the Icicle Creek ordinary high water mark, and outside of the 100-year floodplain. Erosion control BMPs (**Appendix D**) will be in place to prevent sediment transport to Icicle Creek during construction. Access to the construction site will be established from the intake access road during site preparation, which is described above in this section.

The PISMA sluiceway pipe is proposed to extend from the PISMA into the existing outlet channel, which is a compacted, human-modified feature created from historical, periodic sluicing of up to 54 cfs from the gatehouse. This activity has also created a hydraulic low spot where sluiced water exits the gatehouse and plunges into the outlet channel. The existing low spot presents a fish stranding hazard during sluicing activities. The 24-inch diameter sluiceway pipe will extend into the existing outlet channel, and approximately 30 feet into/below the Icicle Creek ordinary high water mark. This would remove the existing fish stranding hazard with buried pipe and the area would be regraded and vegetated. The upper portion of the existing gatehouse outlet channel, which is proposed to be bypassed by the proposed sluiceway pipeline, will be returned to a pre-project (pre-1939) condition. There will be herbaceous and shrub vegetation planted in this area (see *Phase III*). The lower section of the outlet channel will remain in its compacted, human-modified state, below the sluiceway pipe outlet. The sluiceway pipe outlet will discharge at the existing grade to avoid creating an undercut or pond.

Though the sluiceway pipe would extend approximately 30 feet into/below the Icicle Creek ordinary high water mark, this area is typically dry during the summer months when construction is proposed.[7] As such, the sluiceway pipeline is not proposed to be constructed within the confines of a temporary cofferdam, and Reclamation does not anticipate dewatering or fish salvage to be necessary. The sluiceway pipeline will be placed in the upper portion of the existing outlet channel. This is also part of the PISMA and will be about a 30 foot run down the existing channel. An excavator will work from the side of the channel with the work area anticipated to be dry. However, if water were present in the construction area during the construction period of late July 2022 to mid-August 2022, the construction area will be isolated from Icicle Creek. This could likely be accomplished with a minimal cofferdam system (e.g., consisting of weed-free straw bales and Visqueen or similar materials). If isolation of the construction area is needed, dewatering and fish

[7] Email from E. Heether, Reclamation, to M. Trieger, EMPSi, on October 6, 2020. Subject: Re: [EXTERNAL] SWISP BA - PISMA outlet channel.

salvage will be conducted in accordance with the protocols described for the temporary cofferdams, above. All fish salvage activities will be conducted by the USFWS Mid-Columbia Fish & Wildlife Conservation Office (Conservation Measure 1; see **Section 3.2**, Conservation Measures). Even if no cofferdam is needed, sediment control measures (**Appendix D**) in compliance with the construction stormwater protection plan will be installed to prevent sediment mobilization into Icicle Creek.

During Phase I construction, specifically for nearly the duration of the in-water work window in 2022, temporary Hatchery water (40 cfs) will primarily be supplied by a gravity-fed diversion. The 24-inch gravity bypass pipeline will divert water from Icicle Creek, and deliver it to the existing conveyance pipeline at a point approximately 300 feet below the existing gatehouse. The gravity bypass pipeline intake will be placed in Icicle Creek, just upstream of the existing low-head diversion dam. It will be a rigid pipe weighted to keep it in place during variable flows, likely through attachment to ecology blocks or geo-bags. The gravity bypass pipeline will run from that point to the gravity bypass outlet on the exiting conveyance pipeline. The gravity bypass pipeline intake will have a trashrack to prevent large debris from entering it, but it would not be screened to NMFS-compliant standards. The trashrack will not be a fine mesh screen but likely rebar fashioned into a screen to prevent debris entry.

Until mid-July 2022, Hatchery water will be supplied by the diversion at the existing intake facilities. The gravity bypass pipeline will be placed in Icicle Creek in mid-July 2022. After this time, there will be an approximately 1-week period where diversion from the existing intake facilities are ceased, and pumping from the spillway pool will be used to supply the temporary Hatchery water supply of 40 cfs. This will be necessary as the gravity bypass pipeline/conveyance pipeline connection point is made. Two pumps will be used to supply temporary water. The diesel-powered pumps will be outside of the Icicle Creek ordinary high water mark, and water quality BMPs (**Appendix D**) would prevent fuels from entering Icicle Creek. At the end of this 1-week period, in late July, the gravity bypass pipeline would be operational and supplying the temporary Hatchery water supply of 40 cfs.

This will continue to early November 2022. At this time, there will be a similar 1-week switch to pumping from the spillway pool while the gravity bypass pipeline/conveyance pipeline connection point was removed, and flow was initiated through the newly installed intake structure and NMFS-compliant fish screens. At this point, the gravity bypass intake and pipeline will be removed.

Cofferdam A (and if used, the PISMA sluiceway cofferdam) will be removed by mid-November (and no later than November 15) 2022. During reintroduction of Icicle Creek flows to the previously dewatered work area, Reclamation will adhere to the USFWS (2012) Recommended Fish Exclusion, Capture, Handling, and Electroshocking Protocols and Standards for Bull Trout (**Appendix E**). These recommend that flows be reintroduced gradually to minimize the intensity of sediment mobilization and resultant turbidity downstream of construction. During cofferdam removal, turbidity monitoring will occur; as described above, in-water construction will temporarily cease if turbidity levels are greater than expected.

Following Phase I construction in areas outside the Icicle Creek ordinary high water mark, in approximately mid-November 2022, hydroseeding of disturbed areas that do not have a surface treatment (e.g., gravel) with an upland or riparian herbaceous plant seed mix, as appropriate, will occur. Seed mixes are described in the Draft Leavenworth National Fish Hatchery Intake Planting Plan (**Appendix C**). Seed mixes will be applied at a rate of 20 pounds per acre, while the ground is free of snow. Additional seeding, and shrub and tree planting activities will occur under Phases II and III, respectively, as described below.

During the 2023 in-water work window, the low-flow boulder weir fishway and roughened channel will be constructed. Construction will begin with installation of cofferdam B to isolate the work area in the northern half of Icicle Creek (stream left, when viewed looking downstream). Cofferdam details, installation methods, and protocols for fish salvage are described above. During cofferdam installation and removal no wet crossings or heavy equipment use will occur in live water. Use of a long-reach excavator or crane will be used for constructing the cofferdams. The large boulder (see **Table 3**, below) will be fractured and removed from Icicle Creek, using 30-pound jackhammers as described for other demolition above. This will be approximately in late July 2023. Construction of the low-flow boulder weir fishway, followed by construction of the northern portion of the roughened channel, will be done between late July 2023 and late August 2023, at which time cofferdam C will be constructed and cofferdam B will be removed. Construction of the remaining portion of the roughened channel will commence after cofferdam C is completed in early September 2023; construction will be complete by late October 2023, at which time cofferdam C would be removed.

Construction of, removal of, and access to and from the cofferdam C area may be done by a number of methods. For example, the construction contractor may use a long-reach excavator or crane to place the cofferdam from the intake headworks built during the 2022 in-water work window, or an excavator or crane working in the dewatered area behind cofferdam B may place cofferdam C. Access to cofferdam C may be provided by a temporary steel or wooden beam bridge constructed between the intake headworks and the cofferdam area. During cofferdam removal, the contractor may shift the cofferdam footprint incrementally, essentially creating a dewatered egress route. No matter the methods used to construct, access, and remove the cofferdam, there will be no wet crossings or heavy equipment use in live water, and fish passage will be maintained over the greatest stream width as possible, while maintaining a minimum depth of water at 0.8 feet (see BMPs in **Appendix D**).

The low-flow boulder weir fishway is designed to provide open-channel fish passage at low flows, and to withstand high flows up to the 100-year flood. The fishway design flow is a minimum of 33 cfs. This flow rate exceeds the minimum flow required by NFMS hydrological criteria of 95 percent exceedance flow (NMFS 2011). Exceedance flow probabilities were developed using average mean-daily flows in Icicle Creek above the existing intake (because exceedance probabilities were developed for upstream of the existing intake, they are 42 cfs higher than below the existing intake). As summarized in Table 1 of Reclamation (2020), the 95 percent exceedance flows range from a low of 54 in September to a high of 599 cfs in June, and the 5 percent exceedance flows range from a low of 295 cfs in September to a high of 3,494 cfs in May.

The low-flow boulder weir fishway is designed to provide depth and velocities at low discharges of 75 cfs (42 cfs diverted at the proposed intake, and 33 cfs in the low-flow fishway) that meet the following criteria: 1 foot depth, less than 1 foot hydraulic drops between boulder weirs, and flow velocities of less than 3 feet per second or 4 feet per second for distances between 10 and 100 linear feet (Reclamation 2020). Recirculation zones (velocity vectors directed upstream) will form along the outer edges of the low-flow fishway and behind boulder weirs. These zones provide resting areas as fish migrate upstream. At approximately 100 cfs, flow begins to fill in the remaining areas of the low-flow boulder weir fishway and spread out over the roughened channel. However, continuous paths of flow depth greater than 1 foot on the roughened channel do not exist until 401 cfs (Reclamation 2020).

Velocities through the low-flow boulder weir fishway are less than the required 3 feet per second for discharges between 100 cfs and 298 cfs. Continuous paths with flow depths of 1 foot or greater begin to form along the right edge of the low-flow fishway at approximately 298 cfs. By 401 cfs, considerable areas of flow depth greater than 1 foot are available for fish passage on the roughened channel. As discharge reaches 401 cfs, large portions of the low-flow fishway have velocity values greater than 3 feet per second. Potential swimming paths are available on the middle portion of the roughened channel where velocities are slower due to the placed boulders (Reclamation 2020).

As discharge increases from 401 cfs, flow depths throughout the roughened channel are greater than 1 foot. Therefore, velocity becomes the dominant factor and focus of upstream fish passage shifts from the low-flow fishway to the roughened channel. At discharges ranging between 586 to 906 cfs, areas with velocity less than 3 feet per second decrease, but potential longitudinal pathways are still present. The distance between low-velocity zones through which fish may be expected to burst is approximately 5 to 10 feet. At approximately 1,600 cfs, zones of higher velocity over the low-flow fishway and along the right side of the boulder clusters become more defined and continuous. The boulder clusters on the roughened channel provide adequate low-velocity and recirculation zones throughout the length of the roughened channel. However, longitudinal paths become less defined. The distance fish are expected to burst swim between resting zones is approximately 10 to 15 feet (Reclamation 2020).

The upper-end of the upstream passage discharges (2,671 and 3,002 cfs) shows the majority of the roughened channel with velocity greater than 3 feet per second. The distance between low-velocity zones behind the boulder clusters increases to approximately 15 to 30 feet in the center of the roughened channel. At these large discharges, fish are expected to navigate the low velocity zones along the margins of the channel, much like they would in the natural system (Reclamation 2020).

The low-flow boulder weir fishway will be constructed by built-up repetitive rock placement of increasing sizes (see **Table 3** for rock sizes and number of rocks of each size). Rocks will be placed by an excavator working from within the cofferdam B dewatered work area, or from the working deck of the intake headworks. The proposed dimensions of the low-flow boulder weir fishway are approximately 195 feet long by 20 feet wide. The fishway will consist of a riprap rock-armored, concrete-grouted channel with chevron-shaped boulder weirs. 35 cubic yards of boulders will be placed (see **Table 3**). The boulder weirs will provide drops of 0.9 feet across each weir at the design flow. The boulder sizes vary up the cross-sectional slope of the fishway; the center, anchor boulder of each weir, at channel invert, is the largest. During construction, the anchor boulder will be used to fine tune the depth of the pool at the design flow. Concrete grouting of the boulders will be necessary to prevent movements with higher flows up to the 100-year discharge. Grouting will be placed using a concrete pumping truck from the shoreline or working deck of the intake headworks. Approximate 290 cubic yards of concrete will be used for construction of both the low-flow boulder weir fishway and the roughened channel. The location of the fishway on stream left helps provide the needed sweeping velocities in front of the fish screens.

Table 3
Fills and Removals Within and Adjacent to Icicle Creek

Activity (clear, removal, fill)	Impact Location	Impact Duration	Amount of Material to be Placed or Removed	Area (square feet, linear feet[1])
Quantities below the ordinary high water mark				
Removal (8'x 8' x 6.375' boulder, roughened channel)	Full OHWM[2] span	Permanent	1 count (15 cubic yards)	8 linear feet, 51 square feet
Fill (chevron weirs, boulders: 1 of 3.5′ x 3.5′x 4', 2 of 3' x 3′x 3.5', 2 of 2' x 2' x 3', roughened channel)	Full OHWM span	Permanent	7 count weirs (35 cubic yards total)	195 linear feet, 19,760 square feet
Fill (8' x 8' x 6.375' boulders, roughened channel)	Full OHWM span	Permanent	27 count (405 cubic yards total)	195 linear feet, 19,760 square feet
Removal (reinforced concrete, fish ladder/sediment sluice, and trashrack)	Full OHWM span	Permanent	147 cubic yards	195 linear feet, 1,190 square feet
Removal (earthen material and rock, headworks; to be reused on-site)	North half within OHWM	Permanent	1,838 cubic yards	165 linear feet, 2,975 square feet
Fill (earthen material, headworks)	North half within OHWM	Permanent	1,733 cubic yards	165 linear feet, 7,200 square feet
Fill (reinforced concrete, headworks)	North half within OHWM	Permanent	410 cubic yards	165 linear feet, 860 square feet
Removal (earthen material and rock, intake pipeline; to be reused on-site)	North half within OHWM	Permanent	176 cubic yards	224 linear feet, 3,450 square feet
Fill (earthen material and gravel, intake pipeline)	North half within OHWM	Permanent	938 cubic yards	234 linear feet, 3,950 square feet
Fill (controlled low-strength material, intake pipeline)	North half within OHWM	Permanent	43 cubic yards	224 linear feet, 3,450 square feet
Removal (earthen material and rock, roughened channel; to be reused on-site)	Full OHWM span	Permanent	3,491 cubic yards	195 linear feet, 19,760 square feet
Fill (earthen material, roughened channel)	Full OHWM span	Permanent	5,882 cubic yards	195 linear feet, 19,760 square feet
Fill (concrete for grouted riprap areas, roughened channel)[7]	Full OHWM span	Permanent	290 cubic yards	195 linear feet, 19,760 square feet
Removal (cofferdam A, stream bed preparation)	Full OHWM span	Permanent	210 cubic yards	360 linear feet, 5,200 square feet

Activity (clear, removal, fill)	Impact Location	Impact Duration	Amount of Material to be Placed or Removed	Area (square feet, linear feet[1])
Fill/removal (cofferdam A, super sacks, sand, and gravel)[3]	Full OHWM span	Temporary (19 weeks[4])	1,890 cubic yards	360 linear feet, 5,200 square feet
Removal (cofferdam B, stream bed preparation)	Full OHWM span	Permanent	210 cubic yards	235 linear feet, 4,600 square feet
Fill/removal (cofferdam B, super sacks, sand, and gravel)[3]	Full OHWM span	Temporary (7–8 weeks[5])	2,142 cubic yards	235 linear feet, 4,600 square feet
Removal (cofferdam C, stream bed preparation)	Full OHWM span	Permanent	189 cubic yards	220 linear feet, 4,000 square feet
Fill/removal (cofferdam C, super sacks, sand, and gravel)[3]	Full OHWM span	Temporary (6–7 weeks[6])	1,890 cubic yards	220 linear feet, 4,000 square feet
Quantities above the ordinary high water mark				
Clear (intake access road)	10 feet from OHWM (outside 100-year floodplain)	Permanent	714 Square Yards	340 linear feet, 6,850 square feet
Removal (earthen material and rock, intake access road and intake pipeline; to be reused on-site)	0 feet from OHWM (partially inside 100-year floodplain)	Permanent	757 cubic yards	466 linear feet, 9,162 square feet
Removal (reinforced concrete, gatehouse)	25 feet from OHWM (outside 100-year floodplain)	Permanent	72 cubic yards	30 linear feet, 530 square feet
Fill (earthen material and gravel, intake access road, and intake pipeline)	0 feet from OHWM (partially inside 100-year floodplain)	Permanent	707 cubic yards	466 linear feet, 9,162 square feet
Fill (controlled low-strength material, intake pipeline)	0 feet from OHWM (inside 100-year floodplain)	Permanent	30 cubic yards	96 linear feet, 2,250 square feet

Notes:
[1] Linear feet are measured in the direction of flow and represents the disturbance length of Icicle Creek; square feet is the total disturbance area. [2] OHWM = ordinary high water mark
[3] Fill areas are estimates of the cofferdam area itself. The approximate area of the dewatered work area behind the cofferdam is included in **Table 2**.
[4] Cofferdam will be in Icicle Creek for the approximate duration of the 2022 in-water work window, no earlier than July 1 and no later than November 15, 2022 (up to 19 weeks).
[5] Cofferdam will be in Icicle Creek for approximately the first half of the 2023 in-water work window, from early July to late August 2023 (7 to 8 weeks).
[6] Cofferdam will be in Icicle Creek for approximately the second half of the 2023 in-water work window, from late August to early October 2023 (6 to 7 weeks).
[7] Based on the calculations,195 linear feet will be grouted. This represents the base of the structure and will be buried with rock.

The 195-foot long creek-width roughened channel (approximately 19,760 square feet) will be constructed with riprap rock, but most of the rocks will not be concreted into place. Some concrete (290 cubic yards between the low-flow boulder weir fishway and roughened channel) will be used to anchor the larger rocks in place as well as to add smaller rocks on top of the larger rock to fill interstitial spaces and cover exposed concrete. This construction would be accomplished using excavators and front-end loaders, which will dump rock within the confines of the cofferdam B and C dewatered work areas. Concreted riprap will be used for the crest of the roughened channel (i.e., the dam crest) to help withstand high flows. The rock "cap" will actually increase the dam elevation slightly compared with the existing low-head diversion dam elevation and will be placed irregularly across the new crest to look more natural. Suitable boulders removed from Icicle Creek during cofferdam installation and other construction in the cofferdammed areas will be reused for construction of the roughened channel. The northern half of the creek-width roughened channel will be constructed behind cofferdam B, and the southern half will be constructed behind cofferdam C. Cofferdams B and C will be removed no later than November 15, 2023. Rewatering work areas will follow the same procedures described for rewatering the cofferdam A work area, above.

Because Phase I construction could occur up to 24 hours per day, nighttime construction is expected. Diesel generators will power construction lighting, including lighting in the intake construction area and potentially in dewatered work areas. Diesel generators will be located outside of Icicle Creek. In most cases the generators will be located at least 50 feet away from the creek, and refill diesel would be at least 250 feet away. Generators placed in a secondary containment could be located closer to the creek. Water quality protection BMPs (**Appendix D**) will ensure fuels from generators do not enter Icicle Creek.

Table 3 summarizes p roposed volumes, areas, and materials of fill and removal within the Icicle Creek ordinary high water mark for Phase I construction. This information has been compiled to inform the Project permit applications.

Phase II

Phase II includes replacement and lining of the conveyance pipeline. All construction under Phase II will be in uplands, though in places, construction will be in relatively close proximity to Icicle Creek (i.e., at CUA 2 and the PISMA, as shown on **Map A-3** in **Appendix A**). Further, temporary Hatchery water supply pumping from the spillway pool is also proposed. Additional detail on site preparation, pipeline replacement and lining, site restoration, and construction sequencing are below.

Several CUAs will be graded along the existing conveyance pipeline alignment to provide a construction area for pipe lining with CIPP on private parcels. Access to CUAs will be on existing paved and dirt access roads on private parcels, on which federal rights-of-way exist. No improvements are needed to existing roads and access routes. Site preparation at each CUA includes installation of erosion control measures such as silt fencing (see **Appendix D**) at the boundary of the construction area, and clearing and grubbing as needed. A small excavator or backhoe will be used to excavate down to the conveyance pipeline. A short section of the existing pipeline will then be cut using a concrete saw, and removed. This will provide access for lining with CIPP.

Hot air blowers will completely dry out the existing pipeline prior to lining with CIPP. These will be used at the PISMA construction area, and at CUAs 2 through 5. The closest distance to the creek that hot air blowers would be used would be at CUA 2, within approximately 50 feet of Icicle Creek. Reclamation assumes that noise generated by this equipment would be up to 115 decibels at five feet from the source and range to 54.79 dB at 5,120 feet from the source. The dBA measurement for the hot air blower is not known at this time. This is because the specifications for and type of hot air blower will be determined by the construction contractor. The hot air blower is expected to take up to 6 hours to dry each pipeline segment in preparation of lining with CIPP. Hot air blowers will not be used past 10:00 p.m.

Following lining activities at each CUA, these areas will be restored to preconstruction conditions. CUA 5, on USFWS property, is within an existing gravel parking area and road prism. These features will be returned to their preconstruction condition. For CUAs 2, 3, and 4, which are on private lands, hydroseeding of disturbed areas with a seed mix is proposed, as described in *Phase I*, above. The seed mixes will be determined by the property owner, and are not known at this time. Seeding methods will be appropriate for the seed mix(es) identified by the property owners.

The existing conveyance pipeline between CUA 5 and the sand settling basin (approximately 1,560 linear feet) on the Hatchery grounds would be replaced (see **Map A-3** in **Appendix A**). Construction, including mobilization, site preparation, pipeline replacement, site rehabilitation, and demobilization, will occur between May 2022 and April 2023. Site preparation will begin with installation of erosion control measures such as silt fencing (see **Appendix D**) at the boundary of the construction area, and clearing and grubbing within the construction area. A new trench will be excavated using an excavator or backhoe parallel to the existing pipeline, and the new pipeline will be placed in this. The new pipeline will terminate at the control valve vault. The disturbance area for the vault is approximately 75 feet by 60 feet; the entirety of the disturbance area will be within the footprint of the conveyance pipeline construction area shown on **Map A-3** in **Appendix A**. After control valve connections are made, the existing pipeline will be decommissioned and abandoned in place.

Lining the conveyance pipeline with CIPP between CUA 5 and CUA 4, and between CUA 4 and CUA 3, will occur between April and May 2023. Lining the conveyance pipeline with CIPP between CUA 3 and CUA 2 will occur between April and May 2024. Lining the conveyance pipeline with CIPP on USFWS and private property, between CUA 2 and the PISMA, will occur between April and May 2024. Preparations for replacement and lining, such as mobilization, site preparation, and excavating the existing pipeline, will likely begin several weeks to a month before the date ranges given above. Similarly, demobilization and site restoration will extend for several weeks to a month beyond these date ranges.

A 20-cfs water supply to the LNFH will be maintained during Phase II construction between April 17 and May 20 in 2022, 2023, and 2024. This will be needed when lining the conveyance pipeline with CIPP, and pipeline interconnections are underway. This will be through pumping from the spillway pool as needed. As described for temporary pumping under *Phase I*, pumps will be screened to prevent aquatic life from entering the intake, and screens will comply with the most recent fish screening guidelines for anadromous salmonids prescribed by the NMFS (see **Appendix D**). Further, as described in *Phase I*, diesel-powered pumps will be outside of the Icicle Creek ordinary high water mark, and water quality BMPs will prevent fuels from entering Icicle Creek.

Phase III

Phase III includes planting of riparian tree cuttings in the Icicle Creek riparian zone and planting containerized upland shrubs and trees in uplands within the Phase I intake construction area. Of the approximately 0.89 acres of surface disturbance proposed under *Phase I*, the area to be revegetated is approximately 0.71 acres, most of which are uplands. Riparian tree cuttings will be planted along approximately 200 linear feet of the Icicle Creek streambanks in the intake construction area. The planting palette and methods are described in the Draft Leavenworth National Fish Hatchery Intake Planting Plan (**Appendix C**). Planting may be done after construction of the low-flow boulder weir fishway and roughened channel is complete in November 2023, or it may be done in fall 2024.

Permitting

Because the Proposed Action would include construction within Icicle Creek, several federal and state regulatory permit approvals would be required before construction begins. Reclamation would obtain all required regulatory permits prior to construction implementation. Reclamation would use the Washington State Joint Aquatic Resources Permit Application form to apply for applicable permits. Permits that would be obtained include:

- USACE Section 404 Nationwide Permits (Nationwide Permit 27—Aquatic Habitat Restoration, Enhancement, and Establishment Activities, and Nationwide Permit 33—Temporary Construction, Access, and Dewatering)
- Ecology Section 401 Water Quality Certification
- WDFW Hydraulic Project Approval

The Proposed Action would also include the use of Icicle Creek Road on National Forest System lands, between the Snow Lakes Trailhead and the Forest Service and Alpine Lakes Wilderness Area kiosks. As a result, Reclamation would secure the required road use approval from the Forest Service, most likely under a special use permit, which would not require a separate National Environmental Policy Act review. The kiosks are approximately 1.25 miles up Icicle Creek Road from the intake access road.

3.2 Conservation Measures

Conservation measures are actions to benefit or promote the recovery of listed species that the federal agency includes as an integral part of the Proposed Action. These actions would be taken by the federal agency or applicant, and serve to minimize or compensate for project effects on the species under review. These may include actions taken prior to the initiation of consultation, or actions that the federal agency or applicant have committed to complete a BA or similar document (USFWS and NMFS 1998).

To minimize impacts on listed species and critical habitat, Reclamation would implement the conservation measures described below.

Conservation Measure 1

When dewatering the proposed in-water work areas, the construction contractor will adhere to the USFWS (2012) Recommended Fish Exclusion, Capture, Handling, and Electroshocking Protocols and Standards for bull trout (**Appendix E**). All fish salvage activities will be conducted by the USFWS Mid-Columbia Fish & Wildlife Conservation Office. Should a dewatered work area become inundated during the course of construction activities, dewatering activities will take place again, following the same protocols as initial dewatering activities.

Conservation Measure 2

Pumps used to temporarily bypass water or to dewater work areas will be screened to prevent aquatic life from entering the intake. Fish screens or guards will comply with the most recent fish screening guidelines for anadromous salmonids prescribed by the NMFS.

Conservation Measure 3

Turbidity monitoring would be done when turbidity-generating construction takes place (for example, installation of cofferdams and reintroducing water to dewatered work areas). The construction contractor will measure the duration and extent of the turbidity plume (visible turbidity above background) generated by turbidity-generating construction. Turbidity measurements will be taken in nephelometric turbidity units (NTUs), and data will be submitted to the USFWS following project construction. In accordance with Washington Administrative Code (WAC) 173-201A-200(1)(e)—Aquatic life turbidity criteria, for the salmonid rearing and migration category, maximum allowable turbidity levels shall not exceed:

- 10 NTU over background when the background is 50 NTU or less; or
- A 20 percent increase in turbidity when the background turbidity is more than 50 NTU.

The turbidity criteria established under WAC 173-201A-200(1)(e) shall be modified, without specific written authorization from the Washington State Department of Ecology, to allow a temporary area of mixing during and immediately after necessary in-water construction activities that result in the disturbance of in-place sediments. This temporary area of mixing is subject to the constraints of WAC 173-201A-400(4) and (6). It can occur only after the activity has received all other necessary local and state permits and approvals, and after the implementation of appropriate BMPs to avoid or minimize disturbance of in-place sediments and exceedances of the turbidity criteria. A temporary area of mixing shall be as follows:

(A) For waters up to 10 cfs flow at the time of construction, the point of compliance shall be 100 feet downstream from the activity causing the turbidity exceedance.

(B) For waters above 10 cfs up to 100 cfs flow at the time of construction, the point of compliance shall be 200 feet downstream of the activity causing the turbidity exceedance.

(C) For waters above 100 cfs flow at the time of construction, the point of compliance shall be 300 feet downstream of the activity causing the turbidity exceedance.

Conservation Measure 4

During Phase I construction, while the temporary gravity bypass pipeline connected to the conveyance pipeline is in use, monitoring, capture, and release all bull trout in the sand settling basin will be done in accordance with the procedures outlined in Term and Condition 4 of the USFWS (2011, p. 157) Biological Opinion for the Operations and Maintenance of the LNFH (**Appendix F**).

Conservation Measure 5

Should a gray wolf den or rendezvous site be located within one-quarter mile of project disturbance activities, Reclamation would implement an April 1 to June 1 timing restriction for project activities within one-quarter mile of all active gray wolf den and rendezvous sites.

Conservation Measure 6

The construction contractor will provide worker environmental training for all project workers and staff to inform personnel of the regulatory compliance requirements and responsibilities for conserving environmental resources. This program would include, but not be limited to, special status species information and conservation, worker compliance responsibilities, noncompliance penalties, and BMPs and conservation measures such as project speed limits, weed control, avoidance of wildlife buffers, species reporting, debris control, and hazardous waste management.

Chapter 4. Status of Listed Species and Critical Habitat

4.1 Bull Trout

In 1999, the USFWS listed all US populations of bull trout as a threatened species under the ESA (64 *Federal Register* 58910, November 1, 1999). The 1999 listing applied to one distinct population segment of bull trout within the United States by including bull trout in the Coastal-Puget Sound populations and Saint Mary-Belly River populations, with previous listings of three separate distinct population segments in the Columbia River, Klamath River, and Jarbidge River basins (63 *Federal Register* 31647, June 10, 1998; 64 *Federal Register* 17110, April 8, 1999; USFWS 2015a). In recognition of available scientific information relating to their uniqueness and significance, six segments of the United States population of the bull trout are considered essential to the survival and recovery of this species and are identified as recovery units: Coastal, Klamath, Mid-Columbia, Columbia Headwaters, Saint Mary, and Upper Snake

Detailed discussions of bull trout conservation needs, life history, diet, reproductive biology, population dynamics, and genetic and phenotypic diversity are included in the USFWS (2011) Biological Opinion for the Operations and Maintenance of the LNFH (see Section III, Status of the Species; Consultation 13260-2011-F-0048/13260-2011-P-0002).

Detailed discussions of the environmental baseline for bull trout are included in the USFWS (2011) Biological Opinion for the Operations and Maintenance of the LNFH (see Section IV, Environmental Baseline).

The sections below describe the status of the species and current condition of habitat in the Action Area.

4.1.1 Status of the Species in the Action Area

A summary of the status of the species in the Action Area is described below. The Action Area is in the Columbia River recovery unit, Wenatchee core area, and Icicle Creek local population. These are also briefly summarized below.

Mid-Columbia River Recovery Unit

The Action Area, on Icicle Creek, is in the Mid-Columbia recovery unit (Mid-C RU) for bull trout. The Mid-C RU comprises 24 bull trout core areas, as well as two historically occupied core areas and a research needs area. Major drainages in the Mid-C RU include the Methow River, Wenatchee River, Yakima River, and others (USFWS 2015a). The Mid-C RU can be divided into four geographic regions. These geographic regions are composed of neighboring core areas that share similar bull trout genetic, geographic (hydrographic), and/or habitat characteristics. The Action Area is in the Upper Mid-Columbia, which includes all core areas that flow into the Columbia River above its confluence with the Snake River.

The Mid-C RU also includes seven segments of shared foraging, migration, and overwintering (FMO) habitat that are outside core area boundaries; however, they may be used by bull trout originating from multiple core areas. These include the Mid-Columbia River and other rivers (see Figure C-1 in USFWS 2015a). FMO habitat is defined as relatively large streams and mainstem rivers, including lakes or reservoirs, estuaries, and nearshore environments, where subadult and adult migratory bull trout forage, migrate, mature, or overwinter. This habitat is typically downstream from spawning and rearing habitat; it contains all the physical elements to meet critical overwintering, spawning, migration, and subadult and adult rearing needs. While year-round occupancy by bull trout in the seven shared FMO habitat segments in the Mid-C RU is possible, stream temperatures are often prohibitive during the warmest times of the years; thus, occupancy is more common from late fall through late spring.

In the Upper Mid-C RU, core areas are distributed along the eastern side of the Cascade Mountains in central Washington. This area contains four core areas (Yakima, Wenatchee, Entiat, and Methow), the Lake Chelan historic core area, and the Chelan River, Okanogan River, and Columbia River FMO habitat areas. The core area populations are generally considered migratory, though they currently express both migratory and resident forms. Movement patterns within the core areas; between the lower river, lakes, and other core areas; and between the Chelan, Okanogan, and Columbia River FMO habitat areas occurs regularly for some of the Wenatchee, Entiat, and Methow core area populations. This type of connectivity has been displayed by one or more fish, typically in non-spawning movements within FMO habitat.

Wenatchee Core Area

The Action Area is in the Wenatchee core area. Seven local populations of bull trout are distributed throughout the Wenatchee core area, including the Icicle Creek local population (**Figure 2**, below). Fluvial, adfluvial, and resident life history strategies are all present in this core area, and the migratory form (i.e., fluvial and adfluvial) is present in every local population in this core area; thus, it represents one of the most diverse assemblages of local populations in the geographic area (USFWS 2015b, p. C-317; Barrows et al. 2016, p. 70). Adult and subadult bull trout move seasonally throughout the Wenatchee core area using the full length of the Wenatchee River and both natal and non-natal tributaries (Barrows et al. 2016, pp. 70–71). Bull trout from local populations in the lower basin (Chiwaukum, Icicle, and Peshastin Creeks) show a preference for the mainstem Wenatchee and Columbia Rivers for FMO habitat, based on radiotelemetry studies (Kelly Ringel et al. 2014).

An estimated small percentage (15 to 20 percent) of bull trout from most local populations in the Wenatchee core area migrates long distances and into other core areas (e.g., Methow, Entiat, and Yakima) for foraging and overwintering; they may migrate back to spawning areas annually, semiannually, or every few years (USFWS 2015b, p. C-317). In the Wenatchee core area there is good connectivity among most local populations (Kelly Ringel et al. 2014); however, the distribution of the migratory (i.e., fluvial and adfluvial) life history is unevenly distributed in the core area, and low flow and physical barriers exist in Icicle Creek and other location populations for at least part of the year.

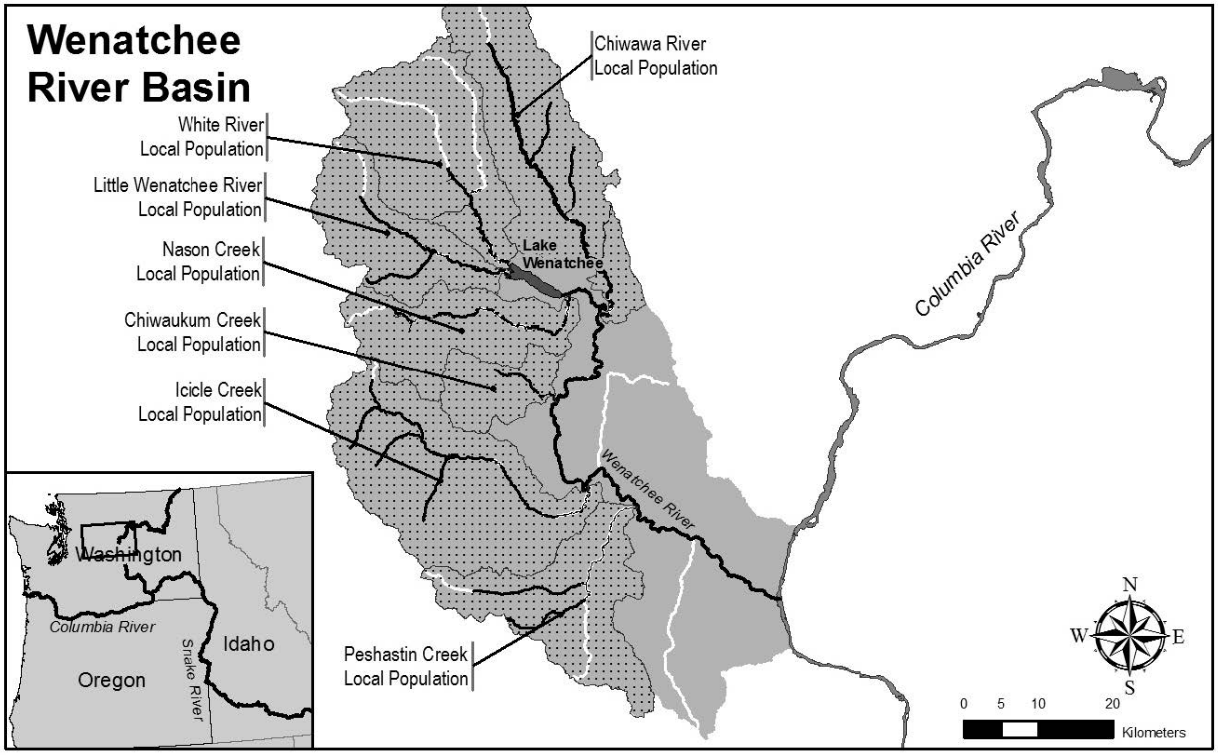

Figure 2. Map of Bull Trout Local Populations in the Wenatchee Core Area

Natural variability in fish populations can occur from year to year based on factors such as streamflow, weather patterns, and partial barriers (e.g., beaver dams and log jams) or complete barriers (e.g., dewatered reaches) that may redistribute spawning bull trout. Bull trout are particularly susceptible to these factors because they spawn in the late fall when spawning streams are typically at or near seasonal low-flow volume (USFWS 2008, p. 24). Most populations in the core area spawn in the general window of mid-September to mid-October (USFWS 2015b, p. C-317).

The core area encompasses the entire Wenatchee River basin and supports seven local populations. These are in the Chiwawa River (including Chikamin, Phelps, Rock, Alpine, Buck, and James Creeks), White River (including Canyon and Panther Creeks), Little Wenatchee River, Nason Creek (including Mill Creek), Chiwaukum Creek, Icicle Creek (including Icicle, French, and Jack Creeks), and Peshastin Creek (including Ingalls Creek). The gray shaded area is the Wenatchee River basin; the dotted area indicates the subbasins and local populations; black lines represent occupied stream reaches; white lines and gray lines are unoccupied stream reaches (Source: Barrows et al. 2016, p. 72).

Icicle Creek Local Population

Most of the Icicle Creek population of bull trout is resident; the bull trout spawn and rear in tributaries to upper Icicle Creek (upstream of the Analysis Area) and mature and forage throughout Icicle Creek, including in the Analysis Area. They could be present in the Analysis Area year-round. For descriptive purposes in this study, the boulder field at approximately RM 5.6 is considered the division between upper and lower Icicle Creek (Nelson et al. 2009).

Icicle Creek is approximately 32 miles long and drains approximately 137,000 acres of primarily steep mountainous terrain. The measured flow in Icicle Creek ranges from a minimum of 44 cfs to a maximum of 14,100 cfs (Reclamation and USFWS 2018, pp. 43–49). Upper Icicle Creek, upstream of the Action Area, is characterized by steep gradients. The average gradient of the upper stream is nearly 3 percent; the gradient in the lower stream, which includes the Action Area, is 0.17 percent. The stream reach within the Action Area is considered to be FMO habitat; spawning and rearing (SR) habitat for bull trout is not present in the Action Area. SR habitat in Icicle Creek is limited to the upper subbasin, within the national forest and wilderness area, and above the boulder field natural barrier at RM 5.6.

Bull trout population data for Icicle Creek, including within the Action Area, have been documented through redd counts and snorkel surveys. **Table 4** summarizes results of redd count surveys in Icicle Creek between 2008 and 2019. Records of redd surveys, although incomplete and highly variable, indicate that the migratory bull trout are persisting within the lower range of the abundance criterion established by the USFWS for the core area. The mean count of redds in Icicle Creek is 5, while the mean count of redds throughout the Wenatchee core area is 539 (values ranged from 128 to 1,029), indicating that spawning habitat in Icicle Creek is limited compared with other areas of the core area. No redds have been observed in lower Icicle Creek, including in the Action Area. Spawning habitat for bull trout is not present in the Action Area (see **Section 4.1.2**, Current Condition of Habitat in the Action Area). Thus, redd counts in **Table 4** depict the number of redds observed in upper Icicle Creek, outside of the Action Area.

Table 4
Redd Count Survey Results, Icicle Creek

Year	Count of Redds[1,2]
2008	8
2009	3
2010	2
2011	4
2012	2
2013	2
2014	—
2015	2
2016	0
2017	0
2018	—
2019	—

Source: USFWS 2020a

Notes:
[1] Not all redd counts were complete, and the length of stream surveyed and number of survey reaches have varied. A dash (—) indicates no survey was conducted.
[2] Redds are in upper Icicle Creek, outside of the Action Area.

Table 5 summarizes unpublished results of bull trout snorkel surveys conducted by the Hatchery in Icicle Creek between 2011 and 2018. Surveys were conducted in the last week in July or first week in August.

Table 5
Bull Trout Snorkel Survey Results Summary, Icicle Creek

Year	Boulder Field to LNFH Intake		LNFH Intake to Structure 2		Historical Channel (Structure 2 to Structure 5)		Structure 5 to Icicle Creek Mouth	
	Total Observed	Size Range (millimeter [mm])	Total Observed	Size Range (mm)	Total Observed	Size Range (mm)	Total Observed	Size Range (mm)
2018	3	350–430	5	150–330	9	210–450	33	250–450
2017	4	190–410	8	210–510	2	250–470	15	250–630
2016	8	170–470	4	270–330	3	250–610	16	170–310
2015	26	230–750	3	310–610	0	—	52	250–630
2014	4	130–650	6	250–490	30	70–350	23	210–510
2013	8	310–650	3	230–450	1	610	14	110–490
2012	3	190–410	2	350–450	5	350–510	10	190–350
2011	0	—	0	—	12	170–450	11	210–450
Total	**56**		**31**		**62**		**174**	

Source: USFWS 2020b

Although the Icicle Creek bull trout population contains both resident and migratory fish, it is the smallest of all seven populations in this core area. It is the only local population that has been reproductively isolated from the metapopulation for the majority of the time due to human-made barriers at LNFH since about 1940, such as the surface water intake diversion dam, other flow management structures (Brown 1992; WDFW 1998; USFWS 2011), and other natural (i.e., boulder field), thermal, or low-flow barriers. Multiple age classes of resident-sized bull trout have been observed in upper Icicle Creek, indicating that bull trout successfully spawn in the Icicle Creek basin. However, due to the LNFH barriers that likely prevented migratory bull trout access to spawning areas in Icicle Creek, all reproduction in the Icicle Creek bull trout local population since 1940 likely depended on small, resident-only life history form (USFWS 2011). Passage opportunities improved in 2001, when the LNFH changed hatchery operations to provide improved upstream passage conditions for bull trout (USFWS 2011).

In recent years (2001, 2006, and 2007, and possibly 2002 and 2004), some migratory-size bull trout passed upstream of the LNFH. Spawning by migratory bull trout has occurred in the upper Icicle Creek since 2008, indicating that recent changes to LNFH operations have provided improved passage opportunities (USFWS 2011).

Nelson and DeHaan (2015) analyzed bull trout genetic samples collected from Icicle Creek, assigned them to the local population of origin, monitored passive integrated transponder-tagged bull trout to investigate subadult movements and timing, and determined whether subadult bull trout are able to access FMO habitat upstream of the LNFH. The authors found that bull trout in Icicle Creek were assignable to eight local populations from three core areas: Chiwaukum, Chiwawa, Icicle, Nason, Etienne, and Ingalls Creeks of the Wenatchee core area; upper Entiat River of the Entiat core area; and Gold Creek of the Methow core area. Nelson and DeHaan (2015) also found that approximately 85 percent of sampled bull trout in Icicle Creek were less than 450 millimeters in length and categorized them as subadults. Using genetic stock identification, Nelson and DeHaan (2015) determined that subadult bull trout that migrated upstream past the LNFH intake diversion dam (the low-head diversion dam) came from six local populations. This demonstrated that some fish passage occurs during existing flow conditions during at least some of the migration season.

Anglin et al. (2013) assessed fish passage for a number of species, including bull trout, associated with a range of Icicle Creek streamflows, including at Structure 2, Structure 5, and structures at the intake (low-head diversion dam and fish ladder/sediment sluice). The authors found that unique conditions associated with each of the structures or locations resulted in variable limitations on fish passage, including for subadult and adult fluvial bull trout. Additional discussion is included in **Section 4.2.1**, Current Condition of Habitat in the Action Area (see *Physical barriers* discussion).

4.1.2 Current Condition of Habitat in the Action Area

Following is a discussion of the current habitat conditions within the Action Area in Icicle Creek. Conditions in other portions of Icicle Creek or the Wenatchee core area are referenced for context where needed. The current condition of habitat is summarized generally, and then evaluated in terms of the USFWS Matrix of Pathways and Indicators (MPI; Table 1 in USFWS 1998). The objective of the MPI is to integrate the biological and habitat conditions to arrive at a determination of the potential effect of land management activities on a proposed or listed species. Indicators are assessed according to the condition levels in the matrix: "functioning appropriately," "functioning at risk," and "functioning at unacceptable risk." The definitions of these condition levels vary by the indicator being assessed, and are available in Table 1 in USFWS 1998.

General Icicle Creek Habitat Description

There are approximately 2.2 miles of instream (aquatic) habitat in the Action Area, which extends from RM 2.3 to RM 4.5. Instream habitat includes the combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources (WDFW 2008). In its approximately 31-mile entirety, Icicle Creek provides important, high-quality, and relatively undisturbed instream habitat for a variety of anadromous and resident fish. However, aquatic habitat quality in lower Icicle Creek (which includes the Action Area) is considered impaired due to previous land uses, such as forestry practices, private land development in the historical floodplain and riparian zone, roads, and agriculture. The installation of dams and diversions has created passage barriers, decreased flows, altered instream morphology and floodplain function, degraded water quality, and caused overall instream habitat degradation (Chelan County and Ecology 2019; NMFS 2017a). Water diversions can also reduce flow in the lower reaches to very low levels during summer and early fall, which may impede upstream bull trout passage to access spawning and rearing habitat in the upper subbasin (Chelan County and Ecology 2019).

Since construction of the LNFH in 1941, Icicle Creek has been split into two distinct channels at a point just upstream of the LNFH. At the upper end of the historical channel, a headgate (Structure 2) controls flow into an artificially excavated canal (i.e., Hatchery channel) or the historical channel, or both. At high flows, most of the Icicle Creek flow goes through the Hatchery channel. At low flows, most of the water flows in the historical channel. Over time, the historical channel has evolved from a riverine system to a wetland, as sediment has accumulated and vegetation has encroached because of reduced flows (USFWS 2002, pp. 3–4).

In the Action Area, two instream structures (Structure 2,at RM 2.8 and Structure 5 at RM 3.8) are used during Hatchery operations and broodstock collection. Operation of these structures periodically limits fish passage on Icicle Creek. Currently, operation of Structures 2 and 5 may limit fish passage during spring and early summer when broodstock collection for LNFH occurs (beginning as early as June 3). Structure 5 is closed once a 50-fish "trigger" has been hit or low Chinook returns warrant a closure. This also prohibits non-Hatchery fish from moving upstream of the LNFH during this time. Until such time, Structure 5 remains open to fish passage (NMFS 2017a). Structure 2 is reopened by June 24, and Structure 5 is reopened by July 7, restoring passage opportunities between RM 2.8 and 3.8 (USFWS 2011). Operation of Structure 2 can also limit passage by decreasing flows in this reach when the gates are closed to divert water into the Hatchery channel (Chelan County and Ecology 2019).

The boulder field at RM 5.6, upstream of the Action Area, also serves as a natural barrier under typical flow conditions; thus, it limits upstream fish passage above the Action Area. At the existing intake facilities, the low-head diversion dam diverts water from Icicle Creek to the intake channel, through an unscreened diversion. The diversion sediment sluice has been modified to function as a fish ladder; however, fish passage is impeded because current flows at the fish ladder/sediment sluice do not meet guidelines for fish attraction. Fish passage is impeded during low flows in particular. There is also the potential for entrainment of fish at the unscreened, existing intake facilities.

In the Action Area, Icicle Creek is characterized by steep slopes on both banks. Vegetation on the banks of Icicle Creek is primarily upland vegetation and shrub habitat (USFWS 2016). Thus, aquatic habitat within the channels essentially transitions to upland habitats with little to no intermediate riparian vegetation or floodplain. This, combined with high water fluctuations throughout the year (flows varying from less than 100 cfs to over 14,000 cfs), limits establishment of mature riparian vegetation. There is also limited streambank complexity in the Action Area, with few slow-moving pools with overhanging banks. Stream velocities and substrate limit production of the macroinvertebrate community and do not offer significant foraging opportunity for fish species. Suitable spawning gravel, cobble patches, and substrate are not common within the Action Area, and much of the substrate is embedded with fine sediment or armored. This makes it unsuitable spawning habitat.

As discussed in **Section 4.1.1**, Status of the Species in the Action Area, most bull trout in Icicle Creek are residents. They spawn and rear in tributaries to upper Icicle Creek (upstream of the Analysis Area) containing high-quality SR habitat, and they mature and forage throughout Icicle Creek, including in the Analysis Area, which is FMO habitat. They could be present in the Analysis Area year-round, as could subadults from other local populations. Migrants from other local populations from three core areas may also be seasonally present in the Action Area during upstream movements to SR habitat in upper Icicle Creek.

Climate change effects (e.g., elevated temperatures and changes in precipitation patterns) are expected to shift the hydrograph, so peak flows occur earlier in the year, with low-flow periods spanning more of the summer months. These changes in streamflow are expected to affect aquatic habitat conditions and fish passage (Chelan County and Ecology 2019). Also, water temperature may increase as water input from snowmelt decreases and input from rain increases, due to climate change. See the *Climate Change* section, below, for a more detailed description of the impacts of climate change on habitat conditions in the Action Area.

Water Quality

Temperature

High and low temperature extremes occur in all reaches of Icicle Creek. Water temperatures are highest in August. Water temperatures in summer months can exceed 59 degrees Fahrenheit (ºF; 15 degrees Celsius [ºC]); during the winter temperatures, water temperatures can fall below 34ºF (1ºC) (WRWSC 1998). Temperatures as high as 70ºF (21ºC) have been recorded in Icicle Creek (Mullan et al. 1992). A Forest Service (1994) stream survey conducted from August 13 to October 17 in upper Icicle Creek, upstream of the Action Area, reported a maximum temperature of 64ºF (18ºC) and a minimum of 47ºF (8ºC) with temperatures in RM 4.8 to RM 17 not meeting Forest Plan standards.

On the Ecology current water quality assessment (Chelan County and Ecology 2020), Icicle Creek has a Category 4a listing (already has an Environmental Protection Agency (EPA)-approved total maximum daily load (TMDL) plan in place and implemented) for temperature. The Category 4a temperature listings occur at various locations in Icicle Creek, including downstream of Snow Creek (RM 5.7, upstream of the Action Area) and two areas downstream of the Action Area (downstream of the East Leavenworth Road Bridge at approximately RM 2.3 and upstream of the Icicle Creek confluence with the Wenatchee River). The temperature listings are being addressed by Ecology's Wenatchee River Watershed Temperature TMDL Water Quality Improvement Report (July 2007; Chelan County and Ecology 2019). In addition, there are multiple Category 2 (some evidence of a water quality problem, but not enough to show persistent impairment) listings for Icicle Creek. Two Category 2 listings for temperature occur in locations both immediately upstream of and within the Hatchery channel, in the Action Area.

The USFWS Mid-Columbia Fish & Wildlife Conservation Office has monitored water temperatures at several locations in Icicle Creek between 2005 and 2016 to monitor effects of Hatchery operations on Icicle Creek water temperatures (Fraser 2017). Monitoring locations range from the IPID diversion (approximately RM 6.0), on Snow Creek above its confluence with Icicle Creek at RM 5.7, to the mouth of Icicle Creek at the Wenatchee River (RM 0). Monitoring locations in the Action Area are at the existing intake facilities, at Structures 2 and 5, and at the spillway pool. During the warm summer months Icicle Creek water typically warms as it moves downstream, with two exceptions: the Snow Creek confluence and the Hatchery spillway pool.

During the summer months, Icicle Creek receives supplemental water from a diversion drawing cold water from the bottom of Snow Lake. This water flows down Snow Creek before joining Icicle Creek at RM 5.7. In 2016, before supplemental flows began, Snow Creek temperatures (measured above its confluence with Icicle Creek) had a high 7DADMax[8] of 1.7°C warmer than Icicle Creek. Once supplemental flows began, water temperatures in Snow Creek dropped to 0.8°C cooler than Icicle Creek, and continued to drop throughout the period of supplementation. The largest water temperature difference between Snow Creek and Icicle Creek was 5°C and occurred on August 15, 2016 (Fraser 2017). Where this cooler water joins Icicle Creek, the overall temperature of Icicle Creek is locally cooled. Bull trout tend to concentrate in this area during supplementation flows, which may be due to the presence of cooler water.[9]

The Hatchery spillway pool receives Hatchery effluent river water mixed with well water. As a result of cool well water additions, the pool is typically cooler than Icicle Creek in this vicinity. In 2016, the pool recorded a high 7DADMax that was on average 1.8°C cooler than in Icicle Creek directly upstream of the spillway pool, which had a high 7DADMax of 66.7°F (19.3°C) (Fraser 2017).

In 2016, monitored water temperatures in Icicle Creek were slightly above the mean of the last 11 years (Fraser 2017). Downstream monitoring sites in Icicle Creek were warmer than more upstream sites with the exception of two locations: immediately downstream of the Snow Creek confluence and at the Hatchery spillway pool; the reasons were discussed above. The lowest temperatures recorded in 2016 were due to the influence of Snow Creek supplementary flows. The warmest site on Icicle Creek in 2016 was at Structure 5.

The results of surface water temperature monitoring from 2019 at the existing intake facilities are summarized in **Figure 3**, Icicle Creek Surface Water Temperatures, LNFH Intake, 2019. Surface water temperatures reached a maximum of 70.5°F (21.4°C) on June 29, 2019. The minimum recorded temperature was on November 20, 2019, when temperatures dropped to 31.1°F (-0.5°C).

The available information on water temperatures in the Action Area indicates that this indicator is functioning at unacceptable risk, in terms of the USFWS MPI (Table 1 in USFWS 1998). This is because temperatures in areas used by adults during migration regularly exceed 59ºF (15ºC).

Sediment and turbidity

The timing and volume of flows along Icicle Creek influence the potential for localized flooding and erosion. In general, the Icicle Creek subbasin is adapted to a range of flow rates, with higher flows in the winter and spring, and lower flows in the late summer and early fall. Under typical conditions, minor streambank erosion occurs in a manner typical to stream systems with peak spring flows resulting in increased stream turbidity. During years when precipitation is higher than average, increased creek flows may contribute to increased localized flooding, erosion, and stream turbidity. Areas with a higher risk of flooding include areas along the banks and floodplain of Icicle Creek from the boulder field at RM 5.6 to the City of Leavenworth (Chelan County and Ecology 2019); this reach includes the entirety of Icicle Creek in the Action Area.

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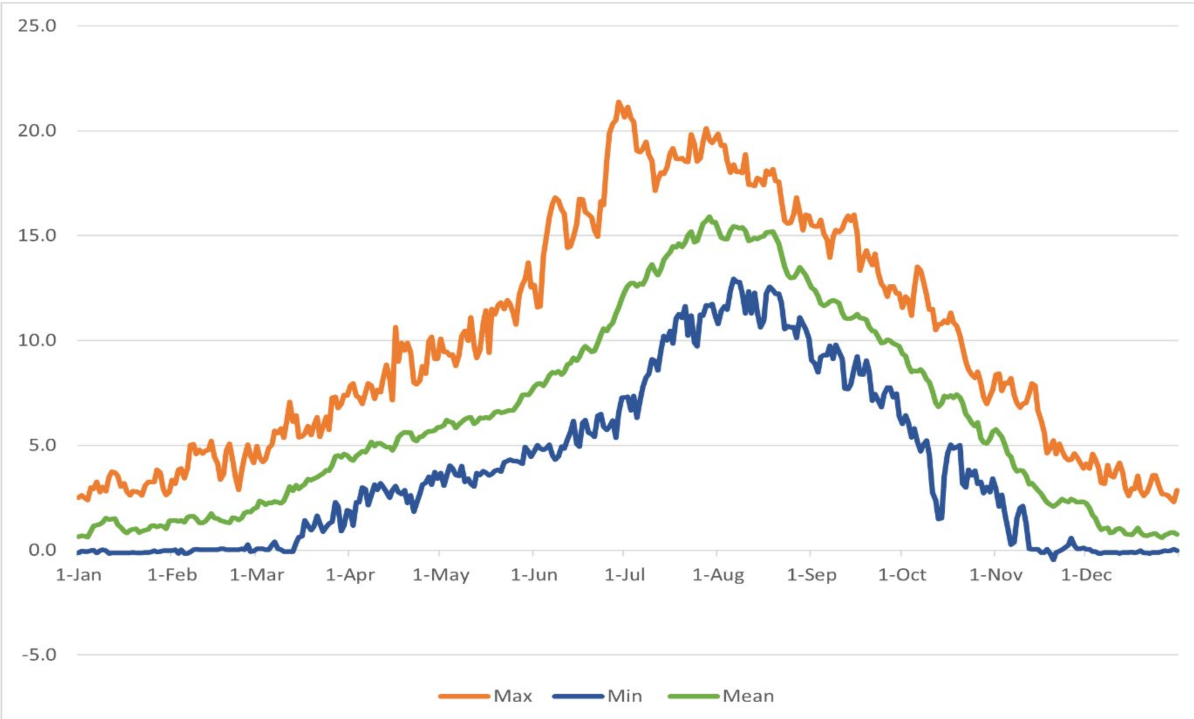
[8] 7-day average of the daily maximum temperatures. The high 7DADMax is the mean of seven consecutive daily maximum temperatures calculated using the day's daily maximum temperature with the daily maximum temperatures of the 3 days prior and the 3 days after.

[9] Video conference between C. Raekes, USFWS, and M. Trieger, EMPSi, on October 2, 2020.



Source: USFWS 2020c

Figure 3. Icicle Creek Surface Water Temperatures, LNFH Intake, 2019

There are no measured sediment load data for the Action Area, but literature, bed-material samples, and anecdotal observations can be used to characterize sediment in Icicle Creek in the vicinity of the existing LNFH intake facilities. Lorang (2005) estimated the mean annual sediment load on Icicle Creek incoming to the LNFH ranges from 3,900 to 5,900 cubic yards (3,000 to 4,500 cubic meters) per year, about the size of an Olympic-sized swimming pool. This estimate assumed that measured sediment deposition behind constructed dams at the LNFH represents the total incoming sediment load, which may underrepresent the actual load, particularly for fine-grained sediment (silt and clay) (Reclamation 2020).

High sediment loads occur, and have historically occurred, throughout the Icicle Creek subbasin. All of the dominant land types in the Icicle Creek watershed have high sediment delivery hazards; background hill slope erosion rates for the watershed are high and estimated to total over 4,500 tons per year (Forest Service 1995). Sediments are filling pools and embedding channel substrates, particularly in the lower, depositional reach of Icicle Creek, including within the Action Area. USFWS biologists conducted five particle size assessments using the Wolman pebble count procedure (Wolman 1954) as part of a stream restoration project below the LNFH in 1998 and 1999, partially within and downstream of the Action Area. The amount of substrate less than 2 millimeters in size ranged from 13 to 32 percent with an average of 24 percent in 1998, and 6 to 26 percent with an average of 18 percent in 1999. Additionally, a few pebble counts were conducted in the lower reach. Substrate less than 2 millimeters in size in these patches ranged from 3 to 9 percent.

Sediment in spawning gravels in upper Icicle Creek, outside the Action Area, was not assessed during the Forest Service (1994) stream survey; however, high sediment delivery rates were reported in a majority of the upper reaches surveyed. The surveyors also reported that sedimentation appeared to be a problem throughout the system. USFWS biologists conducted four pebble counts in the upper reaches of the Icicle Creek in 1999 during a spawning gravel survey. The amount of substrate less than 2 millimeters in size recorded in these counts ranged from 0 to 15 percent.

The limited information on sediment in the Action Area indicates that this criterion is functioning at unacceptable risk (USFWS 1998).

Chemical contamination and nutrients

On the Ecology current water quality assessment (Chelan County and Ecology 2020), Icicle Creek has several Category 4a listings (already have an EPA-approved TMDL plan in place and implemented), including for dissolved oxygen and potential of hydrogen (pH). The Category 4a listings for dissolved oxygen and pH occur downstream of the East Leavenworth Road Bridge and upstream of Icicle Creek's confluence with the Wenatchee River; this reach is immediately downstream of the Action Area. The Icicle Creek Hatchery channel, in the Action Area, is also listed as a Category 4a water for dissolved oxygen. These impairments are being addressed under Ecology's Wenatchee River Watershed Dissolved Oxygen and pH TMDL Water Quality Improvement Report (Revised August 2009) and its associated addendum (March 2012; Chelan County and Ecology 2019).

There are multiple Category 2 (some evidence of a water quality problem, but not enough to show persistent impairment) listings for Icicle Creek. There are seven Category 2 listings for dissolved oxygen, upstream and within the Hatchery channel and upstream of the East Leavenworth Road Bridge, within the Action Area. As with the Category 4a listings, areas of low dissolved oxygen are being addressed under Ecology's Wenatchee River Watershed Dissolved Oxygen and pH TMDL Water Quality Improvement Report (Revised August 2009) and its associated addendum (March 2012; Chelan County and Ecology 2019).

The LNFH has a National Pollution Discharge Elimination System (NPDES) permit to discharge wastewater from the Hatchery into Icicle Creek (NPDES Permit WA0001902). The Hatchery outfall is located at RM 2.7 (Chelan County and Ecology 2019), in the Action Area. The EPA's effluent charts on the Enforcement and Compliance History Online website present dynamic charts and tables of permitted limits, reported releases (discharge monitoring reports), and violations over time for Clean Water Act wastewater discharge permits issued under the NPDES (EPA 2020a). Over the past 3 years, effluent discharge violations had a severity of "Significant/Category 1 noncompliance" for total phosphorus. Facilities identified in Category 1 noncompliance are typically those facilities with the most serious violations of their permit effluent limits in terms of duration, frequency, and magnitude; other permit requirements; or enforcement order (EPA 2020b).

Icicle Creek is very sensitive to any addition of nutrients, especially phosphorus. Although phosphorus levels are relatively low, they are consistently too high to meet the pH water quality standards. Operational changes at the LNFH have taken place; compared with the 2002 concentrations, a decrease in phosphorus concentration in the discharge was observed in 2007. The final mass-loading effluent limit for total phosphorus, on all outfalls at the LNFH, comes directly from the wasteload allocation assigned to the LNFH in Ecology's Wenatchee River Watershed Dissolved Oxygen and pH TMDL Water Quality Improvement Report (revised August 2009) and its associated addendum (March 2012). The maximum daily total phosphorus limit is 1.15 pounds (0.52 kilograms) per day and applies March 1 to May 31 and July 1 to October 31 each year (Reclamation and USFWS 2018).

The limited information available indicates that this criterion is functioning at unacceptable risk (USFWS 1998) because high levels of excess nutrients (phosphorus) are present in the Action Area.

Habitat Access

Physical barriers

The construction of the LNFH and continued development in the Icicle Creek basin has exacerbated aquatic habitat and fish passage issues (Chelan County and Ecology 2019; NMFS 2017a). Anglin et al. (2013) assessed fish passage for a number of species, including bull trout, associated with a range of Icicle Creek streamflows, including at Structure 2, Structure 5, and structures at the intake (low-head diversion dam and fish ladder/sediment sluice). The authors found that the unique conditions associated with each of the structures or locations resulted in variable limitations on fish passage.

Currently, operation of LNFH Structure 5 may limit fish passage during spring and early summer when broodstock collection for the LNFH occurs (mid-May through June; NMFS 2017a), which overlaps with the mean peak upstream migration period for bull trout (June 22 to August 2, based on an 8-year study; Nelson 2008). This time period also overlaps with downstream migration of juvenile bull trout, which typically occurs on the rising limb of the spring (May–June) and fall (September–October) freshets (Wydoski and Whitney 2003) and with adult and subadult downstream migration after foraging April to December (Anglin et al. 2013). Operation of Structure 2 can also limit passage by decreasing flows in the reach between RM 2.8 and RM 3.8 when the gates are closed to divert water into the Hatchery channel (Chelan County and Ecology 2019).

For instance, subadult bull trout upstream passage at Structure 2 is limited or not possible most of the year, except during October when the 90 percent exceedance flow dips to 59 cfs. For fluvial adult bull trout, there are windows during certain time periods when passage is not limited, based on flow conditions in Icicle Creek (Anglin et al. 2013, p. 58). For Structure 5, upstream passage is not a limiting factor during the higher flow months of April through July, though upstream passage for fluvial bull trout was limited at median and lower flows, and ceases in September at the lowest flows (Anglin et al. 2013, p. 60).

Current streamflow in Icicle Creek during low-flow periods is too low for reliable fish passage at the existing LNFH intake facilities. At the existing intake facilities, the low-head diversion dam diverts water from Icicle Creek to the intake channel, through an unscreened diversion. The primary passage issues at the LNFH intake are the suitability of the pool and fish ladder for upstream passage, passage over the dam itself, and downstream passage routes. The diversion sediment sluice has been modified to function as a fish ladder; however, fish passage is impeded because current flows at the fish ladder/sediment sluice do not meet NMFS guidelines for fish attraction.

Researchers assessed factors of the fish ladder, including the entrance location, attraction flows, transportation channels/pools, weirs between the pools to control hydraulic drop, and an exit at the top (Anglin et al. 2013). They found the head differential between pools was generally within criteria for salmon and steelhead except between two weirs; however, the passage depth over the notches in each weir did not meet criteria for fluvial bull trout. Furthermore, the head differential over the last weir into the river was within the lower end of the recommended range, but the discharge was not sufficient to produce the desired streaming flow recommended by WDFW for fish attraction (Anglin et al. 2013). Fish passage at the existing intake facilities is impeded during low flows in particular.

Anglin et al. (2013, p. 61) found that upstream fish passage at the low-head diversion dam is possible via the existing fish ladder/sediment sluice, but that important aspects of passage conditions are suboptimal. For instance, the fishway is typically partially washed out (i.e., overtopped or subsumed) at flows of approximately 1,200 cfs or greater, and weirs that facilitate upstream passage in the fish ladder/sediment sluice are typically removed for sediment flushing at this and higher flows. Fluvial bull trout could be moving upstream during the time period that the fishway is washed out, but passage directly over the dam is possible at these higher flows. At lower flows less than 1,000 cfs when the fishway is no longer washed out, fluvial bull trout could also be moving upstream.

The most significant issue for upstream passage is the fish ladder entrance location and attraction flow (Anglin et al. 2013, p. 62). Fish ladder discharge is related to attraction flow. The entrance location is out of any direct flow paths that migrating fish would likely be following when they approach the dam. There is very shallow water at lower flows and an abundance of boulders that obstruct a direct route to the fish ladder entrance from downstream. Attraction flow is nonexistent. Average velocity near the entrance was less than 1.0 foot per second during one survey at a fishway flow of approximately 4.5 cfs, and less than 0.5 feet per second during a second survey at a fishway flow of approximately 0.75 cfs. These velocities and flow rates are not sufficient to attract fish without significant searching.

There is also the potential for entrainment of anadromous and resident fish at the existing unscreened intake. From 2011 to 2019 between March and November, a total of 63 bull trout were salvaged from the sand settling basin with 84 percent of bull trout salvaged between July and October (Potter 2019).

Upstream of the Action Area there is a natural passage barrier at the boulder field at RM 5.6. The boulder field limits upstream fish passage to over 20 miles of potentially suitable bull trout habitat in the upper Icicle Creek subbasin. Migratory bull trout need to negotiate high spring and summer flows in lower Icicle Creek to approach the boulder field during pre-spawning migrations. Then bull trout encounter the receding end of the hydrograph, which drops rapidly into impassable low-flow periods at the boulder field, shortening the tail end of their migration timing window (Dominguez et al. 2013). The Boulder Field Project (see **Section 2.1**) began construction in June 2020 to improve fish passage at this high-priority barrier. Once this project is complete in October 2020, there should be greater access to quality bull trout FMO and SR habitat upstream of the Action Area. However, downstream barriers, discussed above, could still limit bull trout habitat access to upstream FMO and SR habitats.

The available information indicates that this criterion is functioning at risk (USFWS 1998) in the Action Area because there are barriers present that limit fish passage under certain flow conditions.

Habitat Elements

Substrate embeddedness

As discussed under *Sediment and turbidity*, high sediment loads occur, and have historically occurred, in Icicle Creek. All the dominant land types in the Icicle Creek watershed have high sediment delivery hazards. Background hill slope erosion rates for the watershed are high and estimated to total over 4,500 tons per year (Forest Service 1995); sediments are filling pools and embedding channel substrates, especially in the lower, depositional reach of Icicle Creek, including in the Action Area. Visually assessed substrate embeddedness in the lower reaches of Icicle Creek is greater than 30 percent. The Forest Service (1994) Icicle Creek stream survey of stream reaches in the upper watershed, outside of the Action Area, reported that all reaches had embedded substrate with the percentage of units embedded per reach ranging from 31 to 100 percent. The limited, available data indicate that this criterion is functioning at unacceptable risk (USFWS 1998) in the Action Area. This is because embeddedness is greater than 30 percent.

Large, woody debris

The presence of large, woody debris is limited in the Action Area. Urbanization and road building in the lower reaches of Icicle Creek, including in the Action Area, have reduced the riparian zone in structure and function. The Wenatchee River Watershed Steering Committee (WRWSC) (1998) estimates that 11 percent of the riparian vegetation along the lower portion of Icicle Creek, below the LNFH, has been removed for housing developments. As a result of riparian vegetation reductions, inputs of large, woody debris in the Action Area are lacking. Overall, the available information indicates that this criterion is functioning at risk (USFWS 1998) in the Action Area because potential sources of long-term woody debris to meet minimum values are lacking.

Pool frequency and quality

The wetted width of lower Icicle Creek in the Action Area ranges from 40 to 65 feet. Nine pools per mile are recommended for streams this wide. Recommended pool frequency is likely present where cascade and boulder drops are present in limited portions of the Action Area. For instance, immediately downstream of the existing LNFH intake facilities, a natural boulder drop of about 2 to 3 feet is present with a deep, 3-foot scour hole formed from the hydraulic drop over the boulders (Reclamation 2020). The channel profile consists of numerous runs and riffles with occasional shallow pools. The channel bed consists of large boulders and bedrock armor with sand, gravel, and cobble deposits.

Recommended pool frequency is likely not present in the lower depositional reach of the Icicle Creek Action Area. The limited number of pools that do exist are deep (greater than 3.3 feet); however, there is no cover for fish other than depth and turbulence. Lower Icicle Creek lacks features such as woody debris and large boulders that function in pool creation and maintenance. Pool volume has been reduced by deposition of fine sediments. Summer pool water temperatures are not known, but temperatures in excess of 70ºF (21ºC) have been reported for Icicle Creek (Mullan et al. 1992).

The available information indicates that this criterion is functioning at risk (USFWS 1998) because recommended pool frequency is likely present in portions of the Action Area; but, in other portions of the Action Area, there has been a reduction in pool function.

Large pools

Few large pools with residual depths greater than 3.3 feet (1 meter) deep exist in the Action Area. The spillway pool is one such pool. This criterion is functioning at risk (USFWS 1998).

Off-channel habitat

Off-channel habitat in lower Icicle Creek and the Action Area is limited mainly by residential development and road construction. Wetland habitats in the Icicle Creek historical channel, in the vicinity of the LNFH, provide habitat functions typically provided by off-channel habitat. No other off-channel habitat, such as side channels, backwater areas, ponds, wetlands, or oxbows, are present in the Action Area. This criterion is functioning at risk (USFWS 1998).

Refugia

In the Action Area, summer cool-water refugia for bull trout may be provided in the spillway pool, as water temperatures are lowered by the addition of Hatchery effluent, which contains cool groundwater well water. Similarly, supplementary flows from Snow Lake that enter Icicle Creek via Snow Creek may also provide cool-water refugia while supplemental flows are in effect during summer months. This is upstream of the Action Area. The available information indicates that this criterion is functioning at risk in the Action Area (USFWS 1998) due to the presence of potential cool-water refugia in the spillway pool.

Channel Condition and Dynamics

Width/depth ratio

Rivers and streams act as indicators of environmental stress when sediment supply and channel adjustments occur due to deforestation, changes in vegetation composition, urbanization, road building, and other watershed activities that cumulatively affect river and stream systems. For example, in the lower reach of Icicle Creek in the Action Area, channel features are not being maintained over time, and deposition and erosion are occurring, which are causing the reach to be in a state of flux. This instability is a result of Icicle Creek adjusting to natural and human impacts to achieve a stable dimension, pattern, and profile that are in equilibrium with its gradient, sediment supply, and discharge (USFWS 2011).

Data on width/depth ratios have not been fully documented in Icicle Creek, including for the Action Area reach. However, available information suggests that channel width/depth ratios in lower Icicle Creek, in the Action Area, are increasing and entrenchment ratios are decreasing in response to increases in sediment supply, decreases in riparian vegetation structure and function, and changes in flow regime. Consequently, the creek is becoming shallower and wider (USFWS 2011). The limited, available information indicates that this criterion is functioning at risk (USFWS 1998).

Streambank condition

Urbanization, livestock grazing, and road building in the lower part of Icicle Creek have reduced the riparian zone in structure and function, including in the Action Area. Many large areas of the stream's banks were eroded during the 1995/96 winter floods (WRWSC 1998), though it is likely that most of these areas have recovered in the intervening time. In the proposed intake construction area at the Hatchery's existing intake facilities, streambanks are generally stable. As described under *Sediment and turbidity*, the Icicle Creek subbasin is adapted to a range of flow rates, with higher flows in the winter and spring, and lower flows in the late summer and early fall. Under typical conditions, minor streambank erosion occurs in a manner typical to stream systems with peak spring flows resulting in increased stream turbidity. During years when precipitation is higher than average, increased creek flows may contribute to increased localized flooding, erosion, and stream turbidity. Available information indicates that this criterion is functioning appropriately (USFWS 1998).

Floodplain connectivity

Previous land uses, such as forestry practices, private land development in the historical floodplain and riparian zone, road construction, and agriculture, have occurred in the Action Area. The installation of dams and diversions has decreased flows and altered instream morphology and floodplain function (Chelan County and Ecology 2019; NMFS 2017a). Off-channel habitat in lower Icicle Creek is limited mainly by residential development and road building. In the Action Area, available information indicates that this criterion is functioning at risk (USFWS 1998).

Flow/Hydrology

Change in peak and base flows

Surface flows of Icicle Creek are continuously measured at a US Geological Survey (USGS) gauge station (#12458000) located at RM 5.8, about 1.3 RMs upstream of the Action Area. This gauging station is located upstream of all water diversions. This is the only consistently monitored flow data available for Icicle Creek. Clarkin (2019) conducted a detailed hydrologic analysis for Icicle Creek, accounting for various diversions and reintroduction of water in the intervening drainage area. Mean daily flows peak during snowmelt months in late spring and can drop quite low in fall and winter months. The maximum recorded discharge at the USGS gauge was 19,800 cfs in 1995; the minimum recorded discharge was 44 cfs in November 1936. Another large flood occurred in 2006 with a reported peak of 15,700 cfs.

Since 1905, the discharge of Icicle Creek has been altered by water diversions, which can reduce the flow in the lower reaches to very low levels during the summer and early fall (WRWSC 1998). Water in Icicle Creek is over-allocated (USFWS 2011). Four water users divert up to 174 cfs from lower Icicle Creek: the City of Leavenworth (3 cfs year-round since 1912) and the IPID (117 cfs during the irrigation season since 1910) divert water at RM 5.7, and the LNFH (42 cfs year-round since 1942) and COIC (12 cfs during the irrigation season since 1905) divert water at RM 4.5 (at the existing LNFH intake facilities). Irrigation diversions can remove 48 percent and 79 percent of the mean August and September flows, respectively (Mullan et al. 1992). Water rights at the diversion at RM 5.7 total just over 120 cfs. The IPID uses its water right of just over 117 cfs generally from mid-April through late September or October. The City of Leavenworth diverts from a separate intake on the opposite bank; its water right is about 3 cfs year-round. The other diversion is at RM 4.5, where total water rights at two diversions equal 54 cfs. The LNFH uses 42 cfs of water year-round while the COIC uses 12 cfs of water generally from May through September. Thus, year-round, up to 45 cfs are withdrawn, and generally from May through September up to 174 cfs may be withdrawn (USFWS 2011).

Lower Icicle Creek has a Category 4c listing (impaired by causes that cannot be addressed through a TMDL plan) for instream flow impairment. These conditions are attributed to upstream consumptive uses of water, including streamflow diversions for irrigation, municipal water supply for the City of Leavenworth, and process water supply for the LNFH (Chelan County and Ecology

2019). The NMFS biological opinion for LNFH operations (NMFS 2017a) contains several terms and conditions (2b through 2f, pp. 213–214), including supplementary water releases from the Snow/Nada Lakes basin, and conservation recommendations (C.1 and C7, pp. 219–220) to improve instream flows in Icicle Creek, including to improve streamflow to support habitat for ESA-listed species.

Given evidence of altered flows in the Action Area, and mitigations in place to offset effects of altered flows, this criterion is functioning at risk (USFWS 1998).

Increase in drainage network

No data are available describing increases in the drainage network of Icicle Creek in the Action Area. However, there is a correlation between increases in roads and other hard surfaces, such as buildings, parking lots, and roof tops, and increases in the drainage network. In the Action Area, commercial and residential developments, road construction, and development of other hard surfaces have likely increased runoff into Icicle Creek compared with the historical drainage network conditions. Because the overall significance of potential effects is not known, this criterion is rated functioning appropriately (USFWS 1998).

Watershed Conditions

Road density and location

Road density in the Action Area has not been calculated. For this criterion to be rated as "Functioning Appropriately," there can be no more than 1 linear mile of roads per square mile of catchment area, with no valley bottom roads present. This criterion is likely not met in the Action Area, which contains numerous developed roads in close proximity to Icicle Creek, most of which are near the valley bottom. Observational data indicate this criterion is functioning at unacceptable risk (USFWS 1998).

Disturbance history

Total acreage of disturbance in the Action Area has not been calculated. The Icicle Creek subbasin has a long history of human impacts beginning with sheep herding and mining in the late 1800s. Recent uses include timber harvest, road building, fire suppression, campground development, private residences, commercial development, and recreation, including in portions of the Action Area. Available information indicates this criterion is functioning at risk (USFWS 1998) in the Action Area.

Riparian conservation areas

The structure and function of the Icicle Creek riparian zone has been reduced throughout the watershed, including in the Action Area. Riparian vegetation has been reduced and removed as a result of urban and commercial development, roads and trails, timber harvest, campground development, and other human impacts. In affected areas, cover from shade and large, woody debris recruitment has been reduced. In many affected areas, especially along roads, invasive weeds (i.e., knapweed) have been established. In the proposed intake construction area at the Hatchery's existing intake facilities, riparian vegetation is sparse, consisting of a few deciduous shrubs and trees, with additional conifers in upland areas. Riparian function in this area is generally low, though some shading and woody debris inputs are present. The limited, available information indicates this criterion is functioning at risk (USFWS 1998) in the Action Area.

Disturbance regime

In the Action Area, flooding is the primary source of natural disturbance. Additionally, wildfires in the upper Icicle Creek watershed (especially in 1994, 2001, and 2004) have burned about 25,000 acres (20 percent) of the watershed. Landslides (notably in 1999, 2008, and 2011) are also sources of environmental disturbance (USFWS 2011). The flow regime of Icicle Creek is variable and flashy (see discussion under *Change in peak and base flows*). The maximum recorded discharge at the USGS gauge was 19,800 cubic cfs in 1995, and the minimum recorded discharge was 44 cfs in November 1936. Another large flood occurred in 2006 with a reported peak of 15,700 cfs. LNFH personnel noted that another large flood occurred in 1990, but a measured peak value is not available (Reclamation 2020). Available information indicates this criterion is functioning at risk (USFWS 1998) in the Action Area.

Integration of species and habitat conditions

There is insufficient information on the characteristics of the Icicle Creek bull trout subpopulation to reliably assess a population trend. Records of redd surveys, although incomplete and highly variable, indicate the migratory bull trout are persisting within the lower range of the abundance criterion established by the USFWS for the core area. As described in more detail in **Section 4.1.1**, Wenatchee Core Area, and **Section 4.1.2**, Icicle Creek Local Population, there are bull trout exhibiting both resident and fluvial life history strategies in Icicle Creek, and bull trout from other core areas (e.g., Methow, Entiat, and Yakima) have been detected in Icicle Creek. This indicates that connectivity with other core areas exists. In the Wenatchee core area there is good connectivity among most local populations (Kelly Ringel et al. 2014); however, the distribution of the migratory life history is unevenly distributed in the core area, and low flow and physical barriers exist in Icicle Creek and other location populations for at least part of the year. Also, several substantial, natural obstacles to fish passage occur in Icicle Creek, including in the Analysis Area. This criterion is considered functioning at risk (USFWS 1998) in the Action Area.

Climate Change

During the past 100 years, the Pacific Northwest has become warmer and wetter (Mote and Salathé 2010). Global climate models indicate a continuation of this trend. Temperatures are projected to continue to increase in the Pacific Northwest region, along with small increases in precipitation, shifts in the seasonality of precipitation, and increased high precipitation events; however, to what degree depends on projections based on low, medium, or high greenhouse gas emission scenarios (CIG 2009).

Climatic changes are likely going to decrease the snowpack in the Cascade Range, with earlier snowmelt. The Climate Impacts Group indicated in its 2009 Washington Climate Change Impacts Assessment that probable impacts are as follows: a decreased April 1 snowpack by as much as 40 percent in the 2040s, reduced reservoir storage, and increased stream temperatures. These climate changes could result in the Wenatchee River Watershed transitioning from a snow-dominant watershed to a rain/snowmelt transient watershed by the 2040s. There would be less snowpack, earlier run off, and more precipitation falling as rain (Tohver 2016). These future conditions are anticipated in the Icicle Creek subbasin as well.

Clarkin (2019) reviewed available predictions on climate change relative to streamflow on Icicle Creek. The available information suggests that spring flows will happen earlier in the year with drier summers; peak flows will be wetter, and droughts will be drier.

As described in the *Icicle Creek Water Resources Management Strategy Final Programmatic EIS* (Chelan County and Ecology 2019), changes in climate are projected to have substantial impacts on streamflow in Icicle Creek. By 2030 under low and high greenhouse gas scenarios, higher average monthly flows are projected from December through April, with lower average monthly flows from May through November. Low flows are projected to be lower than what has been observed historically. Average peak flows are projected to occur in mid-April instead of in June, when the average peak flow has historically occurred. These trends are expected to become more extreme in the second half of the century. Systems may become flashier, with lower low flows and higher peak flows. Because runoff in Icicle Creek is projected to increase in the early part of the water year (October 1 to September 30) due to the warmer winters, less water would be available instream during critical low-flow months (Chelan County and Ecology 2019). Current streamflow in Icicle Creek during low-flow periods is too low for fish passage and habitat availability; it is projected to worsen with climate change impacts.

Bull trout rely on cold water throughout their various life stages. The effects described above would likely cause a reduction in the availability of suitable cold water habitat.

Impacts on hydrology associated with climate change will cause shifts in timing, magnitude, and distribution of peak flows that are also likely to be most pronounced in high-elevation stream basins (Battin et al. 2007; CIG 2009) that currently provide cold water for bull trout spawning and incubation. Although lower-elevation rivers are not expected to experience as severe an impact from alterations in stream hydrology, they are generally not cold enough for bull trout spawning, incubation, and juvenile rearing.

These effects also would likely affect distribution. As suitable areas of cold-water habitat contract, suitable habitat patch size decreases, and connectivity between patches is truncated. Populations that are currently connected may become isolated, either by thermal or physical barriers, which could accelerate the rate of local extinction beyond that resulting from changes in stream temperature alone (Rieman et al. 2007).

It is likely that in the future, the hydrograph of Icicle Creek will change as more precipitation falls as rain and the snowpack in the watershed diminishes. The duration and magnitude of current summer and fall low-flow conditions may increase, as would water temperatures. Currently, water temperatures in many areas of Icicle Creek do not meet bull trout life history requirements. Changes in the hydrograph would also likely limit connectivity with other subpopulations. Bull trout subpopulations in the Wenatchee core area would experience similar circumstances.

4.2 Bull Trout Critical Habitat

Designated FMO critical habitat for bull trout occurs in the Action Area; it includes all areas of Icicle Creek in the Action Area that are accessible to bull trout (75 *Federal Register* 63897). The critical habitat designation for bull trout applies only to the stream channel, as defined by its ordinary high water mark by the USACE at 33 CFR 329.11. The critical habitat proposal does not extend to the floodplain or the adjacent land (USFWS 2010).

The Action Area is located in the Wenatchee critical habitat subunit (CHSU), which is a part of the Upper Columbia River basin critical habitat unit (CHU; Unit 10), designated by the USFWS's October 18, 2010, final rule (75 *Federal Register* 63893). The Upper Columbia CHU is located on the east slopes of the Cascade Range and west of the Columbia River in north-central Washington. Each of the three major drainages in this geographic region, the Wenatchee, Entiat, and Methow, comprise a CHSU designated to support their respective core areas, including spawning, rearing, foraging, migration, and overwintering habitat. The Wenatchee CHSU supports one of the largest populations of bull trout and some of the most connected habitat in CHU 10.

Within designated critical habitat, nine primary constituent elements (PCEs) were determined essential for the physical and biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. The status of each PCE relevant to the Action Area is briefly described below. Terminology from the USFWS MPI (USFWS 1998) is used to summarize the status of each PCE relative to the "crosswalk" developed by the USFWS (Krupka et al. 2011), which shows the relationship between the PCEs of critical habitat and MPI habitat indicators (USFWS 1998).

4.2.1 PCE 1

PCE 1: Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia

As described in *Water Quality* in **Section 4.1.2**, there are multiple Ecology listings for temperature and dissolved oxygen in Icicle Creek, including in the Action Area. Outside the Action Area, Icicle Creek has an Ecology listing for temperature and pH in several locations. Valley bottom development, such as residential, commercial, and transportation (roads) development, affects thermal refugia and water quality through reduced and/or altered riparian vegetation and floodplain processes, interrupted hillslope and valley bottom connectivity, and reduced floodplain connectivity. These alterations likely contribute to the Ecology temperature and dissolved oxygen TMDL. As described in *Habitat Elements* in **Section 4.1.2**, summer cool-water refugia for bull trout may be provided in the spillway pool, and supplementary flows from Snow Lake that enter Icicle Creek via Snow Creek may also provide cool-water refugia while supplemental flows are in effect. Monitoring has shown migratory bull trout use lower Icicle Creek during the summer, likely to exploit foraging conditions and thermal refugia (USFWS 2011).

As described in *Channel Condition and Dynamics* in **Section 4.1.2**, floodplain connectivity in the Action Area is functioning at risk (USFWS 1998) due to residential and commercial development; road building; water diversions and other LNFH operations, including groundwater well recharge; and flow manipulation in the historical channel of Icicle Creek. This can reduce the connections between relatively cooler hyporheic flows with surface waters.

Overall, PCE 1 is not properly functioning in the Action Area.

4.2.2 PCE 2

PCE 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

The construction of the LNFH and continued development in the Icicle Creek basin have exacerbated aquatic habitat and fish passage issues, including in the Action Area (Chelan County and Ecology 2019; NMFS 2017a). As discussed in *Habitat Access* in **Section 4.1.2**, operation of LNFH Structure 5 and Structure 2 can limit passage in the Action Area. Further, streamflow in Icicle Creek during low-flow periods is too low for reliable fish passage at the existing LNFH intake facilities. The Icicle Creek boulder field at RM 5.6, upstream of the Action Area, also serves as a natural barrier under typical flow conditions; thus, it limits fish passage above the Action Area reach, including to higher-quality FMO and SR habitat in the upper Icicle Creek subbasin. The Boulder Field Project will modify this barrier to provide better passage; the target completion is in October 2020.

As described in **Section 4.1.1**, bull trout move seasonally throughout the Wenatchee core area using the full length of the Wenatchee River and tributaries, including Icicle Creek. Bull trout from local populations in the lower basin (Chiwaukum, Icicle, and Peshastin Creeks) show a preference for the mainstem Wenatchee and Columbia Rivers for FMO habitat. In the Wenatchee core area there is good connectivity among most local populations; however, low flow and physical barriers exist in Icicle Creek (see *Habitat Access* in **Section 4.1.2**) and other location populations for at least part of the year.

Within the Action Area, the condition of bull trout FMO habitat has been reduced as a result of development (see PCE 1 discussion). Reduced riparian and floodplain conditions have likely contributed to increased stream temperatures, which may impede migration by posing a thermal barrier. Overall, PCE 2 is functioning at risk.

4.2.3 PCE 3

PCE 3: An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish

Quantitative assessments of the bull trout food base are not available for the Action Area. However, water quality impairments (i.e., temperature and dissolved oxygen) and habitat impairments (reduced large, woody debris and minimal riparian vegetation) likely limit the prey base in the Action Area. Adult bull trout, and to a lesser extent subadult bull trout, likely experience periodic beneficial effects associated with enhanced prey from Hatchery smolt releases. Conversely, juvenile bull trout likely experience short-term adverse effects during releases due to a combination of increased competition for rearing sites and food. However, rearing and release strategies are designed to limit the amount of ecological interactions occurring between the Hatchery and naturally produced fish (USFWS 2011). Overall, PCE 3 is functioning at risk.

4.2.4 PCE 4

PCE 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

As discussed in **Section 4.1.2**, legacy effects from previous land uses in the historical floodplain and riparian zone have altered instream morphology and floodplain function, and degraded water quality, habitat-forming elements, channel dynamics, and hydrology. Vegetation on the banks of Icicle Creek is primarily upland vegetation and shrub habitat. There is limited streambank complexity in the Action Area, with few slow-moving pools with overhanging banks. Suitable spawning gravel/cobble patches and substrate are not common, and much of the substrate is embedded with fine sediment or armored. Riparian vegetation removal has reduced the capacity of the riparian zone to provide most of the functions needed to maintain the integrity of aquatic habitats in the Action Area. PCE 4 is not properly functioning in the Action Area.

4.2.5 PCE 5

PCE 5: Water temperatures ranging from 2 to 15°C (36 to 59°F), with adequate thermal refugia available for temperatures that exceed the upper end of this range

Icicle Creek is water quality impaired for stream temperature, as discussed under *Water Quality* in **Section 4.1.2**. Growth and survival of bull trout can be compromised at temperatures greater than 64.4ºF (18°C; Selong et al. 2001). Temperatures as high as 70ºF (21ºC) have been recorded in Icicle Creek (Mullan et al. 1992). As described in *Habitat Elements* in **Section 4.1.2**, summer cool-water refugia for bull trout may be provided in the spillway pool, and supplementary flows from Snow Lake that enter Icicle Creek via Snow Creek, upstream of the Action Area, may also provide cool-water refugia while supplemental flows are in effect. PCE 5 is not properly functioning in the Action Area.

4.2.6 PCE 6

PCE 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.

Because critical habitat in the Action Area is designated FMO, PCE 6 would not apply to critical habitat in the Action Area. This PCE does not apply and is not discussed further. The Proposed Action would have no effect on PCE 6.

4.2.7 PCE 7

PCE 7: A natural hydrograph, including peak, high, low, and base flows within historical and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph

As described in *Flow/Hydrology* in **Section 4.1.2**, surface flows of Icicle Creek peak during snowmelt months in late spring and can drop quite low in fall and winter months. Since 1905, flows have been altered by water diversions, which can reduce the flow in the lower reaches to very low levels during the summer and early fall. Lower Icicle Creek is listed by Ecology for instream flow impairment.

These conditions are attributed to upstream consumptive uses of water, including streamflow diversions for irrigation, municipal water supply for the City of Leavenworth, and process water supply for the LNFH. Mitigations are in place to offset effects of altered flows from Hatchery operations (NMFS 2017a). PCE 7 is functioning at risk.

4.2.8 PCE 8

PCE 8: Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited

Water quality and quantity impairments in the Action Area are associated with the anthropogenic disturbance history in the Icicle Creek subbasin. As long as floodplain developments remain on the landscape, and hillslope and channel processes affect substrate, recovery of natural processes that regulate and form habitats that contribute to sufficient water quality and quantity for the survival of bull trout may not be fully realized. See also discussions for PCEs 5 and 7. Overall, PCE 8 is not properly functioning.

4.2.9 PCE 9

PCE 9: Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, and 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

Brook trout overlap with bull trout in the Action Area, in the upper Icicle Creek upstream of the Action Area, and in both SR and FMO habitat in other portions of the Wenatchee core area. The presence of brook trout poses a risk of hybridization and competition to bull trout. Genetic analysis has identified brook x bull trout hybrids within the core area; however, the extent of hybridization is not known. In 2007, two fish with a blend of color patterns—suggesting that they were hybrids—entered the LNFH intake, moved through the conveyance pipeline, and were collected alive in the sand settling basin. Confirmed hybridization and movement patterns of this bull trout x brook trout hybrid are described in Nelson et al. (2011). Predicted increases in stream temperature, resulting from climate change (see *Climate Change* in **Section 4.1.2**), can produce favorable conditions for brook trout and nonnative rainbow trout that are more tolerant of warm water. PCE 9 is functioning at risk in the Action Area.

4.3 Gray Wolf

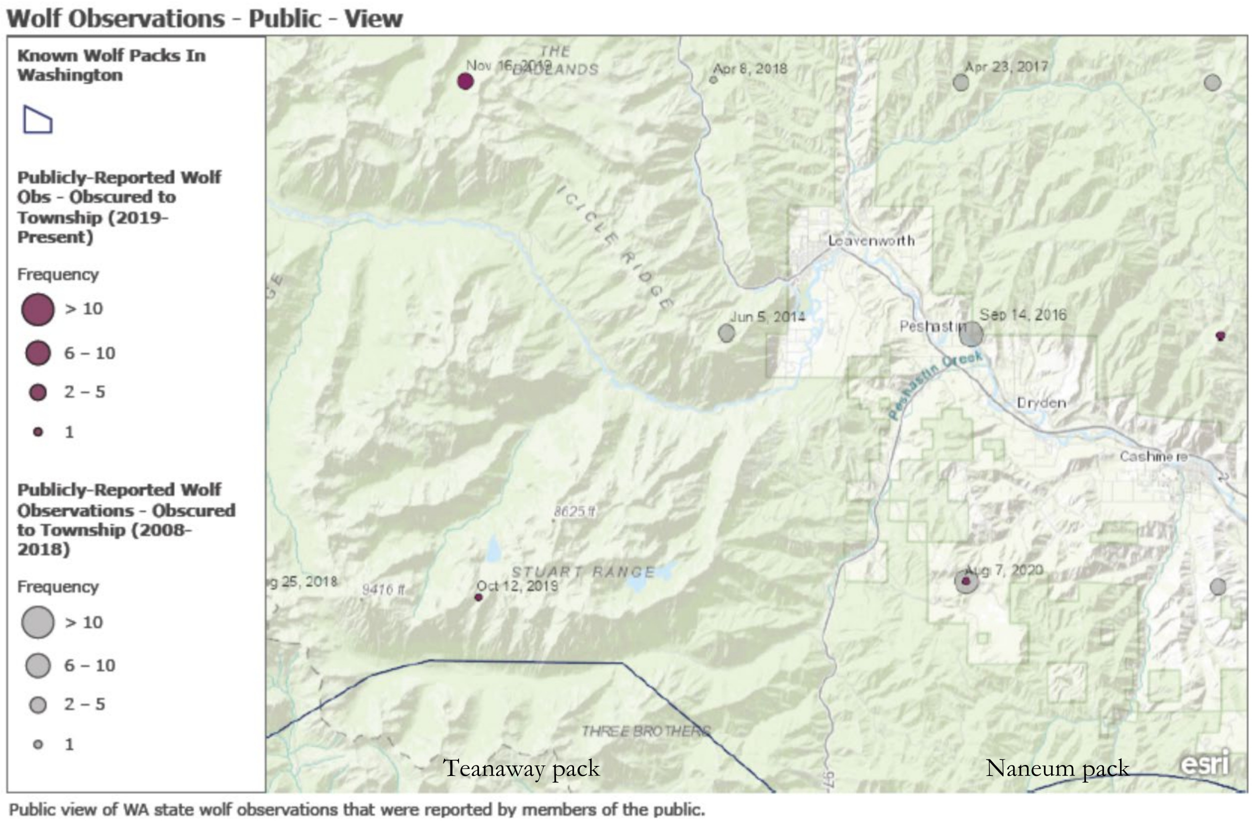
Gray wolves have been classified as endangered in Washington since federal lawmakers enacted the ESA in 1973. In 2011, the USFWS delisted gray wolves in the eastern third of the state due to recovery, but retained it for those in the western two-thirds where the Action Area lies (USFWS 2011). Under Washington state law, wolves were listed as endangered in 1980 for the entire state.

Wolves are generalists in their habitat use. Within their historical geographic distribution, wolves occurred in every habitat with large ungulates, including forests, deserts, prairies, swamps, tundra, and coasts. The majority (77–93 percent) of habitat used by two packs in Washington has been on public land, primarily National Forest System lands (Wiles et al. 2011). The Action Area is in close proximity to residential development, recreation use areas, and roadways. This, along with low-quality disturbed habitats, would likely deter wolves from using the Action Area other than occasional transitions to reach other higher-quality and less human-disturbed habitats.

Historically, gray wolves were common throughout much of Washington, but their numbers declined as the human population increased after 1850. They were thought to be extirpated from Washington by the 1930s due to hunting. People reported seeing wolves sporadically over the next several decades, and reports increased in the 1990s and early 2000s; however, no resident packs were documented until 2008 in Okanogan County in north-central Washington. Wolves that dispersed from growing populations in Idaho, Montana, and British Columbia, Canada, were likely responsible for confirmed reports of wolves in northern Washington after 1990. Since that time, wolves have continued to naturally recolonize the state by dispersing from resident Washington packs and neighboring states and provinces. The greatest threat to gray wolves remains human-caused mortality, including authorized lethal removal due to livestock depredation conflicts.

There are no known den sites or mapped pack polygons in the Action Area. The Action Area is approximately 7.5 miles from the Teanaway pack polygon and 11 miles from the Naneum pack polygon mapped for year 2019 (WDFW GIS 2020). The Naneum wolf pack was confirmed as a pack in 2018. According to the 2019 annual population survey, the pack had a minimum count of three wolves and was not considered a successful breeding pair in 2019 (WDFW et al. 2019). The Teanaway wolf pack was confirmed as a pack in 2011. The pack had a minimum count of six wolves and was considered a successful breeding pair in 2019 (WDFW et al. 2019).

Gray wolves have large territories that support large ungulates averaging about 350 square miles in Washington; individuals will disperse from packs an average of 60 miles with maximum dispersal distances of more than 680 miles (USFWS 2011; Wiles et al. 2011). Large home ranges and dispersals could account for several public sightings of individual wolves in the Action Area vicinity (see **Figure 4,** Gray Wolf Sightings). These sightings are obscured to the center of townships where they were reported. But, sighting notes indicate one wolf was sighted crossing Icicle Creek Road close to Eightmile Campground in 2013, and fresh tracks were noted near Ski Hill in 2018. Both these sightings, indicative of transitory wolf individuals, would be less than 5 miles from the Action Area.



Source: WDFW GIS 2019

Figure 4. Gray Wolf Sightings

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Chapter 5. Effects on Listed Species and Critical Habitat

5.1 Bull Trout

5.1.1 Effects on Bull Trout

Construction-related effects on bull trout are anticipated to occur from one or more effect pathways, including noise and disturbance, fish passage, fish entrainment, and water quality (i.e., sediment and turbidity, and contaminants and spills), as described in the following sections. As discussed in **Section 3.1**, the Proposed Action includes construction of the SWISP Project only, and does not include associated O&M, such as sediment management or management of the proposed fish screens during icing conditions. Therefore, effects from O&M are not included in this analysis.

The potential for construction-related effects on bull trout would occur primarily during the in-water work window of July 1 to November 15, in 2022 and 2023. The potential for effects would be higher as a result of specific activities conducted over specific durations within the in-water work windows. These are described in further detail below. The proposed in-water work window extends beyond the approved in-water work window (July 1 to August 15) for Icicle Creek (USACE 2018). In general, extending the window to include August 16 through November 15 would increase the potential for impacts on bull trout by extending the length of time—by approximately 12 weeks—that in-water work would occur. Long-term beneficial effects to bull trout are expected from improved fish passage opportunities and reduced entrainment through LNFH water intake facilities.

Disturbance, Displacement, Injury, and Mortality

Bull trout in the immediate vicinity of the proposed intake access road may be disturbed by construction of this road. This is because construction will involve breaking bedrock with jackhammers, moving broken rock and boulders, and excavation and filling to the design grade to widen and extend the existing access road. Though this construction will be done outside the Icicle Creek ordinary high water mark, it would be within approximately 10 feet of the ordinary high water mark. As a result, the bedrock geology shared by this construction area and Icicle Creek may nevertheless transfer noise and vibrations into the Icicle Creek water column. Reclamation proposes for this construction to occur from late March to mid-April 2022, though the duration of the activities with the potential to generate the greatest noise and vibration (i.e., breaking and removing bedrock) will likely be limited to a few days within this overall time frame. These activities may occur up to 24 hours per day.

High levels of underwater sound can have negative physiological effects on fish (Hastings and Popper 2005). The severity of the effect depends on physical, environmental, and biological factors, including the sound-generating activity, sound intensity, sound duration, distance of fish from the point of origin, depth of water and the location of the fish in the water column, size of fish, fish species, and ambient noise levels. While sound generated by breaking bedrock to construct the intake access road is not expected to reach intensities associated with blasting or impact pile driving, limited duration behavioral effects (disturbance) resulting from a fish species' startle response may occur. The startle response is observed as an involuntary reaction to an introduced noise disruption that results in a change in an individual's behavior. Bull trout are likely to avoid the construction area and displace into nearby habitat while noise and vibration activities occur.

Because it is not possible to define sound exposure criteria for every possible sound source, type of response, or fish species, recent guidelines for fishes on interim sound exposure criteria are based on research that show a general correlation between the extent of effects and the cumulative level of sound energy to which fish were exposed (Popper et al. 2014; Andersson et al. 2017; Popper and Hawkins 2019; Popper et al. 2019). For species that rely on particle motion detection (such as bull trout), cumulative sound exposure levels of 203 dB (or greater than 207 dB peak) may result in recoverable injury, while cumulative sound exposure levels of greater than 186 dB may cause temporary threshold shifts (Popper et al. 2014; Andersson et al. 2017; Popper and Hastings 2019). At the closest distance of 50 feet from the creek, noise from the use of various construction equipment under the proposed action (e.g., jackhammers, pneumatic tools) would range from 76 to 98 dB (see Table 5 in the SWISP Project EIS Noise and Vibration Resource Report). Therefore, Project noise would likely not be of an intensity that would cause physiological damage or temporary threshold shifts (Popper and Hawkins 2019; Popper et al. 2019). However, fish near the noise source (within tens of meters) may be at moderate risk of sound masking and high risk of behavioral responses (Popper and Hawkins 2019; Popper et al. 2019). As described in **Section 3.1** (see *Phase I*), the noise level of the pneumatic tool used at the intake construction area is approximately 85 dBA at 50 feet from the source. At 200 feet from the source, this noise level is expected to attenuate to approximately 73 dBA (Table 6 in the SWISP Project EIS Noise and Vibration Resource Report). Reclamation measured ambient noise levels during EIS preparation (Table 4 in the SWISP Project EIS Noise and Vibration Resource Report), which range from 62 dBA to 72 dBA in the Project vicinity. Thus, noise levels from jackhammer use may approximately equivalent to the high-range of ambient levels along approximately 400 linear feet of Icicle Creek (200 feet both upstream and downstream of this location). As a result, bull trout are likely to avoid the construction area (up to 400 linear feet of Icicle Creek) and displace into nearby habitat while noise and vibration activities occur. They may also experience masking of biologically relevant sounds. As a result, there may be a slight decrease in utilization of FMO habitat and slight increase in competition in nearby habitat during jackhammer use for intake access road construction, which is anticipated to be a few days in duration in March or early April 2022.

Placement of cofferdams A, B, and C, to isolate the in-water work area, and their subsequent removal, would also temporarily disturb nearby bull trout individuals due to noise and vibration. Noise and vibration will be generated by scraping, removing, and leveling substrate materials with an excavator within Icicle Creek to prepare the cofferdam footprint area (this activity will also result in impacts from elevated turbidity, as discussed under *Sediment and Turbidity* below). Jackhammers would not be used during this activity. Noise and vibration will also be generated by placement of filled geo-bags in Icicle Creek to construct the cofferdams. As described in **Table 2**, cofferdams will isolate between 0.4 and 0.3 acres below the Icicle Creek ordinary high water mark each (this includes the actual footprint of the cofferdam itself, as described in **Table 3**), or a total of approximately 1 acre. Each of the three cofferdams is anticipated to take between 10 and 14 days to install and between 3 and 5 days to remove. Durations that each cofferdam will be installed are in **Table 3**.

Disturbance and displacement effects on bull trout, as described above, could result from noise and vibration during cofferdam A, B, and C placement in July or August, and removal in October or

November. Entrainment records show the greatest amount of bull trout in the Action Area in July (14 individuals over a 9-year period from 2011 to 2019), but records did not detect any individuals from 2011 to 2013 or from 2016 to 2019. In 2015 entrainments had the highest total of all years with 12 bull trout observed in July that year. Over the past 9 years, November has had less entrainments with four bull trout (two in 2012 and two in 2017) (USFWS 2020b).

If needed, hand-building of the straw bale and Visqueen cofferdam to isolate the PISMA sluiceway pipe work area would result in negligible sound and vibration disturbance effects on bull trout; however, fish salvage from within the isolated area would have effects, as described below.

Bull trout may be stranded inside the work areas established by cofferdam placement. Per Conservation Measure 1, the USFWS Mid-Columbia Fish & Wildlife Conservation Office would capture and remove bull trout (and other fish species) stranded inside the work area. Handling activities, even when accomplished carefully and efficiently, are likely to result in sublethal adverse effects (abrasions and stress) to all bull trout handled (USFWS 2011). To minimize harm from capture, handling, and relocation into Icicle Creek during this process, fish salvage activities would be done in accordance with the USFWS (2012) Recommended Fish Exclusion, Capture, Handling, and Electroshocking Protocols and Standards for Bull Trout (**Appendix E**). Adherence to the protocol will minimize, but not avoid, effects of handling, which can include physiologic stress and risk of injury. Up to four fish salvage events may be needed, as summarized in **Table 2**. Should a dewatered work area become inundated during the course of construction activities, dewatering activities will take place again, following the same protocols as initial dewatering activities.

The use of block nets (seine and dip nets) to catch and remove fish from cofferdam footprint area would affect those fish that are caught. The main effect would be increased physiologic stress and potential for minor injury from netting and handling; this would be less detrimental than if fish were left in the area, in which case they could be injured or killed from scraping boulders in the streambed out of the way to put in cofferdams. As described above, all fish salvage activities, including netting, would be conducted by the USFWS Mid-Columbia Fish & Wildlife Conservation Office.

There would be a minor, but not insignificant, chance that some fish may be stranded in the cofferdam placement area after block nets are installed. In these cases, stranded fish could be injured or killed (e.g., from crushing) during preparation of the cofferdam footprint area. The types of activities that may impact fish include scraping, removing, and leveling of substrate materials with an excavator within Icicle Creek.

Breaking apart the existing large boulder to facilitate its removal from the intake construction area, and partially demolishing existing intake facilities using a 30-pound pneumatic tool, will generate impact sounds, which result from a rapid release of energy when two objects hit one another (Hastings and Popper 2005). Generally, impact sound propagates in the air; when impact sounds are generated in water, sound waves and vibration will also propagate into the surrounding water. High levels of underwater sound can have negative physiological effects on fish (Hastings and Popper 2005). The severity of the effect depends on physical, environmental, and biological factors, as described above, including the sound-generating activity (such as pile driving or explosive detonation).

While sound generated by the pneumatic tool is not expected to reach intensities associated with blasting or impact pile driving, some nonlethal physiological effects on bull trout could occur if individuals were present in or near the work area. Because fish would be removed from the dewatered work area behind the cofferdam in accordance with Conservation Measure 1, effects on fish in the immediate work area are not anticipated. This is because this area will be dewatered and the fish will be salvaged prior to construction, and all fish salvage activities would be conducted by qualified biologists from the USFWS Mid-Columbia Fish & Wildlife Conservation Office, in accordance with the USFWS (2012) Recommended Fish Exclusion, Capture, Handling, and Electroshocking Protocols and Standards for Bull Trout (Appendix E). As described below, however, effects on fish in the Icicle Creek water column may occur as a result of demolition.

As described above, sound levels experienced by fish would likely be of intensities that would cause behavioral effects and possible sound masking (Popper and Hawkins 2019; Popper et al. 2019). Short of direct injury or mortality, hydroacoustic pressure can result in limited-duration behavioral effects (disturbance) resulting from a fish species' startle response, as described above. Such behavioral effects on bull trout outside of the dewatered work area could occur during demolition. This is because sound waves and vibration from work in this area are expected to propagate into the Icicle Creek water column via the air, and also via the bedrock and boulder substrate of the streambed. Effects would be temporary, lasting the duration of the noise-generating demolition activity (e.g., during use of the pneumatic tool or heavy machinery in the dewatered work area). Demolition would begin in late July 2022 and last approximately 1 month. It could occur 24 hours per day. The amount of noise and vibration that propagates into the Icicle Creek water column would likely be partially muffled by needing to travel through the dense, compacted sand and gravel cofferdam. At their bases, cofferdams are anticipated to be approximately 12 feet wide. The noise level would also depend on the distance of the noise source from the Icicle Creek water column; the noise level of the pneumatic tool is approximately 85 dBA at 50 feet from the source (see Table 6 in the SWISP Project EIS Noise and Vibration Resource Report). These activities are likely to result in sublethal avoidance and displacement of bull trout into available nearby habitat of Icicle Creek while noise and vibration activities occur, as described above. Fish within tens of meters of the construction area (both upstream and downstream of the construction area) are anticipated to have a moderate likelihood of experiencing masking effects and a high likelihood of experiencing behavioral effects (Popper and Hawkins 2019; Popper et al. 2019). While demolition is ongoing, there may be a slight decrease in utilization of FMO habitat and a slight increase in competition in nearby habitat.

Sounds generated by general construction activities in the dewatered work areas during formwork, reinforcement, pouring concrete, and placing boulders for the roughened channel may also result in similar disturbance and displacement effects on nearby bull trout in the Icicle Creek water column. Effects are expected to be of lower intensity than those resulting from demolition, as generated noises are expected to be of lower intensity. However, effects are not anticipated to be insignificant. These effects are expected to occur on a more or less continuous basis while construction is ongoing over the two in-water work window seasons in 2022 and 2023. Fish within tens of meters of the construction area (both upstream and downstream of the construction area) are anticipated to have a moderate likelihood of experiencing masking effects and a high likelihood of experiencing behavioral effects (Popper and Hawkins 2019; Popper et al. 2019).

Sound generated by sump pumps used to dewater the cofferdammed work areas may also result in temporary behavioral effects, such as avoidance of the immediate area around the cofferdam, while pumping is ongoing. This is because sound waves and vibration from pumping would propagate into the Icicle Creek water column via the air and also via the pump intake within the water column. Effects would be temporary; they would last the duration of pumping, which is expected to be over 1 to a few days during initial cofferdam work area dewatering after cofferdams are built. Intermittent to daily pumping over the duration of cofferdam installation may also need to occur to remove nuisance water that seeps into the dewatered work area. Effects are expected to result in bull trout avoidance of the area and displacement into other areas of Icicle Creek, as described above.

Sounds generated by sump pumps used for the temporary Hatchery water supply of 40 cfs during Phase I construction, and 20 cfs during Phase II construction, may also result in temporary behavior effects, as described above. Phase I pumping will occur at the spillway pool for an approximately 1-week period in mid-July 2022, and another 1-week period in early November 2022, while the gravity bypass pipeline/conveyance pipeline connection point is made and removed. Phase II pumping will occur between approximately April 17 to May 20 in 2022, 2023, and 2024. This will be needed when lining the conveyance pipeline with CIPP and when pipeline interconnections are underway. Pumping will occur 24 hours per day. Fish within tens of meters of the pump intakes are anticipated to have a moderate likelihood of experiencing masking effects and a high likelihood of experiencing behavioral effects (Popper and Hawkins 2019; Popper et al. 2019).

Use of hot air blowers to dry out the existing pipeline prior to lining it with CIPP would also generate noise that could potentially disturb bull trout. The noise level experienced by bull trout would depend on the distance of the hot air blower from the creek, and would range from 115 dBA at 5 feet from the source to 54.79 dBA at 5,120 feet from the source. Disturbance would most likely occur when the hot air blowers are used at CUA 2, which is the closest to Icicle creek. At this CUA, the hot air blower will likely be used within 50 feet of the creek. At this distance, noise from the hot air blower would attenuate to approximately 95 dBA (see Table 7 in the SWISP Project EIS Noise and Vibration Resource Report). At 640 feet from the source, this noise level is expected to attenuate to approximately 73 dBA, which is one dBA higher than the higher-range of ambient noise levels in the Project vicinity (see Table 4 in the SWISP Project EIS Noise and Vibration Resource Report). Thus, noise levels from hot air blower use may be over ambient levels along approximately 1,280 linear feet of Icicle Creek (640 feet both upstream and downstream of this location). As a result, bull trout are likely to avoid the CUA 2 construction area (up to 1,280 linear feet of Icicle Creek) and displace into nearby habitat while the blower is in use. As a result, there may be a slight decrease in utilization of FMO habitat and slight increase in competition in nearby habitat during hot air blower use, which is anticipated to be up to 6 hours (not after 10:00 p.m.) in April or May 2024. All other CUA locations are significantly more inland from Icicle Creek, such that noise experienced by bull trout is expected to have insignificant effects.

Because Phase I construction could occur up to 24 hours per day, Reclamation expects nighttime construction. Nighttime construction lighting used in the intake construction area may depress or alter bull trout movements and behavior in the vicinity of the intake construction area. Water depths in the vicinity of the intake construction area are generally shallow, as the channel profile consists of numerous runs and riffles with occasional shallow pools. Relatively deeper water (between 1 and 2 meters deep) is present upstream of the existing low-head diversion dam, and immediately downstream of the existing intake facilities, a natural boulder drop and relatively deep (about 1 meter) scour hole is present (Reclamation 2020). It is expected that construction lighting will penetrate to the stream bottom in the immediate vicinity of the intake construction area. These effects are expected to occur on a more or less continuous basis while nighttime construction is ongoing over the two in-water work window seasons in 2022 and 2023.

Bull trout in the cofferdam footprint areas may be injured or killed from crushing or other physical injury sustained during preparation of the streambed for cofferdam placement or in placing the cofferdams. As described above, most bull trout are expected to temporarily avoid these activities due to noise and vibrations generated during the construction; however, the potential for injury or mortality is not discountable. The potential for this effect would be during streambed preparation and cofferdam placement in July 2022 (cofferdam A) and July and August 2023 (cofferdams B and C; see **Table 2**).

To minimize the potential that bull trout in the Icicle Creek water column are injured or killed due to being impinged on the exterior faces of the cofferdams while the cofferdams are installed in Icicle Creek, exterior cofferdam walls will be smooth and free of joints. The potential still exists that bull trout may become impinged or otherwise entrapped in the cofferdam structure or appurtenances. If impinged or entrapped fish are observed during regular visual inspections of the cofferdams by the construction contractor, this will be reported immediately to Reclamation. Reclamation would notify the USFWS, and USFWS staff will investigate the reason for impingement or entrapment. The contractor will implement any mitigation measures developed by USFWS Ecological Services, in consultation with Reclamation, to reduce or prevent further impingement or entrapment.

Bull trout that become entrained in the gravity bypass pipeline during Phase I construction may be injured or killed by injuries sustained during transportation in the conveyance pipeline to the sand settling basin. This effect is described in further detail under *Fish Entrainment* below.

Fish Passage

Currently, fish passage is impeded because the location of current flows at the fish ladder/sediment sluice does not adequately attract upstream-moving fish, as discussed in **Section 4.1.2** (see the *Physical barriers* discussion). The Surface Water Intake Screening and Fish Passage 2D Hydraulic Modeling Report (Reclamation 2020) analyzed hydraulic conditions at the proposed low-flow boulder weir fishway and roughened channel. Anticipated flow velocities and depths are described in **Section 3.1** (see *Phase I*).

The fishway will provide adequate upstream passage between flows of approximately 75 to 401 cfs, meeting both depth and velocity criteria. This would be an improvement over current passage conditions, especially at lower flows, as described in **Section 4.1.2** (see *Physical barriers*). This indicates that passage for upstream-migrating bull trout will be improved during upstream migration periods in the fall.

At the fishway exit into the upstream pool, depth over the roughened channel crest is 0.4 feet at 75 cfs. The hydraulic drops between all pools in the low-flow fishway meet criteria and do not exceed 1 foot high. Velocities within the fishway pools meet velocity criteria of 3 feet per second. The average velocity through the fishway at 75 cfs is 2.5 feet per second, with zones of recirculation behind the boulder weirs. There would be minimal flow residence time (approximately 1 minute) and therefore minimal impact on warming water temperature as flow passes through the steep (5.5 percent grade) roughened channel (Reclamation 2020).

Although velocity criteria are not met for flows over 401 cfs, hydraulic conditions in the proposed roughened channel would likely be similar to the natural channel of Icicle Creek. Even at 1,600 cfs, a considerable portion of the roughened channel was below the 3 foot per second velocity criterion. However, at these discharges it is likely that upstream migrating fish will be using low-velocity routes along the roughened channel margins, as they are required to in portions of the natural channel. Further, there are slower velocities throughout the roughened channel created in areas where large (5 to 8 foot diameter) rocks will create hydraulic roughness. The un-grouted portions of the roughened channel are expected to adjust over time and develop more variability likely to support improved fish passage conditions (Reclamation 2020).

Anglin et al. (2013) notes that the existing fish ladder is partially washed out at flows of approximately 1,200 cfs or greater and "…fluvial bull trout… could be moving upstream during the time period that the fishway is washed out, but passage directly over the dam is possible at these higher flows [up to 2,600 cfs]." With the improved design of a roughened channel, fish passage at higher flows should be improved over existing conditions. While the roughened channel does not meet the 3 feet per second criteria for the entire length at flows greater than 906 cfs, there are multiple slower velocity zones created by the placed boulders that create velocities equivalent or slower than adjacent reference areas in Icicle Creek (Reclamation 2020).

Temporary effects on fish passage during construction are discussed in further detail in the following paragraphs.

During the 2022 in-water work window from early July to mid-November, cofferdam A will constrict the width of Icicle Creek and concentrate flows in the south half (stream right when looking downstream) of Icicle Creek. Fish passage during the in-water work window would be maintained over the greatest stream width as possible, while maintaining minimum depth of water at 0.8 feet during construction (see BMPs in **Appendix D**). Nonetheless, this constriction may potentially improve passage opportunities around cofferdam A during the low-flow period by increasing water depths in the remaining channel width; this would, therefore, improve opportunities for upstream and downstream movement of fish. This potential beneficial effect may be partially offset if bull trout avoid the construction area during periods of noise-generating demolition or construction, as discussed above. This may affect resident bull trout, those migrating upstream to spawn, or those migrating downstream after spawning, depending on the timing of the noise-generating activity.

When the cofferdams are removed at the end of the 2022 in-water work window, fish passage would likely be improved over existing conditions, as discussed in **Section 5.1.2** (see the *Habitat Access* discussion). This is due to the notch that will be cut in the low-head diversion dam during the 2022 in-water work window, reducing its height and allowing more fish to pass over this barrier. It is also due to a reduction in the overall stream width. The stream width would be reduced because the intake structures (composed of the screens and facilities at the IO&MA) would be in place after the 2022 in-water work window. This may have the effect of deepening the water in the remaining width of Icicle Creek during the low-flow period, which is similar to how cofferdam A would do so during the 2022 in-water work window.

During the 2023 in-water work window, first the low-flow fishway would be constructed, then the roughened channel would be constructed. Similar to above, the presence of cofferdams B and then C may improve temporary fish passage. This is because Icicle Creek flows would be concentrated, increasing depths in the remaining channel width. As above, this potential beneficial effect may be partially offset if bull trout avoid the area during periods of noise-generating construction.

Fish Entrainment

The screened intake will prevent bull trout entrainment in the water delivery system when the screens are in use. The Surface Water Intake Screening and Fish Passage 2D Hydraulic Modeling Report (Reclamation 2020) analyzed hydraulic conditions at the proposed fish screens. The recommended sweeping velocity of 0.8 feet per second for the proposed cylindrical screens (with an approach velocity of 0.4 feet per second) will be achieved for an estimated 89 percent of annual flow conditions, or all flows greater than or equal to 100 cfs. It is not achieved for low flows (less than 100 cfs) which is expected to be for, on average, 11 percent of the year. The creek-width roughened channel creates an artificially slow backwater pool, but this pool is necessary to meet fish screen submergence criteria and generate enough head to conduct gravity fed diversion to the LNFH. If downstream migration occurs during flows less than 100 cfs, the fishway has been designed such that if the fish stays within the main current, it is expected to be transported directly toward the low-flow fishway, and away from the fish screens. Further, the modeled exposure time along the screens at the critical design low flow is less than 60 seconds for all months evaluated (Reclamation 2020).

Temporary, construction-related entrainment effects are discussed in the following paragraphs.

During Phase I construction from early July to early November 2022, the temporary Hatchery water supply of 40 cfs via the gravity bypass pipeline would divert water from Icicle Creek and deliver it to the existing conveyance pipeline below the intake facilities. The gravity-fed bypass intake would be unscreened, meaning that bull trout individuals could be entrained in the gravity bypass pipeline. Entrained individuals would be carried via the gravity bypass pipeline and existing conveyance pipeline to the sand settling basin on the LNFH grounds. Because the gravity-fed diversion would be in Icicle Creek for most of the 2022 in-water work window, this may affect resident bull trout, those migrating upstream to spawn, or those migrating downstream after spawning.

Per Conservation Measure 4, while the gravity-fed diversion is in place, monitoring, capture, and release of all bull trout in the sand settling basin will be done in accordance with the terms and conditions of the USFWS 2011 Biological Opinion for the Operations and Maintenance of the LNFH. The effects of entrainment would be the same as those described in the biological opinion (USFWS 2011, p. 112; see **Appendix F**). However, incidental take for any fish salvage occurring during the Proposed Action will be authorized separate from the 2011 Biological Opinion for LNFH. In summary, effects would be physiologic stress, risk of injury due to abrasion in the pipeline, and stress and potential for injury associated with capture and salvage from the sand settling basin and return to Icicle Creek. Though capture and salvage from the sand settling basin would be done according to the biological opinion, even when accomplished carefully and efficiently, handling is likely to result in sublethal adverse effects (abrasions and stress) to all bull trout handled.

Under existing conditions, between 2011 and 2019, 63 bull trout were entrained in the LNFH water delivery system. Bull trout have been salvaged from the sand settling basin in the months of March through November. Most individuals (55 percent of the total) were salvaged between July and November; the other months each had four or less individuals over the 9-year period (Potter 2019). Installation of NMFS-compliant screens at the proposed intake facilities in Phase I will prevent bull trout entrainment in the surface water intake and delivery system. Over the long term, this would prevent the types of direct effects described above, including injury and stress from entrainment in the conveyance pipeline and salvage from the sand settling basin.

The proposed screens will be intermittently raised for maintenance or other purposes, such as protection from frazil ice. This means diverted water will be periodically unscreened. In these scenarios, bull trout entrainment would have the potential to occur. As discussed in **Section 3.1**, O&M activities will be covered in a separate ESA Section 7 consultation, so these effects are not described further here.

Temporarily dewatered work areas behind cofferdams may be partially dewatered prior to fish capture. To prevent bull trout entrainment in sump pumps, Reclamation will screen sump pump intakes to prevent aquatic life from entering the intake, per Conservation Measure 2. Fish screens or guards will comply with the most recent fish screening guidelines for anadromous salmonids prescribed by the NMFS. Adherence to these guidelines would also be sufficient to protect juvenile bull trout from entrainment in sump pump intakes. The duration of pumping to dewater cofferdam work areas is described, above, under *Disturbance, Displacement, Injury, and Mortality*.

Sump pumps will be used to supply temporary Hatchery water of 40 cfs during Phase I construction, and 20 cfs during Phase II construction. To avoid bull trout entrainment, as described above, Reclamation would screen the spillway pool pump intakes to prevent aquatic life from entering the intake, per Conservation Measure 2. Also per Conservation Measure 2, fish screens or guards will comply with the most recent fish screening guidelines for anadromous salmonids prescribed by the NMFS, per Conservation Measure 2. Phase I pumping will occur at the spillway pool for an approximately 1-week period in mid-July 2022 and another 1-week period in early November 2022, while the gravity bypass pipeline/conveyance pipeline connection point is made and removed. Phase II pumping will occur between approximately April 17 and May 20 in 2022, 2023, and 2024. This will be needed when lining the conveyance pipeline with CIPP and pipeline interconnections are underway. Pumping will occur 24 hours per day.

Sediment and Turbidity

Placement (including leveling the streambed prior to placement) and removal of the cofferdams would mobilize sediments on the Icicle Creek streambed. This could increase suspended sediments in and downstream of the work area temporarily, exposing bull trout to elevated levels of suspended sediments. Bash et al. (2001) summarize numerous studies that describe a range of effects of turbidity in Pacific Northwest fish. They summarize effects such as high levels of suspended solids that may be fatal to salmonids and lower levels of suspended solids and turbidity possibly causing chronic sublethal effects, such as a loss or reduction of foraging capability, reduced growth, decreased resistance to disease, increased stress, and interference with environmental cues necessary for orientation and migration. Exposure to increased turbidity would have relatively greater effects on migrating bull trout in the fall, when background turbidity levels in Icicle Creek are low, and relatively little effect on resident bull trout in the spring when turbidity levels in Icicle Creek are relatively high.

Elevated turbidity is expected to be highest during cofferdam A, B, and C construction and removal. Construction is anticipated to take between 10 and 14 days each in July 2022 (cofferdam A) and July and August 2023 (cofferdams B and C). Reclamation anticipates removal to take between 3 and 5 days each in November 2022 (cofferdam A) and October and November 2023 (cofferdams B and C). Reclamation anticipates the turbidity plumes resulting from these actions to be most intense within approximately 300 feet downstream of the action before dissipating to near-background levels. Potential exposure of bull trout from these activities could be minimized. This is because, as above, most bull trout would be expected to move to other areas of Icicle Creek in response to the noise and vibration caused by placing and removing the cofferdams. Still, since elevated turbidity can persist after disturbance activities and further downstream, sublethal effects on bull trout could occur, as summarized by Bash et al. (2001).

Per Conservation Measure 3, the construction contractor would monitor and collect water samples to measure potential increases in turbidity to ensure compliance with Water Quality Standards for Surface Waters (WAC 173-201A) during cofferdam placement and removal. In accordance with the WAC aquatic life turbidity criteria for the salmonid rearing and migration category, maximum allowable turbidity levels shall not exceed a 10-NTU increase over background when the background is 50 NTU or less, or a 20 percent increase in turbidity when the background turbidity is more than 50 NTU. Should observed turbidity exceed allowable levels at the point of compliance specified in the conservation measure (which is between 100 and 300 feet downstream, based on the flow rate of Icicle Creek during construction), in-water construction will temporarily stop until turbidity has cleared. In-water construction could then recommence at a slower rate to minimize generated turbidity. Monitoring and additional temporary work stoppages would occur, as needed, in accordance with the conservation measure.

Contaminants and Spills

The use of heavy machinery increases the risk for accidental spills of concrete, fuel, lubricants, hydraulic fluid, or similar contaminants into the riparian zone, or directly into the water, where they could injure or kill aquatic food organisms, or directly expose bull trout to hazardous materials. Adherence to water quality BMPs (**Appendix D**) and the construction stormwater pollution and prevention plan would minimize the risk of spills entering the water and affecting bull trout. Such measures would include conducting fueling and maintenance away from Icicle Creek, regularly checking equipment for leaks, having proper concrete washing sites, and maintaining spill prevention and cleanup kits on-site. It is unlikely that any machinery or equipment fluids or accidental concrete would be spilled in volumes or concentrations large enough to harm bull trout in or downstream of the Action Area.

5.1.2 Effects on the Current Condition of Habitat

Water Quality

Temperature

Construction of the proposed intake facilities would result in approximately 0.89 acres of surface disturbance, and as a result, removal of approximately 20 to 25 mixed conifer and broadleaf trees and shrubs in the intake construction area on the north (left) Icicle Creek bank.[10] Some of these trees (those closest to the Icicle Creek ordinary high water mark) provide shading to Icicle Creek, contributing to stream temperature moderation. Removal of trees that provide shade to the creek may contribute to increases in water temperature, especially during summer months. Construction BMPs would minimize the number of mature trees removed by limiting ground disturbance to the smallest area necessary. Nonetheless, approximately 0.18 acres of existing vegetation will be removed permanently, likely including six to eight mature trees and shrubs, which would result in some loss of shading to the creek.

Following construction of the proposed intake facilities, woody vegetation would be reestablished by planting native upland and riparian trees and shrubs, as described in the Draft Leavenworth National Fish Hatchery Intake Planting Plan (**Appendix C**). This would occur on approximately 0.71 acres. Container plantings would be installed in temporarily disturbed upland areas, while riparian tree cuttings would be installed in the Icicle Creek riparian zone. Where deciduous riparian trees are planted and grow to maturity, this would be an improvement of riparian vegetation structure and function compared with existing conditions. Over time, and as planted vegetation matured, the amount of shade provided to Icicle Creek would be maintained relative to current conditions. This would help to moderate stream temperatures, especially during summer months. Overall, there would be an adverse, but likely insignificant, effect on this habitat indicator following construction due to the small impacted area's influence on water temperature. There would be long-term maintenance of this indicator in the Action Area as planted riparian vegetation matured.

Sediment and turbidity

The Proposed Action would result in disturbances in the Icicle Creek ordinary high water mark. As discussed under *Sediment and Turbidity* in **Section 5.1.1**, the construction contractor would monitor for increases in downstream turbidity to ensure compliance with state water quality standards, per Conservation Measure 3. Should observed turbidity exceed allowable levels at the point of compliance specified in the conservation measure, in-water construction will temporarily stop until turbidity has cleared. In-water construction could then recommence at a slower rate to minimize generated turbidity. Monitoring and additional temporary work stoppages would occur, as needed, in accordance with the conservation measure.

The Proposed Action would also result in disturbances in uplands adjacent to Icicle Creek. Approximately 0.89 acres of surface disturbance are proposed in the intake construction area on the north (left) Icicle Creek bank. In terms of the distance from Icicle Creek, the surface disturbance would range from 0 feet from the ordinary high water mark (abutting it) to approximately 80 feet from it. Erosion control measures, such as silt fencing (see **Appendix D**), would be installed at the

[10] The number of trees to be removed is an estimate based on the amount of ground disturbance proposed. The precise number of trees that would eventually be removed is not known at this time.

boundary of the intake construction area to prevent sediment transport into Icicle Creek; this would prevent increased turbidity downstream of the intake construction area from construction-generated sediment transport (see *Sediment and Turbidity* in **Section 5.1.1**). Preparation of, and adherence to, a stormwater pollution and prevention plan, and checking to ensure that erosion control measures are in working order for the project's duration would also help prevent the release of sediment into Icicle Creek during construction. Hydroseeding of temporarily disturbed surfaces with herbaceous vegetation in the fall when the ground is free of snow, as described in the Draft Leavenworth National Fish Hatchery Intake Planting Plan (**Appendix C**), would stabilize soils and minimize or prevent erosion and release of sediment into Icicle Creek as vegetation matured over one to several growing seasons following construction.

Overall, there would be short-term adverse effects on this indicator during construction, particularly during in-water construction. Overall, in the long term there would be maintenance of this habitat indicator and possibly slight improvement since intake design will pass sediment more efficiently and normalize the sediment regime downstream of the intake, compared with existing conditions.

Chemical contamination and nutrients

As discussed under *Contaminants and Spills* in **Section 5.1.1**, surface disturbances and equipment use in and adjacent to Icicle Creek could result in contaminants (such as diesel fuel, lubricants, solvents, or other chemicals or materials) directly or indirectly entering the creek and affecting the quality of the water. Water quality BMPs (**Appendix D**) would be incorporated, including those drawn from the general conservation measures for ESA-listed salmonids in the programmatic biological opinion for USACE permitting of fish passage and restoration actions in Washington State (NMFS 2017b); adherence to the construction stormwater pollution and prevention plan would minimize the potential for spills entering Icicle Creek. Such measures would include conducting fueling and maintenance away from Icicle Creek, regularly checking equipment for leaks, and maintaining spill prevention and cleanup kits on-site. While these measures would minimize the potential for a contaminant entering Icicle Creek, they may not completely prevent it.

The Ecology TMDL indicates phosphorus is the limiting nutrient in Icicle Creek. Cement is rich in calcium and contains aluminum and iron also. All three can readily bind phosphorus. Also, Setunge et al. (2009) report freshwater contact with freshly cast concrete can lead to an increase in the pH level of water in contact with the concrete during the first 4 days from the casting of the concrete. To avoid the potential that construction would increase phosphorus or pH levels in Icicle Creek, concrete used in the dewatered work areas, including for grouting of boulders in the roughened channel and the low-flow boulder weir fishway, would be cured in place behind cofferdams for at least 4 days before exposure to Icicle Creek water. This is in adherence with BMPs (**Appendix D**). This would guard against fresh concrete increasing phosphorus or pH levels in Icicle Creek. Additional water quality conditions may be stipulated in project permits from the USACE, Ecology, or WDFW. If stipulated, Reclamation will comply with these measures.

These actions would result in maintenance of this habitat indicator.

Habitat Access

Physical barriers

Cofferdams A, B, and C at the intake construction area would be a partial physical barrier to bull trout passage while they are installed, between early July and mid-November 2022 (cofferdam A) and between early July and late October (cofferdams B and C; see **Table 2**). At no point would the cofferdams block the entire stream reach; however, the cofferdams would temporarily reduce the effective width of Icicle Creek while they are installed. One would intuitively assume this would limit, but not completely block, passage opportunities. However, to facilitate fish passage during construction, while cofferdams are in place, a minimum water depth of 0.8 feet would be maintained within the greatest amount of natural streambed width possible (see BMPs in **Appendix D**). During low summer flows, which typically occur while the cofferdams would be in place, 0.8 feet may represent an improvement in passage conditions over the baseline, as water depths at the existing intake facilities can be less than 0.8 feet (Anglin et al. 2013). Nonetheless, this potential beneficial effect may be partially offset if bull trout avoid the construction area during periods of noise-generating demolition or construction, as discussed in **Section 5.1.1**.

Anglin et al. (2013) note that the existing fish ladder is partially washed out at flows of approximately 1,200 cfs or greater and that "fluvial bull trout . . . could be moving upstream during the time period that the fishway is washed out, but passage directly over the dam is possible at these higher flows [up to 2,600 cfs]." With the improved design of a roughened channel, fish passage at higher flows should be improved over existing conditions. While the roughened channel does not meet the 3-feet-per-second flow velocity criterion for the entire length at flows greater than 906 cfs, there would be multiple slower velocity zones created by placed boulders that create velocities equivalent or slower than adjacent reference areas in Icicle Creek. Further, the proposed low-flow boulder weir fishway would provide NMFS-compliant fish passage during typical low flows, and the portion of the roughened channel extending upstream of the existing low-head diversion dam would facilitate fish passage overall and at higher flows in particular. Additional analysis on fish passage is in **Section 5.1.1** (see *Fish Passage*).

The Proposed Action would increase the opportunity for bull trout to migrate upstream of the existing intake facilities at RM 4.5. As a result, this would result in long-term restoration of this habitat indicator in the Action Area, as well as cumulatively for Icicle Creek. In combination with the Boulder Field Project, which will be complete in October 2020, bull trout would have increased access to over 20 miles of high-quality FMO and SR habitat in the upper Icicle Creek subbasin, upstream of the Action Area.

Habitat Elements

Substrate embeddedness

The LNFH's existing intake facilities currently remove large quantities of sediment from Icicle Creek; these become entrained in the surface water intake and accumulate in the sand settling basin where they are then removed to an upland location. The largest portion of the incoming sediment load is estimated to be sand to fine gravel, with a small portion being larger gravels and cobbles. Under existing conditions, there may be a slight beneficial effect on substrate embeddedness downstream of the intake, due to the entrainment of fine sediments in the existing intake facilities.

However, under the existing condition, higher-quality gravel and cobble substrates are also entrained; their loss may offset the beneficial effect of fine sediment entrainment.

The proposed intake facilities are expected to result in less native substrate material being removed from Icicle Creek due to entrainment. Instead, native materials, including fine sediments, and larger gravels and cobbles would be retained in Icicle Creek. While there may be slight detrimental effects on substrate embeddedness downstream of the intake because additional fine sediments will remain in Icicle Creek, more gravels and cobbles will also remain in Icicle Creek. This will help to offset this effect. There would likely be little effect on the capacity of downstream substrates to support production of macroinvertebrates, or on filling of interstitial spaces in the substrate used for shelter by bull trout of all life stages (see Section **5.1.1**, *Effects on Bull Trout*, for more information on direct effects of temporarily increased turbidity from construction).

Effects on the substrate embeddedness indicator are expected to be negligible overall.

Large, woody debris

As described in *Temperature*, above, construction of the proposed intake facilities would result in approximately 0.89 acres of surface disturbance. This would result in removal of several mature mixed conifer and broadleaf trees and shrubs in the intake construction area on the north (left) Icicle Creek bank. These trees are potential sources of woody debris to Icicle Creek; their removal would reduce the long-term availability of woody debris sources in the Action Area. Construction BMPs would minimize the number of mature trees removed by limiting ground disturbance to the smallest area necessary. Nonetheless, approximately 0.18 acres of existing vegetation will be removed permanently.

Following construction, woody vegetation would be reestablished by planting native upland and riparian trees and shrubs on approximately 0.71 acres. Where planted trees grow to maturity, they would provide a long-term source of woody debris in the Action Area. However, because there would be a net loss of acres of potential vegetated areas compared with existing conditions, this habitat indicator would be adversely affected.

Pool frequency and quality

The Proposed Action would not significantly create or remove pools nor change pool quality in the Action Area. Immediately downstream of the existing LNFH intake facilities, a natural boulder drop of about 2 to 3 feet is present with a deep, 3-foot scour hole formed from the hydraulic drop over the boulders (Reclamation 2020). This pool would be retained during construction of the roughened channel and low-flow fishway.

During construction of the proposed intake facilities during the 2022 in-water work window, the temporary Hatchery water supply of 40 cfs would be supplied via the gravity bypass pipeline. This diversion rate would result in increased flows (an additional 2 cfs) in Icicle Creek relative to existing conditions during the 2022 in-water work window (early July to mid-November). As a result, pool depths below the intake may be temporarily increased; however, Reclamation expects the amount of this beneficial effect to be minor to negligible, given the relatively small and temporary increase in flow rates that are expected. Overall, this habitat indicator would be maintained in the long term.

Large pools

The Proposed Action would not change the frequency or quality of large pools in the Action Area. This habitat indicator would be maintained.

Off-channel habitat

The Proposed Action would not change the distribution or quality of off-channel habitat in the Action Area. This habitat indicator would be maintained.

Refugia

Effects on this indicator are largely related to effects on habitat connectivity and habitat access between the Action Area and refugia habitat upstream of the Action Area in the upper Icicle Creek subbasin. As described under *Physical barriers*, above, the proposed low-flow boulder weir fishway would increase the opportunity for bull trout to migrate upstream of the existing intake facilities at RM 4.5 and access cold-water refugia habitat at the confluence of Icicle Creek and Snow Creek (RM 5.7) during supplementary flow releases from Snow and Nada Lakes. This is because the low-flow boulder weir fishway would improve upstream passage conditions during low-flow conditions in Icicle Creek, which is typically when supplementary releases occur. Further, when combined with the Boulder Field Project, which will be complete in October 2020, there will be increased connectivity between FMO habitats in the lower Icicle Creek and high-quality FMO and SR habitats and cold-water refugia in the upper Icicle Creek subbasin. Overall, there would be a long-term restoration of this habitat indicator in the Action Area.

Channel Condition and Dynamics

Width/depth ratio

The Proposed Action would effectively reduce the width-to-depth ratio in the immediate vicinity of the intake by a small amount, having a minor to negligible beneficial effect on this indicator. This is because the proposed intake structures (i.e., headworks and retaining walls) would result in a minor narrowing of Icicle Creek—by about 25 feet in width—where the structures are built, with no change in stream depth. The roughened channel and low-flow boulder weir fishway are not expected to alter the width-to-depth ratio.

As described under *Pool frequency and quality*, there would be slightly increased flows (an additional 2 cfs) in Icicle Creek, relative to existing conditions, during the 2022 in-water work window. As a result, somewhat more habitat area will be available to bull trout in the reach between the LNFH intake at RM 4.5 and the spillway pool at RM 2.8, where LNFH water returns to Icicle Creek. The amount of additional habitat available would vary depending on channel morphology. It will be most noticeable in reaches where there are shallow margins near a narrow thalweg. For example, in the relatively narrow reach adjacent to the Icicle River RV Resort (near RM 4.2), additional shallow margin habitat is likely to remain submerged. This is due to the additional flows added to this reach during the 2022 in-water work window, particularly during typical summer and fall low-flow conditions. This may benefit bull trout prey, such as young-of-year juvenile salmonids, which have been observed in these margins in the past (USFWS 2011). In contrast, where the width-to-depth ratio is high, such as immediately upstream of Structure 5, there will be little difference in available habitat.

Overall, this habitat indicator would be maintained in the Action Area.

Streambank condition and floodplain connectivity

These indicators are grouped together since the Proposed Action would have similar effects on them. As described in *Temperature*, above, woody vegetation at the intake construction area would be reestablished by planting native upland and riparian trees and shrubs, as described in the Draft Leavenworth National Fish Hatchery Intake Planting Plan (**Appendix C**). This would occur on approximately 0.71 acres. Where deciduous riparian trees are planted and grow to maturity, this would be an improvement of riparian vegetation structure and function, compared with existing conditions. Over time, this may facilitate increased streambank stability and development of undercut banks as planted riparian vegetation matures. These beneficial effects would not be realized for a decade or more, however, until planted vegetation matures. The Proposed Action would not result in land use changes in the Icicle Creek floodplain.

Overall, these habitat indicators would be maintained.

Flow/Hydrology

Change in peak and base flows

The Proposed Action would not change peak and base flows in the Action Area. This habitat indicator would be maintained.

Increase in drainage network

Improvement of the existing intake access road and construction of the IO&MA and PISMA would increase the area of impermeable surfaces in the Action Area relative to baseline conditions, including in the Icicle Creek riparian zone. Because these surfaces will be gravel surfaced or made of concrete, Reclamation expects effects from sedimentation into Icicle Creek to be minimal. The amount of hard surface area increase under the Proposed Action is small relative to the amount of hard surfaces associated with existing roads, buildings, and other developed areas in the Action Area, including, but not limited to, Icicle Creek Road directly upgradient of the intake construction area. As a result, increases in sediment deposition into Icicle Creek would likely be indistinguishable from background conditions.

Overall, this habitat indicator would be maintained.

Watershed Conditions

Road density and location

Extension of the intake access road would not appreciably change the road density in the Action Area relative to baseline conditions, including in the icicle Creek riparian zone. Potential effects, namely increases in impermeable surfaces and attendant potential increases and concentration of runoff, would be similar to those described under *Increase in drainage network*. As described above, gravel surfacing of the access road would minimize effects, and increases in impermeable surface area would be small. As a result, this habitat indicator would be maintained.

Disturbance history

The Proposed Action would increase the amount of surface disturbance in the Action Area relative to baseline conditions, including in the Icicle Creek riparian zone. Approximately 0.89 acres of surface disturbance is proposed. Following construction of the proposed intake facilities, woody vegetation would be reestablished by planting native upland and riparian trees and shrubs, as described in the Draft Leavenworth National Fish Hatchery Intake Planting Plan (**Appendix C**). This would occur on approximately 0.71 acres. Nonetheless, approximately 0.18 acres would be permanently developed. Given the small amount of overall disturbance and revegetation of temporarily disturbed areas, there would be minor adverse effects on this indicator.

Riparian conservation areas

Effects on this indicator are expected to be similar to those described for *Temperature*, *Streambank condition*, and *Floodplain connectivity*. In the Action Area, the geographic scope of effects on this habitat indicator is limited to the area of the proposed intake facilities at RM 4.5. Approximately 0.89 acres of surface disturbance is proposed. Following construction of the proposed intake facilities, woody vegetation would be reestablished by planting native upland and riparian trees and shrubs, as described in the Draft Leavenworth National Fish Hatchery Intake Planting Plan (**Appendix C**). This would occur on approximately 0.71 acres. Nonetheless, approximately 0.18 acres would be permanently developed. Effects of this scale would have little influence on the functionality of riparian reserves at the watershed (subbasin) scale. In the Action Area, where deciduous riparian trees are planted and grow to maturity, this would be an improvement of riparian vegetation structure and function, compared with existing conditions. Over time, and as planted vegetation matured, there would be an increase in riparian structural diversity and function in the Action Area.

Overall, there would be a short-term adverse effect on this habitat indicator following construction. There would be long-term maintenance of this indicator in the Action Area as planted riparian vegetation matured.

Disturbance regime

The Proposed Action would not alter the capacity of floods to reshape the Icicle Creek channel in the Action Area. This habitat indicator would be maintained.

Integration of species and habitat conditions

The Proposed Action is expected to have the most pronounced effects on the Water Quality pathway (USFWS 1998), including the *temperature*, *sediment and turbidity*, and *chemical contamination and nutrients* indicators, as well as the *physical barriers* indicator under the Habitat Access pathway. This is because bull trout passage past the LNFH intake would be improved once the roughened channel and low-flow fishway are installed. With regards to temperature, removal of several mature trees in the intake construction area will reduce shading to Icicle Creek, contributing to increased temperatures during the summer months. Riparian tree planting would mitigate this negative effect in the long term by increasing riparian vegetation function; however, this beneficial effect would be delayed until planted vegetation matured, and there would be a minor net loss of vegetation in the intake construction area of 0.18 acres. Installation and removal of temporary cofferdams has the potential to temporarily increase suspended sediments and turbidity downstream of the construction area, though measures (see Conservation Measure 3) will be in place to minimize this effect.

Measures would also be in place to minimize the potential for construction-related inputs of sediment or contaminants into Icicle Creek (see water quality BMPs in **Appendix D**).

While effects on habitat indicators, particularly the *sediment and turbidity* indicator, may temporarily and detrimentally alter the normal behavior of bull trout, temporary behavior alteration would be offset by long-term benefits from improved habitat connectivity and passage opportunities between the Action Area and high-quality FMO and SR habitat in the upper Icicle Creek watershed.

5.2 Bull Trout Critical Habitat

Construction will result in approximately 1.1 acres of temporary disturbance to bull trout critical habitat within the Icicle Creek ordinary high water mark. This would occur during the 2022 and 2023 in-water work windows as a result of temporary cofferdam installation (see **Table 2**). Approximately 0.45 acres of critical habitat will be permanently altered due to partial demolition of the existing intake facilities (i.e., low-head diversion dam and fish ladder/sediment sluice) and construction of the creek-width roughened channel and low-flow boulder weir fishway (see **Table 3**). Approximately 0.15 acres of critical habitat will be permanently lost due to construction of the proposed intake headworks, intake pipeline, and IO&MA.

The analyses of effects on habitat indicators in **Section 5.1.2** are used to inform effects on the PCEs of critical habitat for bull trout. To assess these effects, the relationship between habitat indicators (USFWS 1998) and the PCEs of critical habitat for the bull trout are "crosswalked" using the matrix developed by the USFWS (Krupka et al. 2011; see **Appendix G**). This is shown in **Table 6**.

Table 6
Relationship of the Matrix Indicators to the PCEs of Bull Trout Critical Habitat

Pathways (bold) and Indicators	PCE 1	PCE 2	PCE 3	PCE 4	PCE 5	PCE 6	PCE 7	PCE 8	PCE 9
Water Quality									
Temperature	X	X			X			X	X
Sediment and turbidity	X	X	X	X		X		X	
Chemical contamination and nutrients	X	X	X					X	
Habitat Access									
Physical barriers		X							
Habitat Elements									
Substrate embeddedness	X	X	X	X		X			
Large, woody debris			X	X					
Pool frequency and quality			X	X					
Large pools				X	X				
Off-channel habitat	X		X	X	X				
Refugia	X	X	X	X	X	X	X	X	X

Pathways (bold) and Indicators	PCE 1	PCE 2	PCE 3	PCE 4	PCE 5	PCE 6	PCE 7	PCE 8	PCE 9
Channel Condition and Dynamics									
Width/depth ratio		X		X	X			X	
Streambank condition	X		X	X	X	X	X	X	
Floodplain connectivity	X		X	X	X	X	X	X	
Flow/Hydrology									
Change in peak and base flows	X	X			X		X	X	
Increase in drainage network	X				X	X	X	X	
Watershed Conditions									
Road density and location	X			X	X	X	X	X	
Disturbance history	X				X		X		
Riparian conservation areas	X		X	X	X	X	X	X	
Disturbance regime				X		X		X	

Source: USFWS 1998; Krupka et al. 2011
Notes:
Abbreviated descriptions of the critical habitat PCEs are as follows:
PCE 1—Springs, seeps, groundwater
PCE 2—Migratory corridors
PCE 3—Abundant food base
PCE 4—Complex habitats
PCE 5—Temperature
PCE 6—Substrate
PCE 7—Hydrograph
PCE 8—Water quality/quantity
PCE 9 —Nonnative species
See **Section 5.1.2** for the analysis of effects on habitat indicators.

5.2.1 PCE 1

Of the habitat indicators that correspond to PCE 1, the Proposed Action is primarily expected to have short-term adverse effects on *temperature* and *sediment and turbidity*. As discussed in **Section 5.1.2**, this would come about due to removal of shade-providing vegetation in the intake construction area, and in-water construction to install and remove temporary cofferdams. This indicates there would be short term adverse effects on this critical habitat PCE. While riparian planting would help maintain the *temperature* indicator after plantings mature, there would nonetheless be a minor amount of vegetated area permanently lost due to construction of the proposed intake facilities.

The Proposed Action would also have a long term beneficial effect on the *refugia* indicator, helping to maintain this PCE. As discussed in **Section 5.1.2**, this would come about because the Proposed Action would increase bull trout access to cold water refugia at the confluence of Icicle Creek and Snow Creek (RM 5.7) during supplementary releases from Snow and Nada lakes. Increased access to this cold water refugia would come about from improved passage opportunities at the existing intake facilities at RM 4.5. Further, when considered in combination with the Boulder Field Project, which will be complete in October 2020, the Proposed Action will improve bull trout access to over 20 miles of high-quality habitat in the upper Icicle Creek subbasin, upstream of the Action Area.

5.2.2 PCE 2

Of the habitat indicators that correspond to PCE 2, the Proposed Action is primarily expected to have beneficial effects on *physical barriers*, resulting in a long-term beneficial effect on this PCE. As discussed in **Section 5.1.2**, this would come about because the Proposed Action would increase the opportunity for bull trout to migrate upstream of the existing intake facilities at RM 4.5. When considered in combination with the Boulder Field Project, which will be complete in October 2020, the Proposed Action will improve bull trout access to over 20 miles of high-quality FMO and SR habitat in the upper Icicle Creek subbasin, upstream of the Action Area.

Nonetheless, during the 2022 and 2023 in-water work windows (July 1 to November 15), bull trout passage opportunities may be temporarily diminished. This is because bull trout may avoid the construction area during periods of turbidity-generating construction during cofferdam installation and removal, and during noise-generating demolition or construction. This may affect resident bull trout, those migrating upstream to spawn, or those migrating downstream after spawning, depending on the timing of the noise-generating activity. This indicates there would be short-term adverse effects on this critical habitat PCE.

5.2.3 PCE 3

Of the habitat indicators that correspond to PCE 3, the Proposed Action is primarily expected to have short-term adverse effects on *sediment and turbidity* and *large, woody debris*. As discussed in **Section 5.1.2**, this would come about due to temporary cofferdam installation and removal, and the removal of vegetation in the intake construction area that would provide woody debris inputs to Icicle Creek. Increased turbidity and vegetation removal would have adverse, short term effects on the prey base, including benthic macroinvertebrates, and inputs of terrestrial invertebrates, into Icicle Creek. Further, increased turbidity may affect individual bull trout ability to locate prey in turbid water. This indicates there would be short-term adverse effects on this critical habitat PCE. While upland and riparian tree planting would help maintain the *large, woody debris* indicator and provide a source of terrestrial invertebrate food base after plantings mature, there would nonetheless be a minor amount of vegetated area permanently lost due to construction of the proposed intake facilities.

5.2.4 PCE 4

Of the habitat indicators that correspond to PCE 4, the Proposed Action is primarily expected to have short-term adverse effects on *sediment and turbidity* and *large, woody debris*. As discussed in **Section 5.1.2**, this would come about due to temporary cofferdam installation and removal, which will generate turbidity and temporarily displace bull trout from habitat features in and immediately downstream of the construction area. Short-term adverse effects will also come about due to the removal of vegetation in the intake construction area that provides woody debris inputs to Icicle Creek. This indicates there would be short-term adverse effects on this critical habitat PCE. While upland and riparian tree planting would help maintain the *large, woody debris* indicator after plantings mature, there would nonetheless be a minor amount of vegetated area permanently lost due to construction of the proposed intake facilities.

5.2.5 PCE 5

Of the habitat indicators that correspond to PCE 5, the Proposed Action is primarily expected to have short-term adverse effects on *temperature*. As discussed in **Section 5.1.2**, this would come about due to the removal of shade-providing vegetation in the intake construction area. This indicates there would be short-term adverse effects on this critical habitat PCE. While riparian planting would help maintain the *temperature* indicator after plantings mature, there would nonetheless be a minor amount of vegetated area permanently lost due to construction of the proposed intake facilities.

The Proposed Action would also have a long-term beneficial effect on the *refugia* indicator, resulting in a long-term beneficial effect on this PCE. As discussed for PCE 1, above, this would come about because the Proposed Action would increase bull trout access to cold-water refugia at the confluence of Icicle Creek and Snow Creek during supplementary releases from Snow and Nada Lakes. This would improve bull trout access to over 20 miles of high-quality habitat in the upper Icicle Creek subbasin, upstream of the Action Area.

5.2.6 PCE 6

Because critical habitat in the Action Area is designated FMO (see **Section 4.2**), PCE 6 would not apply to critical habitat in the Action Area. The Proposed Action would have no effect on PCE 6.

5.2.7 PCE 7

Reclamation does not expect the Proposed Action to have effects on the habitat indicators that correspond to PCE 7. The Proposed Action would have no effect on PCE 7.

5.2.8 PCE 8

Of the habitat indicators that correspond to PCE 8, the Proposed Action is primarily expected to have short-term adverse effects on *temperature* and *sediment and turbidity*. As discussed in **Section 5.1.2**, this would come about due to the removal of shade-providing vegetation in the intake construction area, and in-water construction during temporary cofferdam placement and removal. This indicates there would be short-term adverse effects on this critical habitat PCE. While riparian planting would help maintain the *temperature* indicator after plantings mature, there would nonetheless be a minor amount of vegetated area permanently lost due to construction of the proposed intake facilities.

5.2.9 PCE 9

Of the habitat indicators that correspond to PCE 9, the Proposed Action is primarily expected to have short-term adverse effects on *temperature*. As discussed in **Section 5.1.2**, this would come about due to the removal of shade-providing vegetation in the intake construction area. As discussed in **Section 4.2.9**, brook trout are present in the Action Area and in upper Icicle Creek upstream of the Action Area. Increased stream temperature can produce favorable conditions for brook trout and other nonnative fish that are more tolerant of warm water than are bull trout. This indicates there would be short-term adverse effects on this critical habitat PCE.

As discussed in **Section 4.2.9**, bull trout x brook trout hybrids are present in the Action Area. Increased movement opportunities and access to habitat in the upper Icicle Creek subbasin that would result from the Proposed Action (see PCE 5 analysis, above) would increase spawning opportunities between bull trout. This would reduce the risk of hybridization. Specifically, since brook trout are widely distributed in Icicle Creek, passage obstacles may restrict movement of female fluvial bull trout and increase the potential for pairing with male brook trout (Nelson et al. 2011). The usual pairing during hybridization is a female migratory bull trout with a male brook trout (Kanda et al. 2002). Conversely, the Proposed Action may increase female fluvial bull trout movements within the Action Area and into upper Icicle Creek, and provide more opportunities for pairing with a male bull trout, therefore reducing opportunities for hybridization. This indicates there would be a long-term beneficial effect on this critical habitat PCE.

5.3 Gray Wolf

The Action Area contains habitat that would be suitable for wolves; however, there are no known rendezvous or denning sites near the Action Area. Gray wolves are not known to occupy the Action Area, and the Action Area does not contain high-quality, continuous habitat for wolf breeding or wolf hunting; however, sightings of transitory individual wolves have been reported in the vicinity. In the unlikely event a wolf den or rendezvous site is located in the Action Area, Conservation Measure 5 would minimize effects during sensitive reproduction periods between April 1 and June 1. Deer and other prey for wolves can be found in the Action Area.

There is a possibility an individual wolf could move through the Action Area and be affected by Proposed Action activities. Effects could include disturbance and avoidance of construction activities during transition movements. This would likely have negligible effects due to the abundance of surrounding quality habitat wolves can move through. Also, avoidance would not affect survivorship nor cause injury or mortality. Wolves are nocturnal, and with proposed nighttime work hours, there could be a slight potential for vehicle collisions. However, there have been no documented vehicle-caused wolf mortalities in the county. The primary threat to wolves remains human shootings and authorized lethal removal in response to livestock depredation. The Proposed Action would not change these primary threats, and worker environmental training, in accordance with Conservation Measure 6, would ensure that construction crews would not intentionally harm any wildlife. Overall, potential effects on the gray wolf are anticipated to be insignificant based on their presumed low abundance in the Action Area and low magnitude of effect if disturbance did occur.

Chapter 6. Effect Determinations

6.1 Bull Trout

The Proposed Action **may affect and is likely to adversely affect** bull trout. Migrating and foraging bull trout may be present in Icicle Creek during the in-water work period; as such, they have the potential to be directly affected during construction of the proposed intake facilities. The potential for direct effects would generally come about from water quality effects during cofferdam installation and removal, from capturing and handling fish during construction area dewatering, from noise and vibration generated during construction, from alterations in passage conditions during construction, from potential entrainment in the temporary gravity bypass pipeline and the subsequent capture and handling, and from temporary pumping from the spillway pool. Incorporating BMPs in **Appendix D** and conservation measures would reduce or minimize direct effects, but effects would not be discountable, insignificant, or completely beneficial.

With regards to bull trout habitat effects, the Proposed Action is expected to have the most pronounced effects on the Water Quality pathway, including the *temperature*, *sediment and turbidity*, and *chemical contamination and nutrients* indicators, as well as the *physical barriers* indicator under the Habitat Access pathway. This is because bull trout passage past the LNFH intake would be improved once the roughened channel and low-flow fishway are installed. With regards to temperature, removal of several mature trees in the intake construction area will reduce shading to Icicle Creek, contributing to increased temperatures during the summer months. Riparian tree planting would mitigate this negative effect in the long term by increasing riparian vegetation function, but this beneficial effect would be delayed until planted vegetation matured. Also, there would be a minor net loss of vegetation in the intake construction area of 0.18 acres. Installation and removal of temporary cofferdams will temporarily increase turbidity downstream of the construction area, though measures (see Conservation Measure 3) will be in place to minimize this effect. Measures would also be in place to minimize the potential for construction-related inputs of sediment or contaminants into Icicle Creek (see water quality BMPs in **Appendix D**).

6.2 Bull Trout Critical Habitat

The Proposed Action **may affect and is likely to adversely affect** bull trout critical habitat. Construction will result in approximately 1.1 acres of temporary disturbance to bull trout critical habitat due to temporary cofferdam installation. Approximately 0.45 acres of critical habitat will be permanently altered by construction of the creek-width roughened channel and low-flow boulder weir fishway; approximately 0.15 acres of critical habitat will be permanently lost due to construction of the proposed intake headworks, intake pipeline, and IO&MA.

Adverse effects on critical habitat PCEs 1, 3, 4, 5, 8, and 9 are expected to result from turbidity-generating in-water construction and from vegetation removal in the intake construction area, which will reduce shading and large, woody debris inputs to Icicle Creek. These effects are small in scale (less than an acre of vegetation alteration) and temporary in nature (increased sediment during construction) such that impacts are not anticipated to measurably diminish the value of the habitat to provide for the survival and recovery of bull trout.

Beneficial effects on bull trout PCEs 1, 2, 5, and 9 would result because bull trout passage past the LNFH intake at RM 4.5 would be improved once the roughened channel and low-flow fishway are installed. This would improve connections between FMO and SR habitat in upper Icicle Creek, including upstream refugia for bull trout at the Icicle Creek and Snow Creek confluence and in the upper Icicle Creek subbasin. It would also improve connections between FMO habitats in the lower Icicle, Wenatchee, and Columbia Rivers.

6.3 Gray Wolf

The Proposed Action **may affect but is not likely to adversely affect** the gray wolf. Gray wolves are unlikely to be present near residential areas; therefore, the Action Area does not have suitable habitat to support gray wolf breeding or hunting, and project actions would not affect important habitat elements. No critical habitat has been designated for gray wolves in Washington, so the Proposed Action would have no effect on critical habitat for gray wolf.

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Appendix A

Maps

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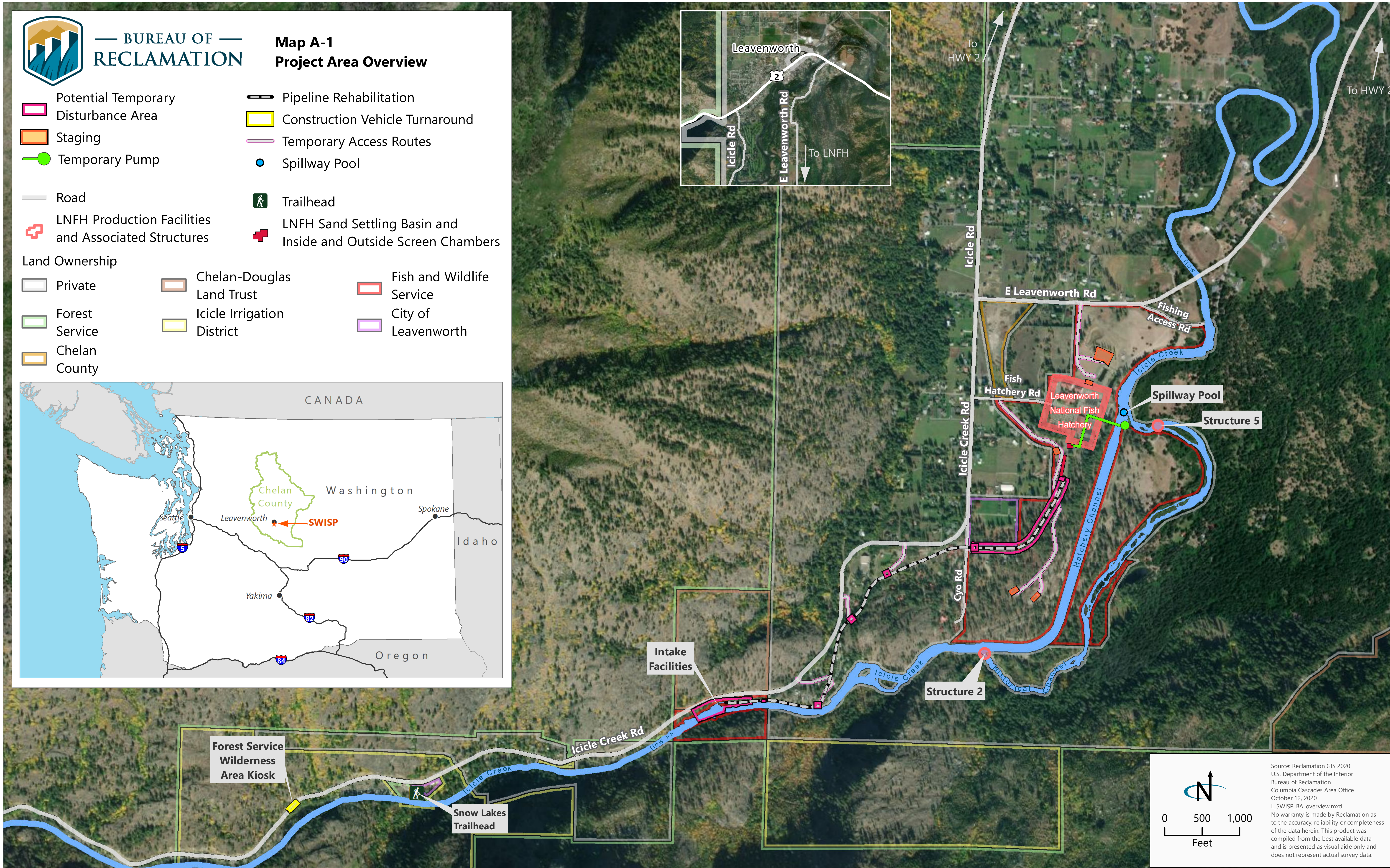

BUREAU OF RECLAMATION
Map A-1
Project Area Overview
Potential Temporary Disturbance Area
Staging
Temporary Pump
Road
LNFH Production Facilities and Associated Structures
Pipeline Rehabilitation
Construction Vehicle Turnaround
Temporary Access Routes
Spillway Pool
Trailhead
LNFH Sand Settling Basin and Inside and Outside Screen Chambers
Land Ownership
Private
Forest Service
Chelan County
Chelan-Douglas Land Trust
Icicle Irrigation District
Fish and Wildlife Service
City of Leavenworth
CANADA
Washington
Idaho
Oregon
Chelan County
Seattle
Leavenworth
SWISP
Spokane
Yakima
Leavenworth
Icicle Rd
E Leavenworth Rd
To LNFH
To HWY 2
To HWY 2
Icicle Rd
E Leavenworth Rd
Fishing Access Rd
Icicle Creek
Fish Hatchery Rd
Leavenworth National Fish Hatchery
Spillway Pool
Structure 5
Icicle Creek Rd
Cyo Rd
Hatchery Channel
Intake Facilities
Structure 2
Icicle Creek
Historical Channel
Icicle Creek Rd
Forest Service Wilderness Area Kiosk
Snow Lakes Trailhead
0 500 1,000
Feet
Source: Reclamation GIS 2020
U.S. Department of the Interior
Bureau of Reclamation
Columbia Cascades Area Office
October 12, 2020
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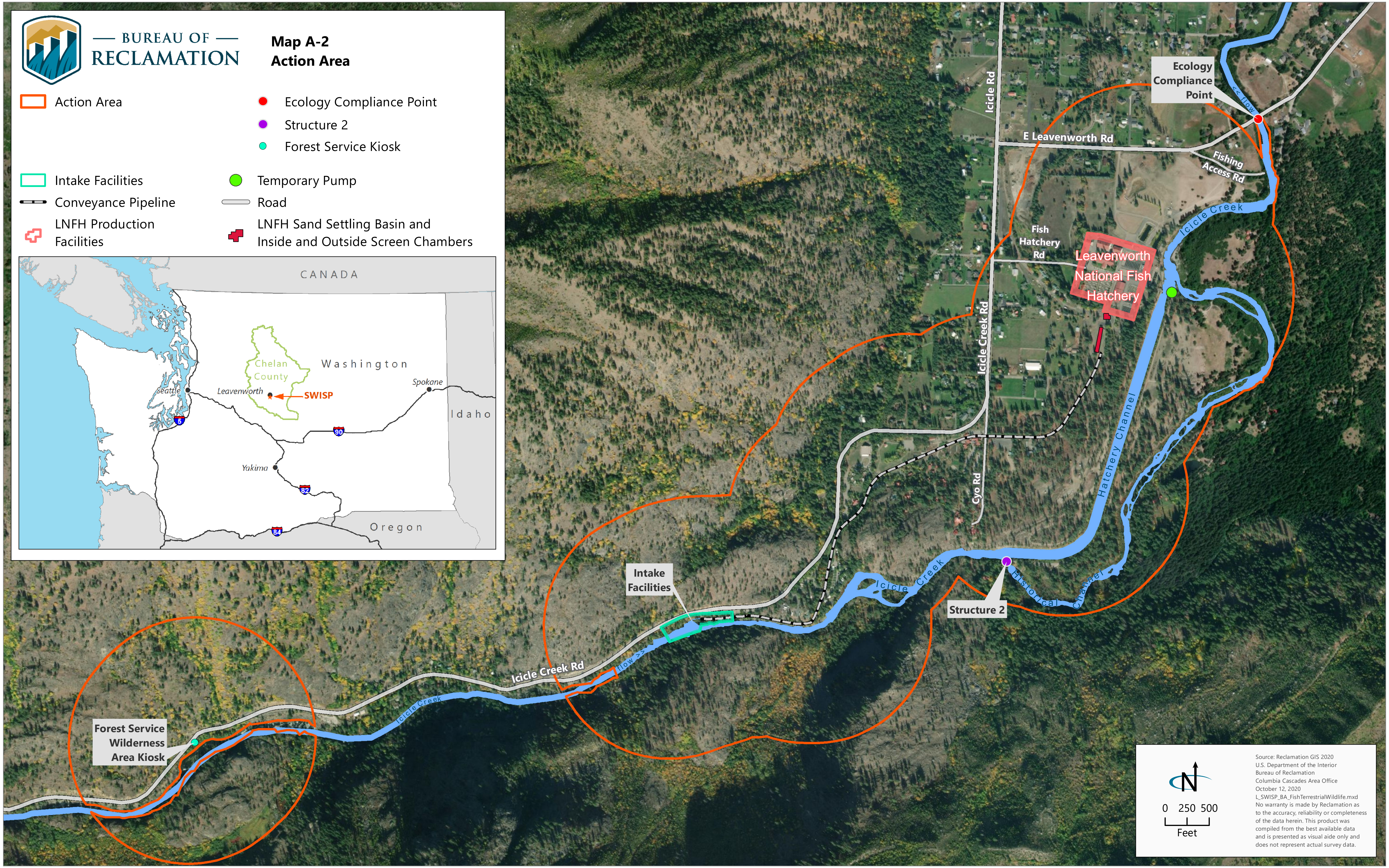
BUREAU OF RECLAMATION
Map A-2
Action Area
Action Area
Ecology Compliance Point
Structure 2
Forest Service Kiosk
Intake Facilities
Temporary Pump
Conveyance Pipeline
Road
LNFH Production Facilities
LNFH Sand Settling Basin and Inside and Outside Screen Chambers
CANADA
Washington
Chelan County
Leavenworth
SWISP
Seattle
Spokane
Yakima
Idaho
Oregon
5
90
82
84
Icicle Rd
E Leavenworth Rd
Ecology Compliance Point
Fishing Access Rd
Icicle Creek
Fish Hatchery Rd
Leavenworth National Fish Hatchery
Icicle Creek Rd
Hatchery Channel
Cyo Rd
Intake Facilities
Icicle Creek
Historical Channel
Structure 2
Icicle Creek Rd
flow
Icicle Creek
Forest Service Wilderness Area Kiosk
N
0 250 500
Feet
Source: Reclamation GIS 2020
U.S. Department of the Interior
Bureau of Reclamation
Columbia Cascades Area Office
October 12, 2020
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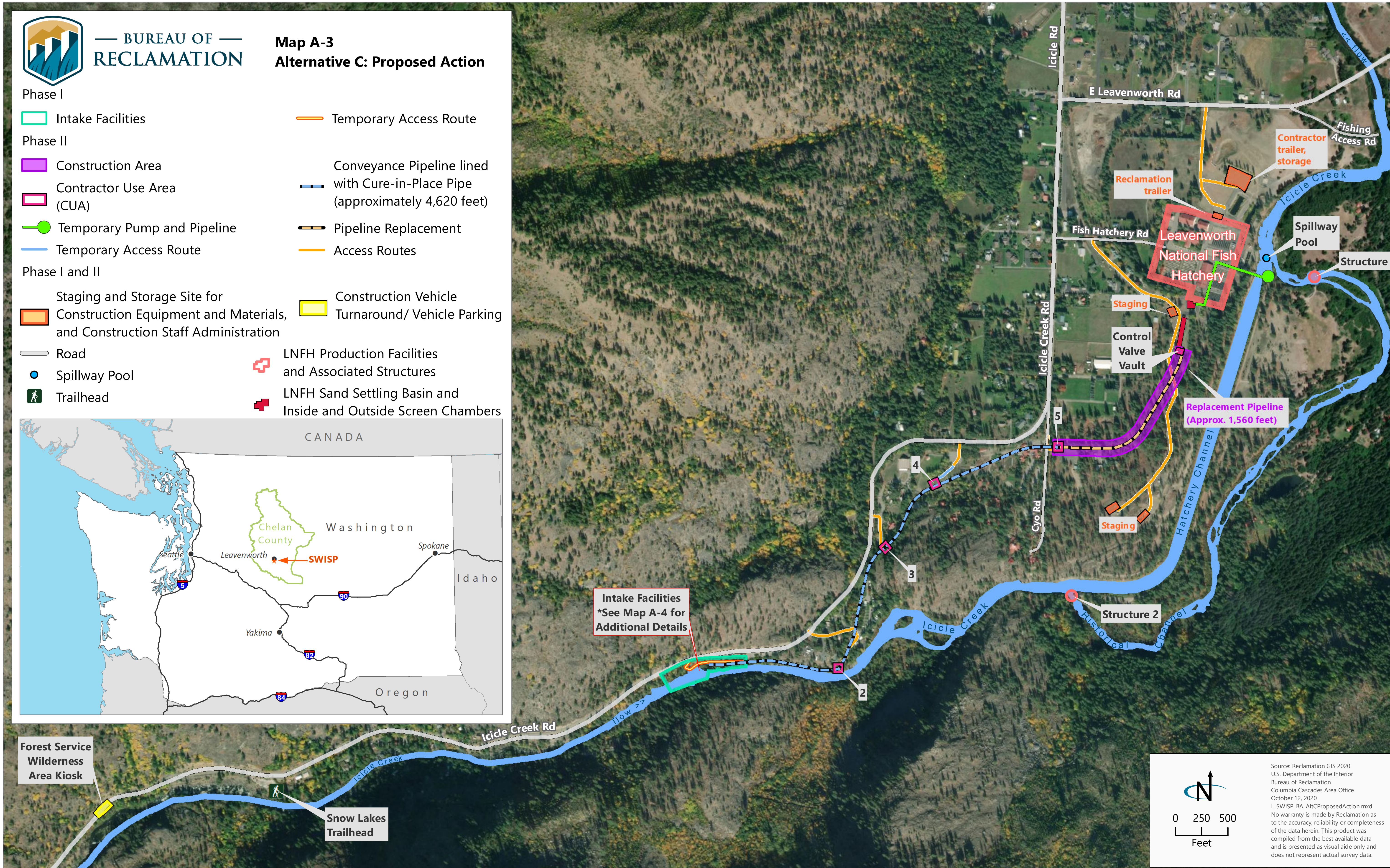
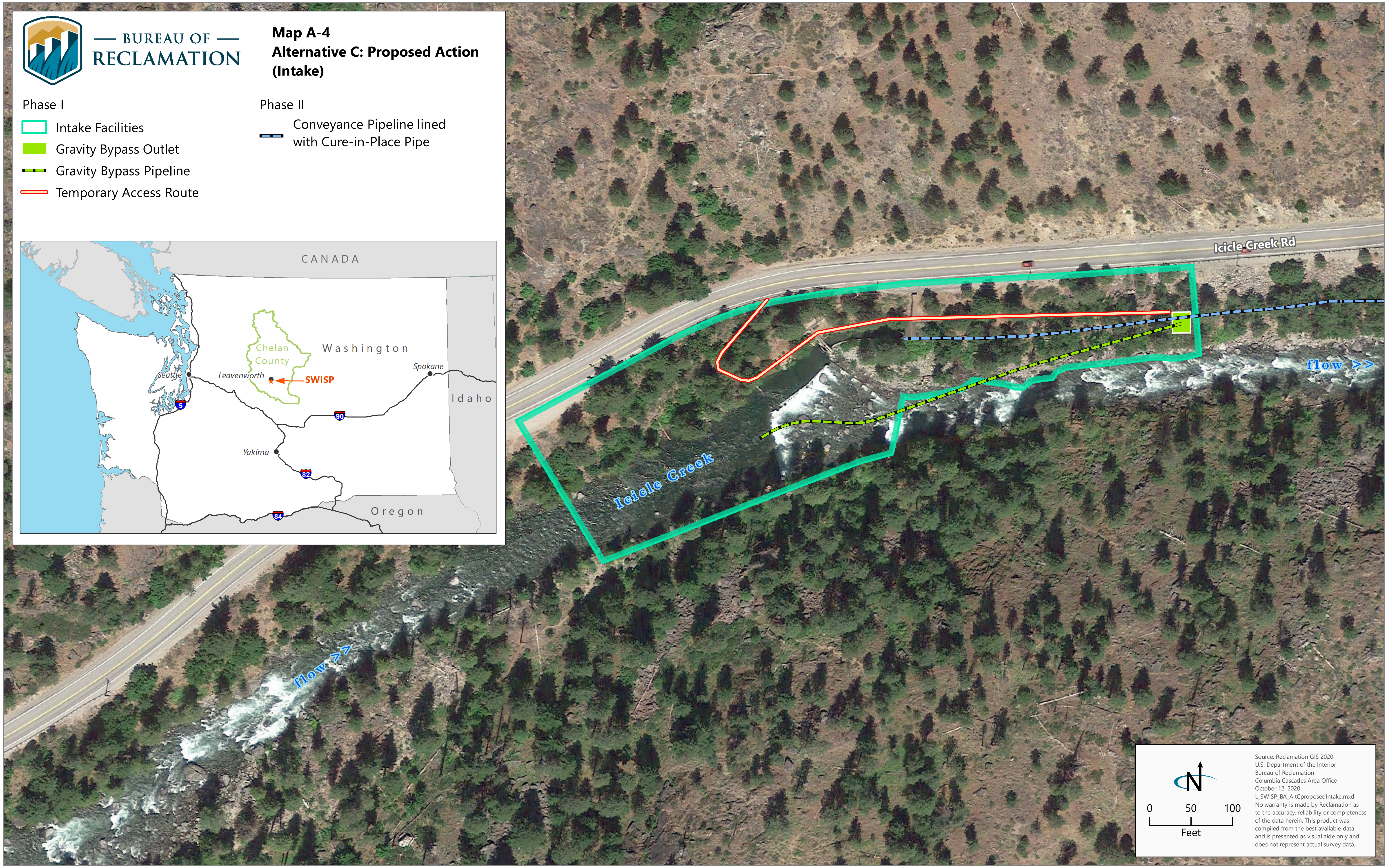
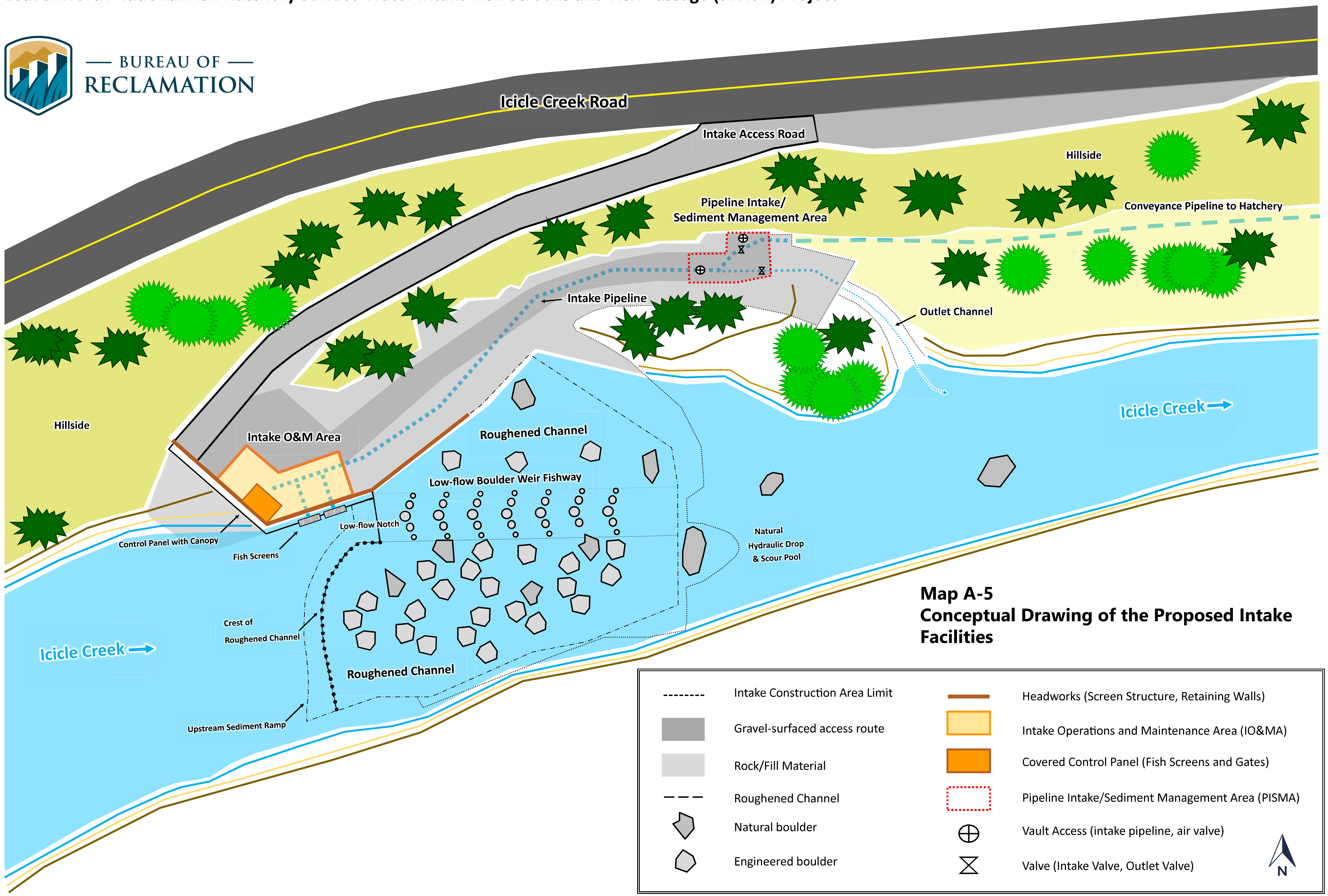


BUREAU OF RECLAMATION
Map A-3
Alternative C: Proposed Action
Phase I
Intake Facilities
Temporary Access Route
Phase II
Construction Area
Contractor Use Area (CUA)
Conveyance Pipeline lined with Cure-in-Place Pipe (approximately 4,620 feet)
Temporary Pump and Pipeline
Pipeline Replacement
Temporary Access Route
Access Routes
Phase I and II
Staging and Storage Site for Construction Equipment and Materials, and Construction Staff Administration
Construction Vehicle Turnaround/ Vehicle Parking
Road
LNFH Production Facilities and Associated Structures
Spillway Pool
Trailhead
LNFH Sand Settling Basin and Inside and Outside Screen Chambers
CANADA
Washington
Chelan County
Seattle
Leavenworth
SWISP
Spokane
Idaho
Yakima
Oregon
5
90
82
84
Icicle Rd
E Leavenworth Rd
Fishing Access Rd
Contractor trailer, storage
Reclamation trailer
Icicle Creek
Fish Hatchery Rd
Leavenworth National Fish Hatchery
Spillway Pool
Structure 5
Staging
Icicle Creek Rd
Control Valve Vault
Replacement Pipeline (Approx. 1,560 feet)
Hatchery Channel
5
4
3
2
Cyo Rd
Staging
Intake Facilities
*See Map A-4 for Additional Details
Icicle Creek
Structure 2
Historical Channel
flow >>
Icicle Creek Rd
Forest Service Wilderness Area Kiosk
Icicle Creek
Snow Lakes Trailhead
N
0 250 500
Feet
Source: Reclamation GIS 2020
U.S. Department of the Interior
Bureau of Reclamation
Columbia Cascades Area Office
October 12, 2020
L_SWISP_BA_AltCProposedAction.mxd
No warranty is made by Reclamation as to the accuracy, reliability or completeness of the data herein. This product was compiled from the best available data and is presented as visual aide only and does not represent actual survey data.


BUREAU OF RECLAMATION
Map A-4
Alternative C: Proposed Action (Intake)
Phase I
Intake Facilities
Gravity Bypass Outlet
Gravity Bypass Pipeline
Temporary Access Route
Phase II
Conveyance Pipeline lined with Cure-in-Place Pipe
CANADA
Washington
Chelan County
Seattle
Leavenworth
SWISP
Spokane
Idaho
Yakima
Oregon
5
90
82
84
Icicle Creek Rd
Icicle Creek
flow >>
flow >>
N
0
50
100
Feet
Source: Reclamation GIS 2020
U.S. Department of the Interior
Bureau of Reclamation
Columbia Cascades Area Office
October 12, 2020
L_SWISP_BA_AltCproposedIntake.mxd
No warranty is made by Reclamation as to the accuracy, reliability or completeness of the data herein. This product was compiled from the best available data and is presented as visual aide only and does not represent actual survey data.

Leavenworth National Fish Hatchery Surface Water Intake Fish Screens and Fish Passage (SWISP) Project

BUREAU OF RECLAMATION



Map A-5
Conceptual Drawing of the Proposed Intake Facilities

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Appendix B

USFWS Information for Planning and Consultation Species List

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington Fish And Wildlife Office
510 Desmond Drive Se, Suite 102
Lacey, WA 98503-1263
Phone: (360) 753-9440 Fax: (360) 753-9405
http://www.fws.gov/wafwo/

In Reply Refer To: September 14, 2020
Consultation Code: 01EWFW00-2020-SLI-1680
Event Code: 01EWFW00-2020-E-03239
Project Name: Surface Water Intake Fish Screens and Fish Passage (SWISP) Project

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, and proposed species, designated and proposed critical habitat, and candidate species that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. The species list is currently compiled at the county level. Additional information is available from the Washington Department of Fish and Wildlife, Priority Habitats and Species website: http://wdfw.wa.gov/mapping/phs/ or at our office website: http://www.fws.gov/wafwo/species_new.html. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 et seq.), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether or not the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species, and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:
http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.). You may visit our website at http://www.fws.gov/pacific/eagle/for information on disturbance or take of the species and information on how to get a permit and what current guidelines and regulations are. Some projects affecting these species may require development of an eagle conservation plan: (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

Also be aware that all marine mammals are protected under the Marine Mammal Protection Act (MMPA). The MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas. The importation of marine mammals and marine mammal products into the U.S. is also prohibited. More information can be found on the MMPA website: http://www.nmfs.noaa.gov/pr/laws/mmpa/.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Related website:
National Marine Fisheries Service: http://www.nwr.noaa.gov/protected_species/species_list/species_lists.html

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Washington Fish And Wildlife Office
510 Desmond Drive Se, Suite 102
Lacey, WA 98503-1263
(360) 753-9440

Project Summary

Consultation Code: 01EWFW00-2020-SLI-1680

Event Code: 01EWFW00-2020-E-03239

Project Name: Surface Water Intake Fish Screens and Fish Passage (SWISP) Project

Project Type: WATER SUPPLY / DELIVERY

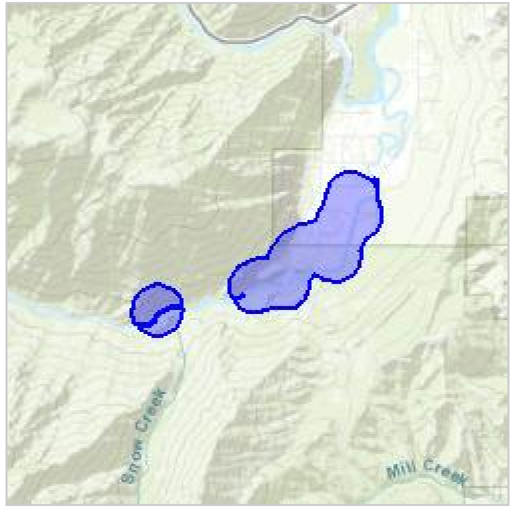
Project Description: The Leavenworth National Fish Hatchery's primary point of diversion and water delivery system on Icicle Creek is nearly 80 years old and is reaching or exceeding its operational life. Currently, the intake facility does not comply with National Marine Fisheries Service (NMFS) criteria for anadromous salmonids and can result in entrainment and mortality of Endangered Species Act (ESA) listed fish. The 2017 NMFS biological opinion covering LNFH operations requires the LNFH to have a surface water intake and delivery system that complies with NMFS current screening and fish passage criteria for anadromous fish passage facilities in place and operating by May 2023.

Reclamation proposes to rehabilitate, replace, and modernize the LNFH intake and delivery system on Icicle Creek by constructing new intake headworks, installing compliant fish screens, building a roughened channel and fishway that conforms to fish passage guidelines, and replacing/lining the surface water conveyance pipeline to the hatchery.

The purpose of the Surface Water Intake Fish Screens and Fish Passage (SWISP) Project is to minimize take of ESA-listed fish species, provide fish passage that complies with current regulatory criteria, and ensure safe, efficient, and reliable delivery of LNFH's full surface water rights from Icicle Creek.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/47.55379829603447N120.67989767541383W



Counties: Chelan, WA

Endangered Species Act Species

There is a total of 12 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
Canada Lynx *Lynx canadensis* Population: Wherever Found in Contiguous U.S. There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3652	Threatened
Gray Wolf *Canis lupus* Population: Western Distinct Population Segment No critical habitat has been designated for this species.	Proposed Endangered
Gray Wolf *Canis lupus* Population: U.S.A.: All of AL, AR, CA, CO, CT, DE, FL, GA, IA, IN, IL, KS, KY, LA, MA, MD, ME, MI, MO, MS, NC, ND, NE, NH, NJ, NV, NY, OH, OK, PA, RI, SC, SD, TN, TX, VA, VT, WI, and WV; and portions of AZ, NM, OR, UT, and WA. Mexico. There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/4488	Endangered
Grizzly Bear *Ursus arctos horribilis* Population: U.S.A., conterminous (lower 48) States, except where listed as an experimental population There is **proposed** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/7642	Threatened
North American Wolverine *Gulo gulo luscus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/5123	Proposed Threatened

Birds

NAME	STATUS
Marbled Murrelet *Brachyramphus marmoratus* Population: U.S.A. (CA, OR, WA) There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/4467	Threatened
Northern Spotted Owl *Strix occidentalis caurina* There is **final** critical habitat for this species. Your location overlaps the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1123	Threatened
Yellow-billed Cuckoo *Coccyzus americanus* Population: Western U.S. DPS There is **proposed** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened

Fishes

NAME	STATUS
Bull Trout *Salvelinus confluentus* Population: U.S.A., conterminous, lower 48 states There is **final** critical habitat for this species. Your location overlaps the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/8212	Threatened

Flowering Plants

NAME	STATUS
Showy Stickseed *Hackelia venusta* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/5210	Endangered
Wenatchee Mountains Checkermallow *Sidalcea oregana var. calva* There is **final** critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/7222	Endangered

Conifers and Cycads

NAME	STATUS
Whitebark Pine *Pinus albicaulis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/1748	Candidate

Critical habitats

There are 2 critical habitats wholly or partially within your project area under this office's jurisdiction.

NAME	STATUS
Bull Trout *Salvelinus confluentus* https://ecos.fws.gov/ecp/species/8212#crithab	Final
Northern Spotted Owl *Strix occidentalis caurina* https://ecos.fws.gov/ecp/species/1123#crithab	Final

Appendix C

DRAFT Leavenworth National Fish Hatchery
Intake Planting Plan

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Leavenworth National Fish Hatchery Intake
Planting Plan

Installation Procedures

Riparian and Upland Zone Seeding

Riparian Seeding Zone		
Seeding Rate= 20lbs per acre		
Species	**Common Name**	**% of Mix**
Calamagrostis canadensis	Bluejoint Reedgrass	37%
Carex aquatilis	Water Sedge	19%
Deschampsia cespitosa	Tuffed Hair Grass	37%
Juncus balticus	Baltic Rush	7%

Upland Seeding Zone		
Seeding Rate = 20lbs per acre		
Species	**Common Name**	**% of Mix**
Elymus glaucus	Blue Wildrye	26%
Pseudoroegneria spicata	Bluebunch Wheatgrass	14%
Festuca idahoensis	Idaho Fescue	18%
Bromus marginatus	Mountain Brome	18%
Koeleria macrantha	Prairie Junegrass	14%
Poa secunda sandbergii	Sandberg Bluegrass	10%

Apply with hydro-seeding at 20 pounds per acre in the early Fall if possible. If not wait until snow is off the site.

Upland Planting Zone

Upland Planting Zones			
Upland Planting Zone potted plant spacing 10' center			
Species	**Common Name**	**Container Size**	**% of Mix**
Acer circinatum	Vine Maple	40 cu.in.	20%
Rosa woodsii	Woods' Rose	40 cu.in	9%
Symphoroicarpos albus	Common snowberry	40 cu.in	11%
Amelanchier alnifolia	Saskatoon Serviceberry	40 cu.in	20%
Philadelphus lewisii	Lewis' Mock-Orange	40 cu.in	20%
Prunus emarginata	Bitter Cherry	40 cu.in	20%

Potted plants must be protected from deer browse.

Plant in early fall.

1. Auger holes approximately 2’ deep on 10’ centers.
2. Protect hole with 3’x 3’ weed mat (VisPore Tree Mats) stapled into the ground.
3. Plant stem ensuring all roots properly covered.
4. Cover planting surface with 3-4” deep chip mulch.
5. Install Rigid Seedling Protectors (5” x48”) with bamboo supports.
6. Water as necessary.*

Riparian Planting Zone

Riparian Planting Zone		
Live Cuttings, lengths =6’; spacing =2’ center		
Species	**Common Name**	**% of Mix**
Salix lasiandra	Shinning Willow	16%
Salix exigua	Narrow Leaf Willow	36%
Salix scouleriana	Scouler’s Willow	12%
Cornus sericea	Redosier Dogwood	36%
Live Cutting, length 8’; Spacing =20 linear feet		
Populus trichocarpa	Black Cottonwood	

Plant in early Fall

1. Cuttings must be at least 6 feet long planted on a 2’ centers.
2. Dip planting end of the cutting in a root stimulator such as Root-Tone to promote faster rooting and prevent fungus.
3. Cutting must be reach the water table.
4. Water as needed.*

An alternate planting strategy is the create fascines out of the cuttings and bury them in trenches during the construction of the facility.

Black Cottonwood

1. Cuttings must be at least 8 feet long planted on a 10’ linear line.
2. Dip planting end of the cutting in a root stimulator such as Root-Tone to promote faster rooting and prevent fungus.
3. Cutting must be reach the water table.
4. Water as needed.*

**Manual watering may be needed once or twice a week during the dry period (July-September) for first two years after installation. This is dependent on the water year and air temperature. Watering can be accomplished with a portable pump and hose or setting up a temporary above ground watering system with timers.*

Appendix D

Best Management Practices

Appendix D. Best Management Practices

D.1 Best Management Practices

To minimize impacts on resources from the Proposed Action, the best management practices (BMPs) described in **Table D-1** would be implemented. BMPs are drawn from the following sources:

- Biological opinions for LNFH operations, issued by the USFWS (addressing threatened Bull Trout; USFWS 2011) and by the NMFS (addressing endangered spring Chinook Salmon and threatened Steelhead; NMFS 2015, NMFS 2017a).
- General Conservation Measures (GCMs) for ESA-listed salmonids in the programmatic biological opinion for USACE permitting of fish passage and restoration actions in Washington State (FPRPIII; NMFS 2017a).
- GCMs for Bull Trout and other ESA-listed salmonids in the programmatic biological opinion for the Washington State fish passage and habitat enhancement and restoration program (NMFS and USFWS 2008)[1].
- Measures described in the construction specifications, including measures associated with site layout, temporary access, staging and stockpile areas, equipment use, erosion control, dust abatement, timing of in-water work and worksite isolation, and spill prevention and control.

Reclamation would also obtain required regulatory permits and implement terms and conditions contained therein. If permit requirements, best management practices, or other measures contradict each other, the contract specification requires that the contractor abide by the most stringent of requirements. A list of general, applicable permit conditions is included following **Table D-1**.

[1] This combined agency programmatic biological opinion expired on December 31, 2013. The USACE and NMFS reinitiated consultation and NMFS has issued subsequent biological opinions for the nationwide permit program. However, the USACE has been operating under consultation extensions from USFWS, with the most recent extension expiring December 31, 2020. Reclamation anticipates that ESA Section 7 consultation with the USFWS for the SWISP Project will result in similar conservation measures as those contained in the expired programmatic biological opinion.

Table D-1. Best Management Practices

Resource Topic	Best Management Practice
General	• Heavy equipment use will be limited to that with the least adverse effects on the environment (e.g. minimally-sized, low ground pressure equipment, use of matting, etc.; NMFS 2017a). • Conduct operations to prevent unnecessary destruction, scarring, or defacing of natural surroundings in the vicinity of the work.
Air Quality and Climate	• Dust control and abatement measures will be implemented during construction. • Vehicle traffic on unpaved surfaces would be limited to 10 miles per hour to minimize dust generation. • Vehicle traffic on government rights-of-way, dirt roads, and paved roads through LNFH property would be limited to 10 miles per hour. • Prevent, control, and abate dust pollution on government rights-of-way. • Provide labor, equipment, and materials, and use efficient methods wherever and whenever required to prevent dust nuisance or damage to persons, property, or activities. • Provide means for eliminating atmospheric discharges of dust during mixing, handling, and storing of cement, pozzolan, and concrete aggregate. • Use reasonably available methods and devices to prevent, control, and otherwise minimize atmospheric emissions or discharges of air contaminants. • Do not operate equipment and vehicles that show excessive exhaust gas emissions until corrective repairs or adjustments reduce such emissions to acceptable levels.
Geology and Soils	• The number of temporary access roads will be minimized and roads will be designed to avoid adverse effects like creating excessive erosion (NMFS 2017a). • Temporary roads and trails across slopes greater than 30 percent will be avoided when feasible (NMFS 2017a). • Existing roadways or travel paths will be used whenever possible (NMFS 2017a).
Water Resources (Stream Conditions)	• Coffer dam placement will maintain natural stream flow, minus the 40 cfs diversion to the hatchery, within the greatest amount of natural streambed width as possible. • Additional flow outage shall require the prior written approval of the COR, and of appropriate Federal and State water quality control agencies.

Resource Topic	Best Management Practice

Water Resources (Water Quality)	**General**
	• Perform construction activities by methods that will prevent entrance, or accidental spillage, of solid matter, contaminants, debris, or other pollutants or wastes into streams, flowing or dry watercourses, lakes, wetlands, reservoirs, or underground water sources.
	• Measures shall be taken to ensure that no petroleum products, hydraulic fluid, fresh cement, sediments, sediment-laden water, chemicals, or any other toxic or deleterious materials are allowed to enter or leach into waters of the U.S. (NMFS 2017a).
	• The use of acids for cleaning or preparing concrete surfaces for repair will not be permitted.
	In-water work
	• Prepare a Work Area Isolation Plan for all work below the bankfull elevation requiring flow diversion or isolation. Include the sequencing and schedule of dewatering and rewatering activities, plan view of all isolation elements, as well as a list of equipment and materials to adequately provide appropriate redundancy of all key plan functions (e.g., an operational, properly sized backup pump and/or generator) (NMFS 2017a).
	• Use of rapidly deployable prefabricated cofferdam systems would minimize impacts to subgrade and surrounding water.
	• When conducting in-water or bank work, machine hydraulic lines will be filled with vegetable oil for the duration of the project to minimize impacts of potential spills and leaks. If this conservation measure is not practicable, the applicant will propose alternative BMPs to avoid the discharge of hydraulic fluids to the aquatic environment. If this conservation measure is not practical the applicant will use low-hour machinery (NMFS 2017a).
	• Spill prevention and clean-up kits will be on site when heavy equipment is operating within 25 feet of the water (NMFS 2017a).
	• To the extent feasible, work requiring use of heavy equipment will be completed by working from the top of the bank (i.e. landward of the OHWM or extreme high tide line) (NMFS 2017a).
	• Equipment shall be checked daily for leaks and any necessary repairs shall be completed prior to commencing work activities around the water (NMFS 2017a).
	• Equipment will cross the stream in-water only under the following conditions: (NMFS 2017a).
	  o A. Equipment is free of external petroleum-based products, soil and debris has been removed from the drive mechanisms and undercarriage; and
	  o B. The substrate is bedrock or coarse rock and gravel; or
	  o C. Mats or logs are used in soft bottom situations to minimize compaction while driving across streams; and

Resource Topic	Best Management Practice
Water Resources (Water Quality, continued)	o D. Stream crossings will be performed at right angles (90 degrees) to the bank if possible; and o E. No stream crossings will be performed at spawning sites when spawners of ESA listed fishes are present or eggs or juvenile fish could be in the gravel; and o F. The number of crossings will be minimized. • Project operations will cease under high flow conditions that could inundate the project area, except as necessary to avoid or minimize resource damage (NMFS 2017a). • If high flow or high tide conditions that may cause siltation are encountered during a project, work shall stop until the flow subsides or the tide falls (NMFS 2017a). • Where practicable, a turbidity and/or debris containment device shall be installed prior to commencing in-water work (NMFS 2017a). • When working in-water, some turbidity monitoring may be required, subject to the Corps permit requirements or CWA section 401 certification. Turbidity monitoring generally is required when working in streams with more than 40 percent fines (silt/clay) in the substrate. Turbidity will be monitored only when turbidity generating work takes place, for example, installation of coffer dams, pulling the culvert in-water, reintroducing water. The applicant will measure the duration and extent of the turbidity plume (visible turbidity above background) generated. The data will be submitted to the Corps, NMFS, and the USFWS immediately following project construction. Turbidity measurements will be taken in NTUs and are used by project proponents to develop procedures to minimize turbidity and estimate take for future projects (NMFS 2017a). • Equipment used in the instream channel will have containment methods to address possible fuel and oil leaks. **Erosion and spill prevention and control** • A Temporary Erosion and Sediment Control plan and a Spill Prevention Control and Containment plan, commensurate with the size of the project, must be prepared and carried out to prevent pollution caused by surveying or construction operations (NMFS 2017a). • A Spill Prevention, Control, and Clean-Up plan will be prepared prior to construction for every project that utilizes motorized equipment or vehicles (NMFS 2017a). • A spill prevention and countermeasures plan (SPCC) in accordance with 40 CFR, Part 112 is required where release of oil and oil products could reasonably be expected to enter into or upon navigable waters of the United States or adjoining shorelines in quantities that may be harmful (40 CFR, Part 110), and aggregate on site oil storage capacity is over 1,320 gallons. Only containers with capacity of 55 gallons and greater are included in determining on site aggregate storage capacity.

Resource Topic	Best Management Practice
Water Resources (Water Quality, continued)	**Erosion and spill prevention and control, continued** o Prevent, stop, and control spills or leaks during construction activities: o Stop source of spill or leak. o Stop migration of spill or leak. o Place berm of sorbent material around perimeter of spill. o Solidify free standing oil. • A supply of emergency erosion control materials will be on hand and temporary erosion controls will be installed and maintained in place until site restoration is complete (NMFS 2017a). • Landward erosion control methods shall be used to prevent silt-laden water from entering waters of the U.S. These may include, but are not limited to, filter fabric, temporary sediment ponds, check dams of pea gravel-filled burlap bags or other material, and/or immediate mulching of exposed areas (NMFS 2017a). • Control pollutants by use of sediment and erosion controls, wastewater and stormwater management controls, construction site management practices, and other controls including State and local control requirements. • Sediment and Erosion Controls: o Establish methods for controlling sediment and erosion which address vegetative practices, structural control, silt fences, straw dikes, sediment controls, and operator controls as appropriate. o Institute stormwater management measures as required, including velocity dissipators, and solid waste controls which address controls for building materials and offsite tracking of sediment. • Pollution Prevention Measures: o Use methods of dewatering, unwatering, excavating, or stockpiling earth and rock materials which include prevention measures to control silting and erosion, and which will intercept and settle any runoff of sediment-laden waters. o Prevent wastewater from general construction activities such as drainwater collection, aggregate processing, concrete batching, drilling, grouting, or other construction operations, from entering flowing or dry watercourses without the use of approved turbidity control methods. o Divert stormwater runoff from upslope areas away from disturbed areas.

Resource Topic	Best Management Practice

Water Resources
(Water Quality, continued)
	Erosion and spill prevention and control, continued
	• Turbidity Prevention Measures:
	  o Use methods for prevention of excess turbidity which include, but are not restricted to, intercepting ditches, settling ponds, gravel filter entrapment dikes, flocculating processes, recirculation, combinations thereof, or other approved methods that are not harmful to aquatic life.
	  o Wastewaters discharged into surface waters shall meet conditions of Clean Water Act section 402, the National Pollutant Discharge Elimination System (NPDES) permit.
	  o Do not operate mechanized equipment in waterbodies without having first obtained a Clean Water Act section 404 permit, and then only as necessary to construct crossings or perform the required construction.
	• Clean up spills or leaks in a manner that complies with applicable Federal, State, and local laws and regulations.
	• Dispose of spilled or leaked materials:
	  o Handle and dispose of spilled or leaked materials contaminated with 50 ppm or greater polychlorinated biphenyls.
	  o Handle and dispose of spilled or leaked materials not contaminated or contaminated with less than 50 ppm polychlorinated biphenyls in accordance with applicable Federal, State, and local regulations.
	
	Discharge water and wastes
	• All discharge water created by construction (e.g. concrete washout, pumping for work area isolation, vehicle wash water, drilling fluids) will be treated to avoid negative water quality and quantity impacts. Removal of fines may be accomplished with bioswales; concrete washout water with an altered pH, may be infiltrated (NMFS 2017a).
	• Wastewater from project activities and water removed from within the work area shall be routed to an upland disposal site (landward of the OHWM or extreme high tide line) to allow removal of fine sediment and other contaminants prior to being discharged to the waters of the U.S. (NMFS 2017a).
	• All waste material such as construction debris, silt, excess dirt or overburden resulting from this project will generally be deposited above the limits of flood water in an upland disposal site. However, material from pushup dikes may be used to restore microtopography (e.g., filling drainage channels) (NMFS 2017a).

Resource Topic	Best Management Practice

Water Resources
(Water Quality, continued)
	Storage and staging
	• When not in use, vehicles and equipment containing oil, fuel, and/or chemicals will be stored in a staging area located at least 150 feet from the Corps' jurisdictional boundary of wetlands and waterbodies. If possible, staging will be located at least 300 feet away from the Corps' jurisdictional boundary of wetlands and waterbodies, and on impervious surfaces to prevent spills from reaching ground water. If moving equipment between the staging area and the worksite would create unacceptable levels of disturbance (for example, requiring multiple stream crossings, multiple passes over sensitive vegetation), a closer staging location with an adequate spill prevention plan may be proposed (NMFS 2017a).
	• Equipment will not be stored overnight in the instream channel.
	• Do not stockpile or deposit excavated materials or other construction materials, near or on, stream banks, lake shorelines, or other watercourse perimeters where they can be washed away by high water or storm runoff or can in any way encroach upon the watercourse.
	• Petroleum Product Storage Tanks Management.
	  o Place oil or other petroleum product storage tanks at least 20 feet from streams, flowing or dry watercourses, lakes, wetlands, reservoirs, and any other water source.
	  o Do not use underground storage tanks.
	  o Construct storage area dikes at least 12 inches high or graded and sloped to permit safe containment of leaks and spills equal to storage tank capacity located in the area plus sufficient freeboard to contain the 25-year rainstorm. Line diked areas with an impermeable barrier at least 50 mils thick.
	  o Areas for refueling operations: Lined with impermeable barrier at least 40 mils thick covered with 2 to 4 inches of soil.
	
	Reclamation of temporary disturbance
	• All temporary access will be removed (including gravel surfaces) and planted after project completion (NMFS 2017a).
	• Within 7 calendar days from project completion, any disturbed bank and riparian areas shall be protected using native vegetation or other erosion control measures as appropriate. For erosion control, sterile grasses may be used in lieu of native seed mixes. Alternative methods (e.g. spreading timber harvest slash) may be used for erosion control if approved by the Corps (NMFS 2017a).

Resource Topic	Best Management Practice
Water Resources (Water Rights)	• A total of 40 cfs shall be continuously provided to the LNFH during Phase I construction. • A total of 20 cfs shall be continuously provided to the LNFH during Phase II construction activities taking place from April 17 to May 20.
Biological Resources (Vegetation)	• Preserve natural landscape and preserve and protect existing vegetation not required or otherwise authorized to be removed. • Protect vegetation from damage or injury caused by construction operations, personnel, or equipment by the use of protective barriers or other approved methods. • Minimize, to the greatest extent practicable, clearings and cuts through vegetation. • Do not use trees for anchorages except in emergency cases or as approved by Reclamation. Where approved, wrap the trunk with a sufficient thickness of approved protective material before rope, cable, or wire is placed. • Use safety ropes where tree climbing is necessary; do not use climbing spurs. • Before bringing construction equipment on site, clean it to remove dirt, vegetation, and other organic material to prevent introduction of noxious weeds, and invasive plant and animal species. • Contractor cleaning procedures shall result in equipment being cleaned as well or better than the procedures described in Reclamation Cleaning Manual (Reclamation 2010). Reclamation will inspect construction equipment following procedures described in Reclamation Cleaning Manual before allowing the equipment onsite. • Restore Contractor use areas to pre-construction condition. • Areas of temporary disturbance must be re-seeded according to a revegetation plan.

Resource Topic	Best Management Practice
Biological Resources (Fisheries and Aquatic Ecosystems)	**Riparian areas** • The removal of riparian vegetation for access will be minimized (NMFS 2017a). • All native, non-invasive organic material (large and small wood) cleared from the action area for access will remain on site (NMFS 2017a). • Boundaries of clearing limits associated with site access and construction will be marked to avoid or minimize disturbance of riparian vegetation, wetlands, and other sensitive sites (NMFS 2017a). • If native riparian vegetation is disturbed it will be replanted with native herbaceous and/or woody vegetation after project completion. Planting will be completed between October 1 and April 15 of the year following construction. Plantings will be maintained as necessary for 3 years to ensure 50 percent herbaceous and/or 70 percent woody cover in year 3, whatever is applicable. For riparian impact areas greater than 0.5 of an acre, a final monitoring report will be submitted to the Corps in year 3. Failure to achieve the 50 percent herbaceous and 70 percent woody cover in year 3 will require the permittee to submit a plan with contingency measures to achieve standards or reasons to modify standards (NMFS 2017a). • Per NWP 27, post-planting monitoring may be required for up to 10 years in order to ensure an 80 percent planting survival rate is met.

Resource Topic	Best Management Practice
Biological Resources (Fisheries and Aquatic Ecosystems, continued)	• Fencing will be installed as necessary to prevent access to revegetated sites by livestock, beavers or unauthorized persons. Beaver fencing will be installed around individual plants where necessary (NMFS 2017a). **Fisheries and aquatic wildlife** • Instream work is limited to July 1 through November 15. • A minimum depth of 0.8 ft shall be maintained within the greatest amount of the natural stream channel width at all times with placement of cofferdams to facilitate fish passage. Fish passage criteria in Icicle Creek Fish Passage Evaluation for the Leavenworth National Fish Hatchery (Anglin et al. 2013, p. 26-28) should be consulted for minimum depth and maximum velocity criteria. The maximum velocity criteria on pages 26-28 are conservative, but attempts should be made to provide fish passage to the greatest extent practical across the natural stream channel width and hydrograph. • Work site dewatering will follow the Dewatering and Fish Capture Protocol in Appendix D (NMFS and USFWS 2008). Fish removal from dewatered work sites would be overseen by a fisheries biologist. Electrofishing for fish relocation/work area isolation must follow the most recent NMFS guidelines (NMFS 2017a). Record all incidents of listed fish being observed, captured, handled, and released (USFWS 2011). • Re-watering of the construction site occurs at such a rate as to minimize loss of surface water downstream as the construction site streambed absorbs water (NMFS and USFWS 2008). • The design of passage structures will follow the appropriate design standards in the most current version of the NMFS Anadromous Salmonid Fish Facility Design manual (NMFS and USFWS 2008). • Roughened channels will be designed to standards contained in the most current version of the NMFS Anadromous Salmonid Fish Facility Design manual (NMFS and USFWS 2008). • Post-construction monitoring of the low-flow fishway would be done to ensure effectiveness. • Boulder weirs will be low in relation to channel dimensions so that they are completely overtopped during channel-forming, bankfull flow events. Boulder weirs will be placed diagonally across the channel or in more traditional upstream pointing "V" or "U" configurations with the apex oriented upstream (NMFS and USFWS 2008). • Boulder weirs will be constructed to allow upstream and downstream passage of all native listed fish species and life stages that occur in the stream at all flows (NMFS and USFWS 2008). • Boulder weirs shall be designed and inspected by a multidisciplinary team (including a salmon or trout biologist) that has experience with these types of structures (NMFS and USFWS 2008).

Resource Topic	Best Management Practice
Biological Resources (Fisheries and Aquatic Ecosystems, continued)	• Screens, including screens installed in temporary pump intakes, will be designed to meet standards in the most current version of the NMFS Anadromous Salmonid Passage Facility Design manual (NMFS and USFWS 2008). • Pumps used to dewater the work isolation area or supply temporary hatchery water during construction, will have a fish screen installed, operated and maintained according to NMFS' fish screen criteria (NMFS 2017a). • All fish screens will be sized to match the water users documented or estimated historic water use or legal water right, whichever is less. Water diversion rates shall not exceed the design capacity of the screen, as calculated by following NMFS Anadromous Salmonid Passage Facility Design manual (NMFS and USFWS 2008). • Irrigation diversion intake and return points will be designed (to the greatest degree possible) to prevent all native fish life stages from swimming or being entrained into the irrigation system (NMFS and USFWS 2008). • Do not use jackhammers in excess of 30 pounds without Reclamation approval. Blasting is not permitted. • Monitor, capture, and release listed fish species in the sand settling basin in accordance with applicable protocol in NMFS (2017a), USFWS (2011), and as identified through consultation for the Project's Biological Assessment. • Schedule annual intake maintenance to avoid the Bull Trout upstream migration period (USFWS 2011). • Disturbing natural-origin spawning salmon and Steelhead during hatchery maintenance activities of diversions and instream structures shall be avoided, as shall disturbing salmon and Steelhead redds (NMFS 2017b).

Resource Topic	Best Management Practice
Biological Resources (Terrestrial Wildlife)	• Schedule all necessary vegetation removal, trimming, and grading of vegetated areas outside of the bird breeding season (generally March 1 to August 31) to the maximum extent practicable. • Avoid construction activities during the bird breeding season to the extent practicable. When project activities cannot occur outside the bird nesting season (March 1 to August 31), conduct surveys prior to scheduled activity to determine if active nests are present within the wildlife analysis area and buffer any active nesting locations found during surveys. Surveys should be conducted by a qualified biologist no more than seven days prior to disturbance activities. If active nests are detected during these surveys a no-activity buffer zone around the nest will be established by a qualified biologist based on species, project disturbance level, topography, existing disturbance levels, and habitat type until fledging has occurred. During ongoing project activities if a bird establishes a new nest the nest vegetation will not be removed or modified but no buffer zone will be required. If there is a pause in project activities greater than seven days an additional nesting bird survey would be needed. • Reclamation would minimize the highest construction noise disturbance to avoid or minimize impacts on mule deer and mountain goat during sensitive periods to the extent practicable. This is between mid-spring to early fall (May 1-September 30).
Cultural Resources	• As required by the Washington State Historic Preservation Officer, the Plan and Procedures for the Inadvertent Discovery of Cultural Resources and Human Remains (Inadvertent Discovery Plan) will be followed in the case of inadvertent discovery of cultural resources or human remains during construction. • A professional archaeological monitor will be present during ground-disturbing activities.
Land Use	• Restore Contractor use areas to pre-construction condition.

Resource Topic	Best Management Practice
Transportation	• Perform work on rights-of-way established by the government as necessary to construct and maintain any roads, bridges, or drainage structures required for establishment and use of haul routes for construction operations. • Use existing available public highways, roads, or bridges as haul routes subject to applicable local regulations. • Minimize interference with or congestion of local traffic. • Provide barricades, flaggers, and other necessary precautions for safety of the public where haul routes cross public highways or roads. • Maintain roadways, parking areas, and haul routes in a sound, smooth condition. • Promptly repair ruts, broken pavement, potholes, low areas with standing water, and other deficiencies to maintain road surfacing and drainage in original or specified condition. • Meet requirements of the Manual on Uniform Traffic Control Devices for Streets and Highways, Part 6 (Temporary traffic control; https://mutcd.fhwa.dot.gov/) and WAC 296-155-305 (Signaling and flaggers). • Provide cones, delineators, concrete safety barriers, barricades, flasher lights, danger signals, signs, and other temporary traffic control devices as required to protect work and public safety. • Provide flaggers and guards as required to prevent accidents and damage or injury to passing traffic. • Do not begin work along public or private roads until traffic control devices for warning, channeling, and protecting motorists are in place in accordance with approved traffic control plan. • Provide unobstructed, smooth, and dustless passageway for one lane of traffic through construction operations except at times when vehicles will be turning around at the USFS kiosk or backing onto the Intake Access Road. • Provide unobstructed, smooth, and dustless passageway for one lane of traffic through construction operations. • Maintain convenient access to driveways and buildings along line of work. • Protect roads closed to traffic with effective barricades and warning signs. Illuminate barricades and obstructions from sunset to sunrise. • Remove traffic control devices when no longer needed.
Noise	• Do not use jackhammers in excess of 30 pounds without Reclamation approval. Blasting is not permitted.
Recreation	• There are no construction activities (such as parking, storage, or vehicle turnaround) allowed in the US Forest Service Snow Lakes Trailhead parking lot.

Resource Topic	Best Management Practice
Visual Resources	• Minimize, to the greatest extent practicable, clearings and cuts through vegetation. Irregularly shape authorized clearings and cuts to soften undesirable aesthetic impacts.
Socioeconomics and Environmental Justice	• Reclamation policy is to avoid impacts on Indian sacred sites whenever possible. Continued coordination with affected Tribes may result in future identification of sacred sites. If this occurs, Reclamation would further evaluate impacts on these resources. Consultation with the Yakama Nation and Confederated Tribes of the Colville Reservation would identify how to protect sacred sites if they were identified and how to provide continued access if any such sites were affected by project construction. • In-water work would not occur in the spillway pool during the Tribal fishing preparations or season.
Utilities	• A locate for underground utilities would be coordinated with the Washington Utility Notification Center (http://www.callbeforeyoudig.org/washington/index.asp) prior to construction
Hazardous Materials and Public Health and Safety	• Vehicle traffic on government rights-of-way, dirt roads, and paved roads through LNFH would be limited to 10 miles per hour. • Nuisance flows from seepage and leakage through the cofferdams will be managed to maintain a safe working environment. • Hazardous Waste Disposal: o Dispose by removal from jobsite. o Recycle hazardous waste whenever possible. o Dispose of hazardous waste materials that are not recycled at appropriately permitted treatment or disposal facilities. o Transport hazardous waste in accordance with 49 CFR 171-179. • Provide protection for personnel and existing facilities from harm due to demolition activities. • Arrange protective installations to permit operation of existing equipment and facilities by the government while work is in progress. • Inadvertent discovery of hazardous wastes or materials will be reported to Reclamation and Ecology within 24 hours of discovery. Construction in the vicinity of the discovery would cease until the appropriate disposal procedures were identified and carried out in coordination with Reclamation and Ecology.

Resource Topic	Best Management Practice
Tribal Interests	• Reclamation policy is to avoid impacts on Indian sacred sites whenever possible. Continued coordination with affected Tribes may result in future identification of sacred sites. If this occurs, Reclamation would further evaluate impacts on these resources. Consultation with the Yakama Nation and Confederated Tribes of the Colville Reservation would identify how to protect sacred sites if they were identified and how to provide continued access if any such sites were affected by project construction.

Sources: As noted in table.

D.2 Regulatory Permit Terms and Conditions

Reclamation will obtain required regulatory permits and comply with the general, regional, and permit-specific terms and conditions contained therein. A general list of anticipated terms and conditions is included below. Regulating agencies may also impose additional conditions on a project-by-project basis.

D.2.1 US Army Corps of Engineers Section 404 Nationwide Permits

USACE General Conditions for all NWPs

- Aquatic Life Movements. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species.
- Spawning Areas. Activities in spawning areas during spawning seasons must be avoided to the maximum extent practicable.
- Suitable Material. Material used for construction or discharged must be free from toxic pollutants in toxic amounts.
- Fills Within 100-Year Floodplains. The activity must comply with applicable FEMA-approved state or local floodplain management requirements.
- Soil Erosion and Sediment Controls. Appropriate soil erosion and sediment controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date. Permittees are encouraged to perform work within waters of the United States during periods of low-flow or no-flow.
- Removal of Temporary Fills. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations. The affected areas must be revegetated, as appropriate.
- Proper Maintenance. Any authorized structure or fill shall be properly maintained, including maintenance to ensure public safety and compliance with applicable NWP general conditions, as well as any activity-specific conditions added by the district engineer to an NWP authorization.
- Tribal Rights. No NWP activity may cause more than minimal adverse effects on tribal rights (including treaty rights), protected tribal resources, or tribal lands.
- Endangered Species. (a) No activity is authorized under any NWP which is likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will directly or indirectly destroy or adversely modify the critical habitat of such species. No activity is authorized under any NWP which "may affect" a listed species or critical habitat, unless ESA section 7 consultation addressing the effects of the proposed activity has been completed.
- Endangered Species. (d) As a result of formal or informal consultation with the FWS or NMFS the district engineer may add species-specific permit conditions to the NWPs.

- Migratory Birds and Bald and Golden Eagles. The permittee is responsible for ensuring their action complies with the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act.
- Historic Properties. (a) In cases where the district engineer determines that the activity may have the potential to cause effects to properties listed, or eligible for listing, in the National Register of Historic Places, the activity is not authorized, until the requirements of Section 106 of the National Historic Preservation Act (NHPA) have been satisfied.
- Discovery of Previously Unknown Remains and Artifacts. If you discover any previously unknown historic, cultural or archeological remains and artifacts while accomplishing the activity authorized by this permit, you must immediately notify the district engineer of what you have found, and to the maximum extent practicable, avoid construction activities that may affect the remains and artifacts until the required coordination has been completed.
- Water Quality. Where States and authorized Tribes, or EPA where applicable, have not previously certified compliance of an NWP with CWA section 401, individual 401 Water Quality Certification must be obtained or waived (see 33 CFR 330.4(c)).
- Regional and Case-By-Case Conditions. The activity must comply with any regional conditions that may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state, Indian Tribe, or U.S. EPA in its section 401 Water Quality Certification.

USACE Seattle District NWP Regional Conditions

- Construction Boundaries: Permittees must clearly mark all construction area boundaries before beginning work on projects that involve grading or placement of fill. Boundary markers and/or construction fencing must be maintained and clearly visible for the duration of construction. Permittees should avoid and minimize removal of native vegetation (including submerged aquatic vegetation) to the maximum extent possible.
- Temporary Impacts and Site Restoration: Native soils removed from waters of the US for project construction should be stockpiled and used for site restoration. Restoration of temporarily disturbed areas must include returning the area to pre-project ground surface contours. If native soil is not available from the project site for restoration, suitable clean soil of the same textural class may be used. The permittee must revegetate disturbed areas with native plant species sufficient in number, spacing, and diversity to restore affected functions. Revegetation must begin as soon as site conditions allow within the same growing season as the disturbance. Temporary erosion and sediment control measures must be removed as soon as the area has established vegetation sufficient to control erosion and sediment.

NWP 27 (Aquatic Habitat Restoration, Enhancement, and Establishment Activities) Conditions

- Only native plant species should be planted at the site.

NWP 33 (Temporary Construction, Access, and Dewatering) Conditions

- Appropriate measures must be taken to maintain near normal downstream flows and to minimize flooding.
- Fill must consist of materials, and be placed in a manner, that will not be eroded by expected high flows.

- The use of dredged material may be allowed if the district engineer determines that it will not cause more than minimal adverse environmental effects. Following completion of construction, temporary fill must be entirely removed to an area that has no waters of the United States, dredged material must be returned to its original location, and the affected areas must be restored to pre-construction elevations. The affected areas must also be revegetated, as appropriate.

D.2.2 Ecology Section 401 Water Quality Certification

General Conditions

- Stormwater pollution prevention: All projects that involve land disturbance or impervious surfaces must implement stormwater pollution prevention or control measures to avoid discharge of pollutants in stormwater runoff to waters of the State.
  - For land disturbances during construction, the applicant must obtain and implement permits (e.g., Construction Stormwater General Permit) where required and follow Ecology's current stormwater manual.
  - Following construction, prevention or treatment of on-going stormwater runoff from impervious surfaces shall be provided.

D.3 References

Anglin, D. R., J. J. Skalicky, D. Hines, and N. Jones. 2013. Icicle Creek Fish Passage Evaluation for The Leavenworth National Fish Hatchery. US Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington.

NMFS (National Marine Fisheries Service). 2015. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation; Leavenworth National Fish Hatchery spring Chinook Salmon Program. National Marine Fisheries Service, West Coast Region, Portland, Oregon.

_____. 2017a. Programmatic Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Seattle District Corps of Engineers Permitting of Fish Passage and Restoration Action in Washington State (FPRP III). West Coast Region, Portland, Oregon.

_____. 2017b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation, Leavenworth National Fish Hatchery Spring Chinook Salmon Program (Reinitiation 2016). National Marine Fisheries Service, West Coast Region, Portland, Oregon.

NMFS and USFWS (National Marine Fisheries Service and US Fish and Wildlife Service). 2008. Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Washington State Fish Passage and Habitat Enhancement Restoration Programmatic. NMFS Tracking No. 2008/03598, USFWS No. 13410-2008-FWS#F-0209. Lacey, Washington.

Reclamation (US Bureau of Reclamation). 2010. Technical Memorandum No. 86-68220-07-05: Inspection and Cleaning Manual for Equipment and Vehicles to Prevent the Spread of Invasive Species, 2010 Edition. Denver, Colorado.

USFWS (US Fish and Wildlife Service). 2011. Biological Opinion for the operations and maintenance (O&M) of the LNFH and effects on the threatened bull trout (*Salvelinus confluentus)* and its designated critical habitat. USFWS Reference No. 13260-2011-F-0048 and 13260-2011-P-0002. Wenatchee, Washington.

Appendix E

USFWS Recommended Fish Exclusion, Capture, Handling, and Electroshocking Protocols and Standards

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Washington Fish and Wildlife Office
U. S. Fish and Wildlife Service

Recommended Fish Exclusion, Capture, Handling, and Electroshocking Protocols and Standards

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U.S. Fish and Wildlife Service
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Lacey, WA
June 19, 2012

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INTRODUCTION

The Washington Fish and Wildlife Office, U. S. Fish and Wildlife Service (FWS) recommends the following protocols and standards for fish exclusion, capture, handling, and relocation where conducted within the range of the federally listed as threatened bull trout. Electroshocking guidelines and references are also included in this document.

This guidance is to provide methods to isolate, capture, and move/relocate fish to minimize effects of construction activities to federally listed bull trout and unlisted species that are present within the affected area. These measures are intended to reduce exposure and risk of potential injury associated with construction activities. Although these measures may result in negative behavioral and, in some cases, physical injury or death to fish, proper implementation of these methods will reduce the likelihood of these effects. These measures are recommended where their implementation will result in the avoidance of the more severe effects fish would experience if they remained in the work area during construction. Implementation of less protective measures may result in additional requirements as part of the Endangered Species Act (ESA) consultation process and/or recommendations provided under the Fish and Wildlife Coordination Act.

WHEN TO USE THIS GUIDANCE

Work below the Ordinary High-Water Mark (or Mean Higher High-Water Mark) will typically be conducted in isolation from flowing waters. Exceptions to this general rule include the following:

1) Implementation of the work area isolation and fish capture and removal protocols described in this document.

2) Placement or removal of small quantities of material (e.g., wood or rock), or installation of structural best management practices (e.g., turbidity curtain), under site conditions where potential exposures and effects to fish are minimized without isolation from flowing waters[1].

3) Work conducted under a declared emergency or under emergency conditions.

4) Work conducted where flow conditions prevent safe implementation of work area isolation and fish capture and removal protocols.

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[1] The applicant shall make this determination with consultation or input from the regulatory agencies with jurisdiction, including the Washington State Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (FWS), and NOAA-National Marine Fisheries Service (NMFS) as appropriate; also, this exception shall not permit work that requires in-water excavation or that presents a risk of increased turbidity beyond the immediate work area or for a duration of more than 15 minutes.

RESPONSIBILITIES AND TRAINING REQUIREMENTS

Implementation of the work area isolation and fish capture and removal protocols will be planned and directed by a qualified biologist (referred to in this document as the directing biologist), possessing all necessary knowledge, training, and experience. We also recommend that the project proponent/consulting agency coordinate with the FWS as early in the planning process as possible to determine the most appropriate in-water work window and identify any conflicts with effects to other listed species, such the marbled murrelet (*Brachyramphus marmoratus*) or the northern spotted owl (*Strix occidentalis caurina*).

If electrofishing is proposed as a means of fish capture, the directing biologist will have a minimum of 100 hours electrofishing experience in the field using similar equipment, and any individuals operating electrofishing equipment will have a minimum of 40 hours electrofishing experience under direct supervision. All individuals participating in fish capture and removal operations will have the training, knowledge, skills, and ability to ensure safe handling of fish, and to ensure the safety of staff conducting the operations.

STAGING AND SEQUENCING OF WORK

The directing biologist will work with the appropriate person (such as the construction and equipment operators for the project) to plan the staging and sequence for work area isolation, fish capture and removal, and dewatering. This plan will consider the size and channel characteristics of the area to be isolated, the method(s) of dewatering (e.g., diversion with bypass flume or culvert; diversion with sandbag, sheet pile or similar cofferdam; etc.), and what sequence of activities will provide the best conditions for safe capture and removal of fish. Where the area to be isolated is small, depths are shallow, hiding cover is limited, and/or conditions are conducive to fish capture6, it may be possible to isolate the work area and remove all fish life prior to dewatering or flow diversion. Where the area to be isolated is large, water is deeper, uncut banks and other hiding cover is present, flow volumes or velocities are high, and/or conditions are not conducive to easy fish capture, it may be necessary to commence with dewatering or flow diversion staged in conjunction with fish capture and removal. The directing biologist will use his/her best professional judgment in deciding what sequence of activities is likely to minimize exposure of fish to conditions causing stress or injury (including stranding, exposure to temperature extremes or reduced dissolved oxygen levels, risk of injury resulting from electrofishing, etc.).

The directing biologist will plan work area isolation, fish capture and removal, and dewatering with consideration for the following: habitat connectivity and fish habitat requirements; the duration and extent of planned in-water work; anticipated flow and temperature conditions over the duration of planned in-water work; and, the risk of exposure to turbidity or other unfavorable conditions during construction. If the area to be isolated includes only a portion of the wetted channel width (e.g., large or deep rivers where diversion from the entirety of the wetted channel is difficult or impossible), or if the bypass flume or culvert will effectively maintain connectivity and fish passage for the duration of construction activities, it may be less important whether fish are herded (and/or captured and released) upstream or downstream of the isolated work area. However, if the area to be isolated includes the entire wetted channel width, or if conditions make it unlikely that connectivity (i.e., upstream/downstream fish passage) can be effectively maintained for the duration of construction activities, then the directing biologist will carefully consider whether to herd fish (and/or capture and release fish) upstream or downstream of the isolated work area to minimize effects to individuals. For example, if conditions upstream of the isolated work area may become unfavorable during construction, then fish will not be herded or released to an upstream location; this situation is probably most common where the waterbody in question is small, where seasonal flows are substantially diminished, and conditions of elevated temperature and/or reduced dissolved oxygen are foreseeable. However, the directing biologist will also consider whether planned in-water work presents a significant risk of downstream turbidity and sedimentation and exposure of fish herded or released to a downstream location.

If large numbers of fish are to be herded (and/or captured and released), and to avoid overcrowding or concentrating fish in areas where their habitat needs cannot be met, it may be appropriate to relocate fish both upstream and downstream of the isolated work area. At locations where habitat connectivity or quality is poor, including along reaches upstream and/or downstream of the isolated work area, the directing biologist will carefully consider whether relocated fish can meet their minimum habitat requirements for the duration of planned in-water work. On rare occasions it may be appropriate to relocate fish at a greater distance upstream and/or downstream (e.g., thousands of feet or miles), so as to ensure fish are not concentrated in areas where their habitat needs cannot be met, or where they may be exposed to unfavorable conditions, including increased predation, during construction. On those rare occasions where relocation to a greater distance is deemed necessary, the entity will provide notice to the FWS field office[2] with jurisdiction in that area in advance of the operations.

Work Area Isolation - Block Nets

The directing biologist will determine appropriate locations for the placement of block nets, based on site characteristics and a consideration of the type and extent of planned in-water work. Sites that exhibit reduced flow volume or velocity, uniformity of depth, and good accessibility are preferred; sites with heavy vegetation, large cobble or boulders, undercut banks, deep pools, etc. should be avoided due to the difficulty of securing and/or maintaining nets. Sites with a narrow channel cross-section (“constriction”) will be avoided if foreseeable flow conditions might overwhelm or dislodge the block nets, posts, or anchors.

[2] Lacey Field Office, Central Washington Field Office (Wenatchee), or Eastern Washington Field Office (Spokane)

The directing biologist will select suitable block nets. Type of material, length, and depth may vary based on site conditions. Typically block nets will be composed of 9.5 millimeter stretched nylon mesh and will be installed at an angle to the direction of flow (i.e., not directly perpendicular to flow) so as to reduce the risk of impinging fish. Block nets must be secured along both banks and the channel bottom to prevent erosion and failure due to debris accumulation, high flows, and/or flanking. Some locations may require additional block net support (e.g., galvanized hardware cloth, affixed metal fence posts, etc.). Anchor bags filled (or half-filled) with clean, washed gravel are preferred over sandbags, especially for nets and anchors that will or may remain in-place for a long duration (i.e., more than 2 weeks). Native materials will not be used as fill for anchor bags. Any use or movement[3] of native substrates or other materials will be incidental and will not appreciably affect channel bed or bank conditions.

Except when planning and intending to herd fish upstream, an upstream block net will be placed first. With a block net secured to prevent movement of fish into the work area from upstream, a second block net will be used as a seine to herd fish in a downstream direction. Where the area to be isolated includes a culvert(s), deep pools, undercut banks, or other cover attractive to fish (e.g., thick overhanging vegetation, rootwads, logjams, etc.) it may be appropriate to isolate a portion or portions of the work area in phases, rather than attempting to herd fish from the entirety of the work area in a single downstream pass. Fish capture and removal will be most successful if an effort is made to strategically focus and concentrate fish in areas where they can be easily seined and netted. Care will be taken not to concentrate fish where they are exposed to sources of stress, or to leave them concentrated in such areas for a long duration (e.g., more than 30 minutes).

Field staff will be assigned the responsibility of frequently checking and maintaining the nets for accumulated debris, general stability, and proper function. A qualified biologist, or other field staff trained in safe fish handling, will be assigned the responsibility of inspecting the nets and safely capturing and relocating any impinged fish. The frequency of these inspections will be determined by the directing biologist on a case-by-case basis, dependent upon the site, seasonal, and weather conditions. Block nets placed within a local population of bull trout (defined as areas used by bull trout for spawning and/or rearing) will be checked every 4 hours, 24 hours a day, for the duration the block net is in operation. If any bull trout are impinged or killed on or by the nets, the frequency of net inspection will be increased to once hourly, 24 hours a day, for the duration the block net is in operation. If any bull trout are impinged or killed on or by the nets, the frequency of net inspection will be increased to once hourly, 24 hours a day. In the event fish are found impinged on the net(s), or if weather or flow conditions change significantly, the directing biologist will re-consider and adjust the frequency of net inspections so as to

[3] Small instream boulders may be used temporarily to hold net in place and returned to their previous instream position upon removal of net.

minimize the risk of impinging and injuring fish. Block nets will remain in-place until work is complete and conditions are suitable for the reintroduction of fish[4].

Depending upon site characteristics, and the planned staging and sequence for work area isolation and dewatering, it may or may not be necessary to place a downstream block net. Typically, however, site characteristics and/or the duration of planned in-water work will necessitate placement of a net(s) to prevent upstream movement of fish into the work area. If groundwater seepage or site drainage has a tendency to re-wet the area, if the area to be isolated is low-gradient or subject to a backwatering influence, or if the area to be isolated is large and considerable effort will be expended in capturing and removing fish, a downstream block net will be placed. If foreseeable flow conditions over the duration of planned in-water work might enable fish to re-enter the work area from downstream, a downstream block net will be placed.

In most instances where gradual dewatering or flow diversion is staged in conjunction with fish capture and removal, it is appropriate to delay installation of the downstream block net(s) until after fish have been given sufficient time to move downstream by their own choosing. If flows are reduced gradually over the course of several hours, or the length of an entire workday, some (perhaps many) fish will make volitional movements downstream beyond the area to be isolated. Gradual dewatering can be an effective means by which to reduce the risk of fish stress or injury. Gradual dewatering and the encouragement of volitional movement are particularly important where the area to be isolated is large and may hold many fish. However, where the area to be isolated includes a culvert(s), deep pools, undercut banks, or other cover attractive to fish, some (perhaps many) fish will not choose to move downstream regardless of how gradually flows are reduced. The directing biologist will use his/her best professional judgment in deciding what sequence of activities is likely to minimize fish stress or injury (including stranding).

Where the area to be isolated is small, depths are shallow, and conditions are conducive to fish capture, it may be possible to remove all fish life prior to dewatering or to implement plans for dewatering staged with fish capture over a relatively short timeframe (e.g., 1 to 2 hours). Where the area to be isolated is large, depths are not shallow, where flow volumes or velocities are high, and/or conditions are not conducive to easy fish capture, dewatering or flow diversion will be staged in conjunction with fish capture and removal over a longer timeframe (e.g., 3 to 6 hours). The largest areas and/or most difficult site conditions may warrant or require that plans for dewatering and fish capture proceed over the length of an entire workday, or multiple workdays. Where this is the case, fish will be given sufficient time and a means to move downstream by their own

[4] If plans for work area isolation and fish capture and removal include the installation of temporary cofferdams, and once the directing biologist has confirmed fish have been successfully excluded from the entire area enclosed by the cofferdam(s), it may be appropriate to remove block nets and allow fish to re-enter the previously isolated work area; this approach is particularly relevant and appropriate where many weeks or months of construction are planned for completion within temporary cofferdams (i.e., isolated from flowing waters).

choosing to reduce the total number of fish exposed to sources of stress and injury (including fish handling). Extra time needed for this voluntary fish movement needs to be considered and provided for as part of the dewatering process.

Dewatering and Flow Diversion

If dewatering and/or flow diversion are necessary, this work (including related fish capture and removal operations) will comply with any provisions contained in the Hydraulic Project Approval (HPA), or applicable General HPA, issued by the WDFW. If the FWS has provided relevant Terms and Conditions from a Biological Opinion addressing the work (or action), this work will also comply with those Terms and Conditions.

If pumps are used to temporarily bypass water or to dewater residual pools or cofferdams, pump intakes will be screened to prevent aquatic life from entering the intake. Fish screens or guards will comply with Washington State law (RCW 77.57.010 and 77.57.070), with guidelines prescribed by the NMFS[5], and any more stringent requirements contained in the HPA or General HPA issued by the WDFW. If pumps are to be used on a more permanent basis, as the primary or secondary method for diverting flow around the isolated work area, plans for dewatering will address contingencies (i.e., extremes of flow or weather). These plans will include ready access to a larger or additional "back-up" pump with screened intake. If the directing biologist has confirmed that all fish have been successfully excluded from the area, if there is no risk of entraining fish, and adequate plans are in-place to address contingencies (including a routine schedule for inspection), then pumps may be operated without a screened intake. Use of an unscreened intake pump shall be documented.

Fish Capture and Removal

Methods for safe capture and removal of fish from the isolated work area are described below. These methods are given in order of preference. At most locations, a combination of methods will be necessary. To avoid and minimize the risk of injury to fish, attempts to seine and/or net fish will always precede the use of electrofishing equipment. Visual observation techniques (e.g., snorkeling, surveying with polarized glasses or Plexiglas bottomed buckets, etc.) may be used to assess the effectiveness of these methods, to identify locations where fish are concentrating, or otherwise adjust methods for greater effectiveness.

If the planned fish capture and removal operations have not been addressed through section 7 consultation (for example, due to an emergency), seining and netting are impracticable (i.e., electrofishing is deemed the only viable means of fish capture), and

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[5] National Marine Fisheries Service. 1997. Fish screening criteria for anadromous salmonids. NMFS Southwest Region, January 1997, 12p. << http://swr.nmfs.noaa.gov/hcd/fishscrn.pdf >>.

bull trout may be present, the directing biologist will provide notice to the FWS. This notice will be provided in advance of the operations, and will include an explanation of the unique site conditions or circumstances. Work conducted under a declared emergency (or emergency conditions) will follow established notification protocols under section 7 of the ESA.

Where bull trout and non-listed fish may be present, the directing biologist will ensure that fish capture and removal operations adhere to the following minimum performance measures or expectations:

1) Only dip nets and seines composed of soft (non-abrasive) nylon material will be used.

2) The operations will not resort to the use of electrofishing equipment unless and until other, less injurious methods have removed most or all of the adult and sub-adult fish (i.e., fish in excess of 300 millimeters); the operations will conduct a *minimum* of three complete passes *without capture* using seines and/or nets prior to the use of electrofishing.

3) The operations will confirm success of fish capture and removal before completely dewatering or commencing with other work within the isolated work area; the operations will conduct a minimum of two complete passes without capture using electrofishing equipment.

4) 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.

5) A plan for achieving efficient return to appropriate habitat will be developed before the capture and removal process.

6) Every attempt will be made to release ESA-listed specimens first.

<u>Seining</u>

Seining will be the preferred method for fish capture. Other methods will be used when seining is not possible, or when/after attempts at seining have proven ineffective. Seines, once pursed, will remain partially in the water while fish are removed with dip nets. Seines with a "bag" minimize handling stress are preferred. Seines with a bag are also preferred where obstructions make access to the water (or deployment/ retrieval of the seine) difficult.

In general, seining will be more effective if fish, especially juvenile fish, are moved (or "flushed") out from under cover. Methods which may increase effectiveness and/or efficiency include conducting seining operations at dawn or dusk (i.e., during low-light conditions), in conjunction with snorkeling, and/or flushing of the cover. In flowing waters, and especially where flow volume or velocity is high or moderately-high, seines that employ a heavy lead line and variable mesh size are preferred.

Small mesh sizes are more effective across the full range of fish size (and age class), but also increase resistance and can make deployment/ retrieval more difficult in flowing waters. Seines which use a small mesh size in the bag (or body), and a larger, less resistant mesh size in the wings may under some conditions be most effective and efficient.

Baited Minnow Traps

Baited minnow traps are typically used before and in conjunction with seining. Traps may be left in the isolated work area overnight. Traps will be inspected at least four times daily to remove captured fish and thereby minimize predation within the trap. Traps will be checked more frequently if temperatures are in excess of 15 degrees C.

Predation within the trap may be an unacceptable risk when minnow traps are left in-place overnight; large sculpin and other predators that feed on juvenile fish are typically much more active at night. The directing biologist will consider the need and plan for work outside daylight hours (i.e., inspection and removal) before leaving minnow traps in-place overnight.

Dip Nets

Dip nets will be used in conjunction with seining. This method is particularly effective when employed during gradual dewatering or flow diversion. To be most effective and to minimize stress and risk of injury to fish (including stranding), the directing biologist will coordinate fish capture operations with plans for dewatering or flow diversion. Plans for dewatering and/or flow diversion will proceed at a measured pace (within constraints), to encourage the volitional downstream movement of fish, and reduce the risk of stranding. The directing biologist shall monitor the dewatering process to insure that water is removed slowly to allow for fish capture and preclude stranding. Plans for dewatering and/or flow diversion will not proceed unless there are sufficient staff and materials on-site to capture and safely remove fish in a timely manner. Generally this will require a minimum of two persons (three if electrofishing), but the directing biologist may find that some sites (especially large or complicated sites) warrant or require a more intensive effort (i.e., additional staffing).

Once netted, fish will remain partially in water until transferred to a bucket, cooler, or holding tank. Dip nets which retain a volume of water ("sanctuary nets") are preferred. However, sanctuary nets may be ineffective where flow volume or velocity is high or moderately-high (i.e., increased resistance lessens ability to net and capture fish). In addition, where water depths are very shallow and/or fish are concentrated in very small receding pools or coarse substrate, "aquarium" nets may be a better, more effective choice. Use of dip nets in conjunction with snorkeling, flushing of the cover, or around the hours of dawn or dusk (i.e., during low-light conditions), can be effective for capturing fish sheltered below cover.

Connecting Rod Snakes

Connecting rod snakes may be used to flush fish out of stream crossing structures (i.e., culverts). Connecting rod snakes are composed of wood sections approximately 3 feet in length. Like other cover attractive to fish, culverts (especially long culverts), can present a challenge to fish capture and removal operations. The directing biologist will plan a strategy for focusing and concentrating fish in areas where they can be easily seined and netted, and will take active steps to prevent fish from evading capture. When first implementing plans for work area isolation, fish capture and removal, and dewatering, it may be appropriate to place block nets immediately upstream and/or downstream of culverts to minimize the number of fish that might seek cover within the culvert(s). Once most or all of the fish have been removed from other parts of the work area, the block net placed downstream of the culvert(s) will be removed to encourage volitional downstream movement of fish.

Electrofishing

Electrofishing will be performed only when other methods of fish capture and removal have proven impracticable or ineffective at removing all fish. The directing biologist will ensure that attempts to seine and/or net fish always precede the use of electrofishing equipment. Larger fish (i.e., adult and sub-adult fish with comparatively longer spine lengths) are more susceptible to electrofishing injury than smaller fish. To minimize the risk of injury (and the number of fish potentially injured), the directing biologist will confirm that other methods have been effective in removing most or all of the adult and sub-adult fish before resorting to the use of electrofishing equipment; see the related performance measure appearing on page 6. As a general rule or performance measure, electrofishing will not be conducted under conditions that offer poor visibility (i.e., visibility of less than 0.5 meter).

The following performance measures will apply to the use of electrofishing equipment as a means of fish capture and removal:

1) Electrofishing will only be conducted when a directing biologist with at least 100 hours of electrofishing experience or completion of and/or certification from acceptable training[6] is on-site to conduct or direct all related activities. The directing biologist will be familiar with the principles of electrofishing, including the effects of voltage, pulse width and pulse rate on fish, and associated risk of injury or mortality. The directing biologist will have knowledge regarding galvanotaxis, narcosis and tetany, their relationships to injury/mortality rates, and will have the ability to recognize these responses when exhibited by fish.

[6] For example, the National Conservation Training Center's *Principles & Techniques of Electrofishing* course.

2) The directing biologist will ensure that electrofishing attempts use the minimum voltage, pulse width, and rate settings necessary to achieve the desired response (galvanotaxis). Water conductivity will be measured in the field prior to each electrofishing attempt to determine appropriate settings. Electrofishing methods and equipment will comply with guidelines outlined by the NMFS[7].

3) The initial and maximum settings identified below (Table 1) will serve as guidelines when electrofishing in waters that may support bull trout. Use only DC or pulsed DC current. [**Note**: some newer, late-model electrofishing equipment includes a "set-up" or initialization function; the directing biologist will have the discretion to use this function as a means to identify proper initial settings.]

Table 1. Guidelines for initial and maximum settings for backpack electrofishing.[8]

	Initial Settings	**Conductivity (µS/cm)**	**Maximum Settings**
Voltage	100 V	≤ 300 > 300	800 V 400 V
Pulse Width	500 µs		5 ms
Pulse Rate	15 Hz		60 Hz [*In general*, exceeding 40 Hz will injure more fish.]

Each attempt will begin with low settings for pulse width and pulse rate. If fish present in the area being electrofished do not exhibit a response, the settings will gradually be increased until the appropriate response is achieved (galvanotaxis). The lowest effective settings for pulse width, pulse rate, and voltage will be used to minimize risks to both personnel and fish. Safe implementation is a high priority. The directing biologist will ensure the safety of all individuals assisting with electrofishing attempts; this includes planning for and providing all necessary safety equipment and materials (e.g., insulated waders and gloves, first aid/CPR kit, a current safety plan with emergency contacts and phone numbers, etc.). Only individuals that are trained and familiar with the use of electrofishing equipment will provide direct assistance during electrofishing attempts.

4) Electrofishing will not be conducted where spawning adults or redds with incubating eggs may be exposed to the electrical current. As a general rule or performance measure, waters that support bull trout will not be electrofished from October 15 through May 15, and resident waters from November 1 through May

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[7] National Marine Fisheries Service. 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act. NMFS Northwest Region, June 2000, 5p. << http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/4d-Rules/upload/electro2000.pdf >>.

[8] Adapted from NMFS (June 2000) and WDFW Electrofishing Guidelines for Stream Typing (May 2001).

15. If located within a local bull trout population (i.e., that support spawning and rearing[9]), seasonal limitations on the use of electrofishing equipment may be more restrictive; if you have questions, contact the FWS. If more restrictive work windows have been identified through consultation, those windows will apply. The directing biologist will ensure that electrofishing attempts are made only during appropriate times of year, and not where spawning adults or redds with incubating eggs may be exposed to the electrical current.

5) An individual will be stationed at the downstream block net(s) during electrofishing attempts to recover stunned fish in the event they are flushed downstream and/or impinged against the block net(s). The nets will also be checked after all electrofishing is complete.

6) The operator will use caution to prevent fish from coming into direct contact with the anode. Under most conditions, the zone of potential fish injury extends approximately 0.5 meter from the anode. Netting will not be attached to the anode, as this practice presents an increased risk of direct contact and injury. Extra care will be taken near in-water structures or undercut banks, in shallow waters, or where fish densities are high. Under these conditions, fish are more likely to come into close or direct contact with the anode and/or voltage gradients may be intensified. Re-adjust voltage and other settings to accommodate changing conditions in the field, including channel depth. When electrofishing near undercut banks, overhanging vegetation, large cobble or boulders, or where structures provide cover, fish that avoid capture may be exposed to the electrical current repeatedly. Repeated or prolonged exposures to the electrical current present a higher risk of injury, and therefore galvanotaxis will be used to draw fish out of cover.

7) Electrofishing will be conducted in a manner that minimizes harm to fish. Once an appropriate fish response (galvanotaxis) is achieved, the isolated work area will be worked systematically. The number of passes will be kept to a minimum, but is dependent upon the numbers of fish and site characteristics and will be at the discretion of the directing biologist. Do not conduct electrofishing unless there are sufficient staff and materials on-site, to minimize the number of passes required and to locate, net, recover, and release fish in a timely manner. Generally, this will require a minimum of three persons, but the directing biologist may find that some sites (especially large or complicated sites) warrant or require a more intensive effort (i.e., additional staffing). Care will be taken to remove fish from the electrical field immediately and to avoid exposing the same fish repeatedly. Fish will not be held in dip nets while electrofishing is in progress (i.e., while continuing to capture additional fish). [Note: where flow velocity or turbulence is high or moderately-high (e.g., within riffles) it may be difficult to see and net fish; these fish may evade capture (resulting in repeated

[9] See bull trout draft recovery plans for local population information. This information is available at http://www.fws.gov/pacific/bulltrout/Recovery.html.

exposure), or may become impinged on the downstream block net(s); a "frame" net, or small and portable block net approximately 3 feet in width, can be effective under these conditions when held downstream in close proximity to the anode.]

8) Carefully observe and document the condition of captured fish. Dark bands on the body and/or extended recovery times are signs of stress or injury. When such signs are noted, settings for the electrofishing unit may require readjustment. The directing biologist will also review and consider changes to the manner in which the electrofishing attempt is proceeding. If adjustments to the electrofishing attempt do not lessen the frequency (or severity) of observed stress, the directing biologist will have the authority to postpone fish capture and removal operations[10]. Each fish must be capable of remaining upright and actively swimming prior to release (see Fish Handling, Holding, and Release).

9) 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 or below 4°C.

Fish Handling, Holding, and Release

- Fish will not be sampled or anesthetized, unless for valid purposes consistent with the entity's section 10 scientific collection permits.

- Fish handling will be kept to the minimum necessary to remove fish from the isolated work area. Fish capture and removal operations will be planned and conducted to minimize the amount and duration of handling. The operations will maintain captured fish in water to the maximum extent possible during seining/netting, handling, and transfer for release.

- Individuals handling fish will ensure that their hands are free of harmful and/or deleterious products, including but not limited to sunscreen, lotion, and insect repellent.

- The operations will ensure that water quality conditions are adequate in the buckets, coolers, or holding tanks used to hold and transfer captured fish. The operations will use aerators to provide for clean, cold, well-oxygenated water, and/or will stage capture, temporary holding, and release to minimize the risks associated with prolonged holding. The directing biologist will ensure that

[10] If the FWS and/or NMFS have provided an Incidental Take Statement from a Biological Opinion addressing the work (or action), the directing biologist shall ensure limits on take have not been exceeded; if the limits on take are exceeded, or if take is approaching these limits, the directing biologist shall postpone fish capture and removal operations and immediately notify the Federal agency (or agencies) with jurisdiction.

conditions in the holding containers are monitored frequently and operations adjusted appropriately to minimize fish stress. If bull trout will be held for more than a few minutes prior to release, the directing biologist will consider using dark-colored, lidded containers only. Bull trout will not be held in containers for more than 10 minutes, unless those containers are dark-colored, lidded, and fitted with a portable aerator; small coolers meeting this description are preferred over buckets. Bull trout will not be kept in the same holding container or area with aquatic species that may prey on or injure them.

- The operations will provide a healthy environment for captured fish, including low densities in holding containers to avoid effects of overcrowding. Large fish will be kept separate from smaller fish to avoid predation. The operations will use water-to-water transfers whenever possible.

- The release site(s) will be determined by the directing biologist. The directing biologist will consider both site characteristics (e.g., flow, temperature, available refuge, and cover, etc.) and the types of fish captured (e.g., out-migrating smolt, kelt, pre-spawn migrating adult, etc.) when selecting a release site(s). More than one site may be designated to provide for varying needs, and to separate prey-sized fish from larger fish. The directing biologist will consider habitat connectivity, fish habitat requirements, seasonal flow, water temperature, and the duration and extent of planned in-water work when selecting a fish release site(s). If conditions upstream of the isolated work area may become unfavorable during construction, then fish will not be released to an upstream location. However, the directing biologist will also consider whether planned in-water work presents a significant risk of downstream turbidity and sedimentation; fish released to a downstream location may be exposed to these conditions. Site conditions may warrant releasing fish both upstream and downstream, or relocating fish at a greater distance (e.g., thousands of feet or miles), so as to ensure fish are not concentrated in areas where their habitat needs cannot be met. For a fuller discussion of this topic see **Staging and Sequencing of Work**.

- The directing biologist will ensure that each fish is capable of remaining upright and has the ability to actively swim upon release.

- Any ESA-listed fish incidentally killed as a result of fish capture and removal operations will be preserved and delivered to the appropriate authority upon request (see Documentation, p. 14; if applicable, see the reporting requirements of the associated Biological Opinion for the action).

- If the limits on take of ESA-listed species are exceeded (harm or harassment), or if incidental take is approaching and may exceed specified limits, the directing biologist will postpone fish capture and removal operations and immediately notify the Federal agency (or agencies) with jurisdiction. If dewatering or flow diversion is incomplete and still in-progress, the entity will take remedial actions directed at maintaining sufficient quantity and quality of flow and lessening sources of fish stress and/or injury. If conditions contributing to fish stress and/or injury may worsen before the federal agency with jurisdiction can be contacted, the entity will attempt to move fish to a suitable location near the capture site while keeping fish in water and reducing stress as much as possible.

Reintroduction of flow and fish to the isolated work area

If conducting work in isolation from flowing waters has required placement of a block net(s), fish capture and removal, and temporary dewatering, the directing biologist will ensure that the block net(s) remain in-place until work is complete and conditions are suitable for the reintroduction of fish[5]. Flows will be gradually reintroduced to the isolated work area, so as to prevent channel bed or bank instability, excessive scour, or turbidity and sedimentation. The directing biologist will inspect the work area and downstream reach to ensure no fish are stranded or in distress during reintroduction of flows. If conditions causing or contributing to fish stress and/or injury are observed, the entity will take remedial actions directed at lessening these sources of stress. This may include a more gradual reintroduction of flow, so as to reduce resulting turbidity and sedimentation.

All temporary structures and materials (e.g., block nets, posts, and anchors; bypass flume or culvert; sandbag, sheet pile or similar cofferdam; etc.) will be removed at the completion of work. The directing biologist will document in qualitative terms the final condition of the isolated work area (including temporary bypass). The directing biologist will identify and document any obvious signs of channel bed or bank instability resulting from the work, and will report these conditions to the appropriate staff for remedy. The entity will document any additional actions taken to correct channel instability, and the final condition of the isolated work area (including temporary bypass).

To avoid and minimize the risk of introducing or spreading nuisance or invasive species, aquatic parasites, or disease, the directing biologist will ensure that all equipment and materials are cleaned and dried before transporting them for use at another site or waterbody.

DOCUMENTATION

- The directing biologist will document and maintain accurate records of the operations, including the following: project location, date, methods, personnel, water temperature, conductivity, visibility, electrofishing equipment settings, and other comments, fish species, number, age/size class estimate, condition at release, and release location.

- If at any time, fish are observed in distress, a fish kill occurs, or water quality problems develop (including equipment leaks or spills), the entity will provide immediate notification to the WDFW consistent with any provisions contained in the HPA (or applicable General HPA).

- Bull trout incidentally killed as a result of fish capture and removal operations will be documented with notification provided to the appropriate authority (FWS) within two working days. Initial notifications may consist of a phone call or voice mail message. Initial notifications will be directed to the following: the nearest FWS Law Enforcement Office, and the Washington Fish and Wildlife Office at (360) 753-9440. Any dead specimens will be kept whole and preserved on-ice or frozen until the entity receives a response and further directions from the appropriate authority; if the entity receives no response within 10 working days, the directing biologist will have the discretion to dispose of specimens. Initial notifications will be followed by a second notification in writing. All notifications will provide at a minimum the following: date, time, entity point-of-contact (the directing biologist and/or supervisor), project name (and FWS consultation tracking number), precise location of any incidentally killed or injured and unrecovered fish, number of specimens and species, and cause of death or unrecoverable injury. If the limits on incidental take are exceeded (harm or harassment), the written notification will also include an explanation of the circumstances causing or contributing to observed levels of take.

- The final condition of the isolated work area (including temporary bypass) will be documented in qualitative terms, including any obvious signs of channel bed or bank instability resulting from the work. The entity will document any additional actions taken to correct channel instability, and the final condition of the isolated work area (including temporary bypass).

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Appendix F

USFWS 2011 Biological Opinion for the Operations and Maintenance of the LNFH

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Biological Opinion

for the

Operations and Maintenance of the Leavenworth National Fish Hatchery

USFWS Reference: 13260-2011-F-0048 and 13260-2011-P-0002
Cross reference: 13260-2011-P-0002 and 13260-2011-I-0056
HUC: 17-02-00-11-04, Icicle/Chumstick

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INTRODUCTION

This document transmits the Fish and Wildlife Service's (Service or USFWS) biological opinion (BO or Opinion) based on our review of the proposed operations and maintenance (O&M) of the Leavenworth National Fish Hatchery (LNFH or Project) and their effects on the threatened bull trout (*Salvelinus confluentus)* and its designated critical habitat. The LNFH is located in Chelan County, Washington. This intra-service consultation was conducted in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*.). Your March 4, 2011, request for formal consultation and the final biological assessment (BA; USFWS 2011) were received on March 7, 2011.

This Opinion is based on information provided in the BA and its drafts, numerous e-mails and meetings notes about the Project compiled since 2003; National Environmental Policy Act (NEPA) documents pertaining to the LNFH; published literature and unpublished reports; the proposed and final rules for listing of the bull trout; the 2002 draft *Bull Trout Recovery Plan* (USFWS 2002a), especially the chapter on the upper Columbia River recovery unit (USFWS 2002b); updates of that draft based on ongoing recovery team meetings through March 2011; the final designations of critical habitat for the bull trout (75 FR 63898); the 5-year review for the bull trout (USFWS 2008a); Icicle Creek watershed analysis, prepared by the U.S. Forest Service (USFS 1995); State of Washington limiting habitat factors analysis for the Wenatchee basin (Andonaegui 2001); Upper Columbia Salmon Recovery Plan (Upper Columbia Salmon Recovery Board 2007) and associated analyses; watershed planning documents; and field visits to the Project site. The decision record for this consultation is on file at the Service's Central Washington Field Office (CWFO) in Wenatchee, Washington.

CONSULTATION HISTORY

March 1999: The Service's Moses Lake Ecological Service's (ES) Field Office issued a memorandum to the LNFH concurring that O&M of the LNFH may effect, but was not likely to adversely affect the bull trout.

April 2003: The Service's ES program in Central Washington (now located in the CWFO), LNFH, and the mid-Columbia Fisheries Resource Office (MCFRO) met to discuss new or updated consultations for several activities that would be implemented at the LNFH over the next few years, including Phase II of the Icicle Creek Restoration Project, and an Intake Rehabilitation Project. ES advised the LNFH to initiate formal consultation on O&M of the LNFH because adverse affects on bull trout were occurring due to those O&M activities.

June 2005: The LNFH advised ES that it would begin developing a BA for the effects of O&M at the LNFH on the bull trout.

November 2005: The LNFH submitted a draft BA on LNFH O&M to ES; ES reviewed the draft BA and requested additional information.

January 2006: The LNFH submitted a second draft BA on LNFH O&M to ES; ES reviewed the draft BA and requested additional information.

March 2006: The LNFH submitted a third and fourth draft BA on LNFH O&M.

April 2006: Upon reviewing the March 2006, draft BAs, ES recommended modifications to the proposed action to reduce project effects on the bull trout, and recommended that these modifications be incorporated into the proposed action as an amendment to the final BA.

July 2006: The LNFH submitted a final BA and requested concurrence/formal consultation on a "may affect, likely to adversely affect" determination for the bull trout.

August 2006: ES issued its BO (USFWS ref 13260-2006-P0010) on the effects of O&M of the LNFH on August 31, 2006, effective through 2011 on the bull trout.

June 2007: The Service announces a decision to remove the bald eagle (*Haliaeetus leucocephalus)* from the list of threatened and endangered species.

December 2006: Washington Trout (now Wild Fish Conservancy) filed an amended complaint challenging the Service's Biological Opinion on the effect of Leavenworth National Fish Hatchery's operation of its facility on bull trout.

November 2007: The Service receives District Court Order granting defendants' motion for voluntary remand in Wild Fish Conservancy v. Kempthorne; Court directs Service to complete new consultation documents by no later than February 18, 2008.

February 2008: ES issues its remanded BO (USFWS ref: 13260-2008-F-0040) on the effects of O&M of the LNFH on the bull trout February 15, 2008, superseding the 2006 BO for O&M 2006-2011. Wild Fish Conservancy challenged the 2008 BO in a second supplemental complaint. Both parties moved for summary judgment. The district court granted the Service's motion and denied the Conservancy's. The Conservancy timely appealed.

December 2009: After having prepared a draft Environmental Analysis (EA) and design to replace the water intake and delivery system, the LNFH held public meetings on the proposed construction and operational changes. The proposed construction sought American Recovery and Reinvestment Act (ARRA) funds to complete this project.

January 2010: The Bureau of Reclamation (BOR) announced on January 14, 2010, that based on the comment received during public meetings, engineering assessments, and deadline constraints, it was releasing ARRA funds secured for LNFH to other BOR projects. BOR stated it would delay the release of the draft EA in order to further investigate the design challenges and to address public concerns presented at December 2009 public meetings.

October 2010: The Service issues its final rule designating critical habitat for the bull trout (75 FR 63898), effective November 17, 2010. ES advised the LNFH that this triggered reinitiation of consultation, but also suggested since the existing BO would expire at the end of 2011, a complete reanalysis of O&M was warranted to cover all existing activities and any anticipated modifications of the proposed action.

November 2010: ES and LNFH staff began discussions to frame the analysis for O&M beyond 2011 to include bull trout critical habitat and any anticipated changes to the proposed action.

December 2010: The 9th Circuit Court of Appeals, in Wild Fish Conservancy v. Salazar, issued an opinion on the 2008 BO that reversed the trial court decision. Among its determinations, the court concluded: (1) the jeopardy analysis did not articulate a rational connection between the facts found and the conclusions made; (2) the BO's focus on a 5-year term was arbitrary; and (3) that certain monitoring requirements Incidental Take Statement were insufficient.

December 2010-February 2011: Numerous emails, telephone and conference calls, and meetings were conducted between Regional fisheries and section 7 staff, ES, LNFH, and MCFRO staff to ensure a common understanding of the 9th Circuit's decision and to devise a remedy. The strategy adopted was to (1) change the term of the proposed action to an indefinite period of time; (2) to modify the proposed action to provide for the maximum opportunity for bull trout passage, while meeting LNFH operational needs and Service's Tribal trust responsibilities for the Tribal fishery at the spillway pool; and (3) to complete the new BO before broodstock collection begins (May 15), which may "take" migratory bull trout through impairment of upstream passage.

March 2011: On March 7, 2011, ES staff at the CWFO received the final BA and request for consultation for LNFH O&M. ES determined that the BA was adequate and contained all the information needed to begin formal consultation, and completed informal consultation (USFWS reference: 13260-2011-I-0047).

April 2011: ES staff at the CWFO completed consultation on April 13, 2011, with the Environmental Protection Agency (EPA) regarding their issuance of a National Pollution Discharge Elimination System (NPDES) permit for the LNFH (USFWS reference 13260-2011-I-0056). This permit regulates effluent limitations and discharges, monitoring and reporting requirements, and best management practices at LNFH. Coordination on this project had begun in late 2010.

May 2011: The U.S. District Court, Eastern District of Washington, granted injunctive relief on May 5, 2011, following the 9th Circuit Court of Appeals remand of Wild Fish Conservancy v. Salazar. Injunctive relief includes "minimize the irreparable harm the Hatchery inflicts on threatened bull trout by removing all racks and boards in structure 5 and by maintaining both radial gates at structure 2 in fully opened positions, subject to those exceptions noted below, until a new biological opinion is issued and determined by the Court to be in compliance with the ESA and the decision in *Wild Fish Conservancy v. Salazar*, 628 F.3d 513 (9th Cir. 2010)." Exceptions include provisions to close structures 2 and 5 under certain conditions for flood control, maintenance and preservation of the structures, pre-smolt release, aquifer recharge, and in the event of more than 50 Chinook pass upstream of structure 5.

BIOLOGICAL OPINION

I. DESCRIPTION OF THE PROPOSED ACTION

The LNFH was authorized by the Grand Coulee Fish Maintenance Project in 1937 and reauthorized by the Mitchell Act of 1938. The hatchery is one of three mid-Columbia stations (consisting of the Leavenworth, Entiat, and Winthrop NFHs) constructed by the BOR as fish mitigation facilities for the Grand Coulee Dam, Columbia Basin Project. Construction of the LNFH and the other two hatcheries began in 1939; funding for construction and operation of these hatcheries was provided through a transfer of funds from the BOR to the Service until 1945. From 1945 to 1993, the Service had funding, management, and operation responsibilities for these 3 hatcheries. Beginning in Fiscal Year (FY) 1994, the BOR assumed funding responsibility for these hatcheries while the Service continued to manage and operate the three facilities. In FY 2004, the interagency agreement between BOR and the Service for O&M of the three hatcheries was approximately $3.9 million.

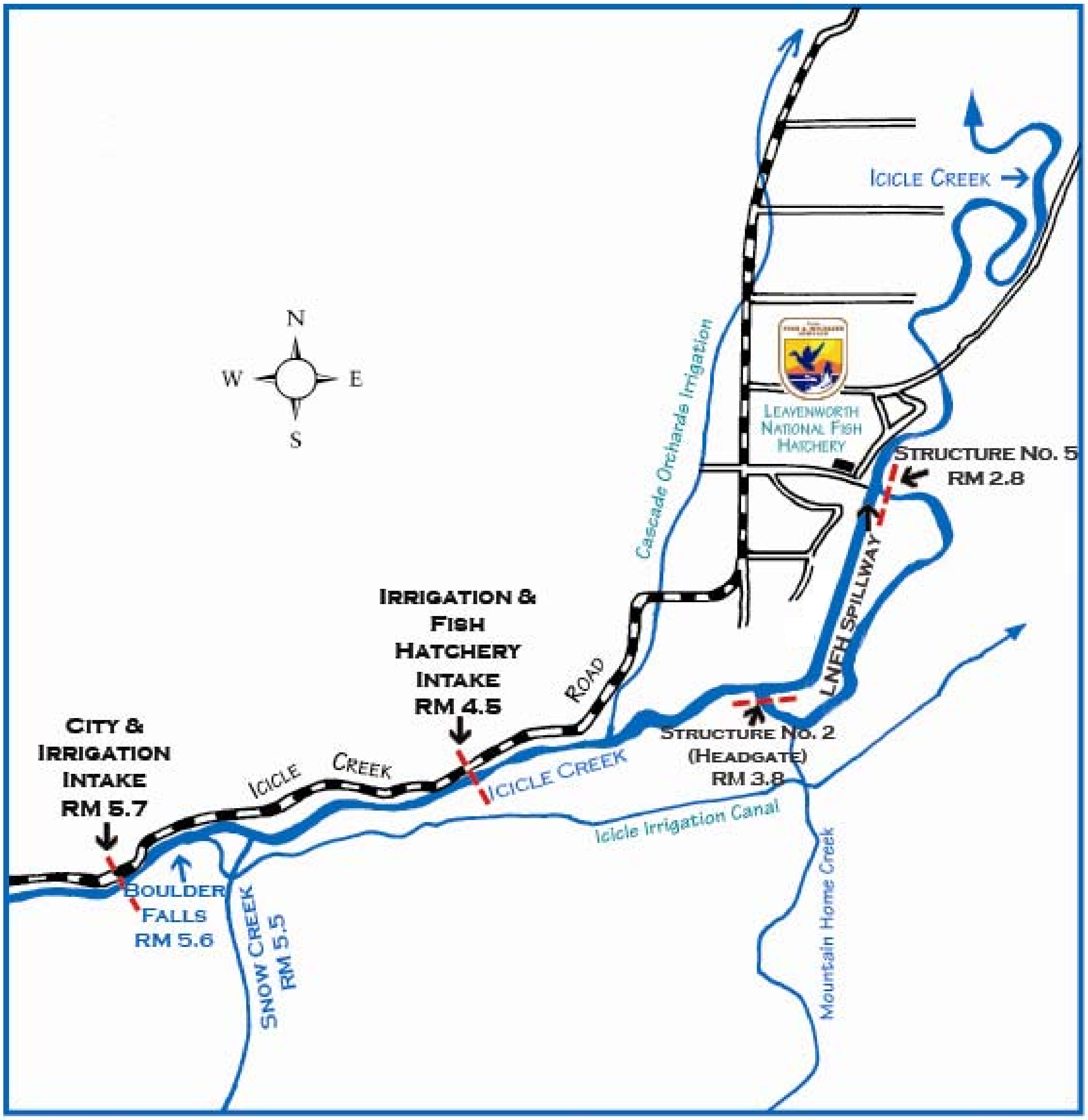
The following discussion is a summary of the proposed O&M of the LNFH beginning in 2011; a complete description is contained in the final BA, portions of which are excerpted below (USFWS 2011). The proposed action described in the BA is incorporated by reference; for a complete description of the proposed action, see the Project BA.

A. Summary of the Proposed Action

The Project involves the operation and maintenance at the LNFH. Briefly, activities are divided into three general project elements: (1) water supply system, (2) broodstock collection (BSC) and rearing of juvenile fish, and (3) release of pre-smolt salmon. The water supply system is comprised of a surface diversion (diverting 42 cfs) and one deep and six shallow aquifer wells. Water is also impounded and released from Snow and Nada Lakes, located above the LNFH in the Alpine Lakes Wilderness, to augment low flows in Icicle Creek and to provide a reliable water supply for the LNFH. BSC typically spans a period of May 15-July 7, with a goal of collecting 900 spring Chinook salmon (*Oncorhynchus tshawytscha*) to be spawned. The resulting eggs are incubated, and juveniles reared, at LNFH facilities. The LNFH currently releases approximately 1.2 million pre-smolt Chinook into Icicle Creek around the third week of April each year.

Associated actions include a variety of maintenance activities, monitoring, and flow manipulations (including helicopter access to manage Snow and Nada Lakes water releases) to facilitate hatchery operations. Pollution abatement pond operation and maintenance and burial of hatchery-spawned salmon carcasses also occur on LNFH lands. The term of the proposed action continues into perpetuity, relying on monitoring to test our reasoned assumptions and consultation reinitiation triggers to address changed conditions.

Figure 1. Vicinity map of the LNFH and associated structures.



Two instream structures are important for managing hatchery operations and broodstock collection (structures 2 and 5). The LNFH has proposed a new operational approach for structures 2 (rm 3.8) and 5 (rm 2.8) to improve passage opportunities for bull trout.

Essentially, structures 2 and 5 will always remain open except under the following conditions (Table 1):

Table 1. Operation of Structures 2 and 5, beginning in 2011.

Condition	Response	Timing
1. >50 Chinook pass above structure 5	Close structure 5 by installing picket gates, dam boards, and trap	Potential exists during BSC (May 15-July 7)
2. During high flow events (i.e., streamflow is one foot from decking of structure 5)	Lower structure 2, minimizing high flows in the historical channel and increasing the flow in the hatchery channel	Typically Spring runoff and rain-on-snow events (event timing varies with the hydrograph)
3. During low flow events (<300 cfs in the Icicle above rm 3.8)	Lower structure 2, increasing flow in the hatchery channel and improving groundwater well recharge	Typically late summer-winter (lasting 15 days or more per event)
4. Maintenance of structure 5	Lower structure 2, minimizing flows in the historical channel	Typically fall and winter (up to 1 week per event)
5. Pre-smolt release	Lower structure 2, maximizing flows in the hatchery channel and facilitating emigration	Typically the 3rd week of April (duration typically up to 10 days)

During BSC, decisions on the period of closure, the extent of closure (i.e., the degree of lowering the radial gates at structure 2 is variable depending on conditions, but is usually not a complete closure), and the re-opening of structures 2 and 5 will be the responsibility of the existing adaptive management group, comprised of the USFWS (ES, MCFRO and the LNFH), National Oceanic and Atmospheric Administration (NOAA) Fisheries, Washington Department of Fish and Wildlife (WDFW), Yakama Nation and the Colville Tribe. The adaptive management group was first formed in late 2006, when the LNFH convened stakeholders to develop a strategy that addresses future passage of bull trout above the hatchery. A Term and Condition from the 2008 Biological Opinion for Operation and Maintenance (13260-2008-F-0040) directed its continuation to minimize the take of bull trout. The goal is to restore upstream passage (i.e., re-open structures 2 and 5 as much and as soon as possible) while facilitating the Tribal fishery and maintaining hatchery operations. A description of selected activities important to understanding the effects to bull trout follows (largely excerpted from the BA). For a complete description of the proposed action, see the Project BA.

Operation of Structures 2 and 5

When the LNFH was constructed in 1939-1941, a one mile section of Icicle Creek was used for holding and spawning adult fish (historical channel, approx. rm 2.8 – 3.8) (Figure 1). A series of structures and weirs were installed in this stream section to create ponds to hold adult salmonids prior to annual spawning. LNFH operations were conducted principally in the creek. It was operationally critical to be able to control stream flow into this channel. Therefore, a head gate (structure 2, rm 3.8) was constructed at the upstream end of the historical channel and a hatchery channel with a spillway structure at its base (rm 2.8) was built to carry high water flows around these structures. Structure 2 is composed of a concrete foundation and two radial gates. Structure 5, at the downstream end of the historical channel, is composed of a bridge with a foundation to support racks, flashboards, and/or fish traps. The historical channel was used for fish production from the 1940s to the late 1970s and seasonally as late as 2005.

From approximately 1940 to 2000, LNFH operations of structures 2 and 5 seasonally impeded fish passage and controlled surface flows between the two channels. Since 2001, LNFH has adaptively managed structures 2 and 5 to increase fish passage opportunities and improve habitat within the historical channel. The LNFH considers numerous aspects such as native fish passage and rearing, riparian habitat, water quality, health of hatchery fish, managing the number of hatchery origin spring Chinook salmon on the spawning grounds, tribal and sport fishing, flood control, and ground water recharge when adaptively managing these structures. Any time structures 2 or 5 are adjusted (raising or lowering gates at structure 2, installing or removing flashboards or weirs at structure 5), it is done slowly and incrementally at a rate that avoids rapid water level changes to prevent stranding fish. However, ramping rates may be increased during emergency flood control actions. After adjustments are complete, the historical channel is surveyed for stranded fish. In the event stranded fish are observed, they will be captured and returned to the main stream channel. To date, no fish have been stranded. Additionally, when making adjustments to structures 2 and 5, LNFH staff collect water samples to measure potential increases in turbidity to ensure compliance with Water Quality Standards for Surface Waters (WAC 173-201A).

As displayed in Table 1, structures 2 and 5 will remain in the open position all year except if the following conditions arise: (1) 50 returning adult spring Chinook salmon pass upstream of structure 5 during BSC collection (mid-May through early July), (2) stream flow through the hatchery channel is not sufficient to promote pre-smolt emigration during release (late April), (3) stream flow in the hatchery channel has not been sufficient enough to recharge the shallow aquifer and hatchery well production is affected (late summer, fall, and early winter), (4) high stream flows are endangering downstream infrastructure (spring runoff and rain on snow events), or (5) during maintenance of structure 5. These conditions are discussed in more detail below and constitute the most substantive changes since the 2006 BA and 2008 BO.

1. Broodstock Collection

The broodstock collection period for spring Chinook salmon typically occurs from mid-May into early July. During this time both structures 2 and 5 will be in the fully open position. In the event 50 adult spring Chinook salmon pass upstream of structure 5, LNFH will consider alternatives along with recommendations from the adaptive management team, which may include blocking fish passage at structures 2 and 5, to further limit upstream passage of spring Chinook salmon while minimizing potential impacts to non-target taxa. The 50 fish threshold was originally developed by the adaptive management group. If it is necessary to block upstream passage for an extended period of time (for more than one week between May 15th and July 7th), LNFH will operate fish traps in structure 5 to capture bull trout and manually move them upstream of structure 2. Fish traps will be checked twice daily, once at the beginning and end of each day, Monday through Friday. If crowding is occurring in the traps or more than 5 bull trout are encountered in one day, the traps will be checked on weekends also. Managing the upstream passage of spring Chinook salmon is necessary to reduce the disease risk to fish rearing in the hatchery and to reduce potential impacts from interactions between the hatchery's adult Carson stock and ESA listed spring Chinook salmon if LNFH's broodstock does not enter or remain in the vicinity of the hatchery. To enumerate the number of spring Chinook salmon that have passed structure 5, a combination of survey techniques will be used including an underwater Didson fish counter (acoustical imaging sonar camera) and weekly snorkel and bank surveys (when conditions are safe to do so).

2. Release

Salmon smolts use physiological and environmental (spring runoff) cues to initiate their downstream migration. It is beneficial for hatchery pre-smolts to emigrate quickly to reduce potential interactions with non-hatchery fish and to take advantage of fish passage spills at Columbia River dams. Therefore, LNFH may increase stream flows down the hatchery channel by lowering structure 2's radial gates to facilitate pre-smolt emigration during release in late April. This is typically necessary every year and flow is controlled for seven to ten days.

3. Aquifer Recharge

The LNFH operates seven wells which produce the quality of water needed to sustain its fish production program. Currently, LNFH needs between 1,060 and 6,590 gpm of ground water during its fish production cycle (Sverdrup 2000). The hatchery's wells draw water from two aquifers, one deep and one shallow. Wells 1-4 and 7 draw water solely from the shallow aquifer, well 5 from the deep aquifer, and well 6 draws water from both. The shallow aquifer is influenced by surface water. Recharge of the shallow aquifer is directly affected by how much water is present in the hatchery channel (GeoEngineers 1995 and BOR 2010). The hatchery channel is dewatered when the stream flow in Icicle Creek above both channels is approximately 300 cfs and flow into the historical channel is unrestricted. Dewatering of the hatchery channel can occur in late summer, fall, and early winter for short or long periods of time. Dewatering of the hatchery channel reduces recharge to the shallow aquifer causing groundwater levels and pumping capacities to drop when wells are in production. LNFH is currently trying to quantify how much and how long water needs to be in the hatchery channel to recharge the aquifer consistent with historic well operation. LNFH has also installed variable frequency drive pumps on all of its wells to increase control of pumping rates and capacity. When stream flow in Icicle Creek is approximately 300 cfs, LNFH may need to lower one or more radial gates of structure 2 for fifteen or more days at a time to ensure that enough water is in the hatchery channel for aquifer recharge (BOR 2010).

4. Flood Control

Floods and/or high stream flow events in Icicle Creek usually occur in the spring and fall and can also occur in winter with a rain on snow event. High discharge events generally last less than two weeks. To reduce potential flood damage of downstream infrastructure, LNFH may lower radial gates at structure 2 when water levels approach within one foot of the bottom of the bridge deck at structure 5 or when excessive amounts of debris accumulate on structure 2 or 5.

5. Maintenance of Structure 5

Large wood and debris can accumulate upstream of structure 5 and may need to be removed. If necessary, structure 2 will be operated to control stream flow into the historical channel to allow for the removal of debris and ensure worker safety. The need for this activity would only occur at low stream flows and would last less than one week. In the past, this activity occurred once or twice a year, however, LNFH expects the frequency of this activity to increase as the extent of time structure 2 is opened increases.

Water Supply System

LNFH shares a point of diversion with Cascade Orchard Irrigation Company (COIC) in Icicle Creek at rm 4.5. LNFH maintains and operates the intake diversion structure and its associated intake structures as part of a 1939 contract between the United States and COIC. LNFH funds the WDFW to maintain COIC's diversions, screens, and fish bypass. COIC has a 1905 water right for 12.4 cfs during the irrigation season (May 1st through October 1st) and LNFH holds a 1942 water right to divert 42 cfs year around. Table 2 lists all water rights held by LNFH.

Table 2: Water Rights for Leavenworth National Fish Hatchery.

CERTIFICATE #	PRIORITY DATE	SOURCE	AMOUNT
1824	03/26/1942	Icicle Creek	42 cfs (18,851 gpm)
1825	03/26/1942	Snow & Nada Lakes	16,000 acre feet
016378	08/01/1939	Groundwater (1 Wells)	1.56 cfs (700 gpm)
016379	06/01/1940	Groundwater (1 Wells)	2.01 cfs (900 gpm)
3103-A	10/16/1957	Groundwater (1 Wells)	2.67 cfs (1200 gpm)
G4-27115C	10/20/1980	Groundwater (4 Wells)	8.69 cfs (3900 gpm)

The hatchery's water supply system consists of four major components: (1) point of diversion and gravity flow delivery system (rm 4.5), (2) Snow/Nada Lake Basin supplementation water supply reservoirs (Snow Creek meets the Icicle at rm 5.5), (3) well system on hatchery property (between rms 2-8-3.8), and (4) water discharge. Each of these four major components is described individually below.

1. Point of Diversion and Gravity Flow Delivery System

LNFH's intake facilities contain several components. The intake system relies on gravity flow to convey water from the intake to the hatchery. Primary to the LNFH water intake system is a rubble masonry diversion structure that spans Icicle Creek (rm 4.5). The low head structure is comprised of a concrete base with flash boards on top and a pool and weir fish ladder. The structure raises water elevations several feet allowing a portion of the flow to be diverted into a concrete water conveyance channel with a grizzly rack (6 inch bar spacing) at its entrance along the left bank. Since 2010, from mid-July through September, LNFH staff may place a section of cyclone fence (plastic coated, 4 inch mesh) in front of the outer grizzly rack to prevent adult spring Chinook salmon from entering the conveyance channel. No fish are known to be impinged on the fence. Water entering the conveyance channel is transported a short distance from the coarse grizzly rack to a small building which houses a fine rack (1 ½ inch bar spacing), an overflow spill section, and a sediment sluicing section. The coarse and fine racks serve to limit the size of objects and debris that may enter the pipeline. Hatchery personnel inspect the intake structure twice daily (once at the start and once at the end of the working day, typically 7:30AM to 4:00 PM) to remove accumulated debris from racks and to ensure adequate flow is entering the diversion canal. Inspections occur more often during higher flows and accompanying heavier debris loads and during colder water temperature periods when ice forms on the racks.

A discharge channel guides the spilled water and sluiced material back to the creek downstream of the building. Water retained in the system is transported from the fine rack into a buried 33 inch diameter pipeline. A slide gate is located at the pipe entrance to regulate flow into the pipe. Normally this gate is left fully open. Approximately 1,260 ft down gradient from the beginning of the pipe system is a gate valve that controls flow into COIC's delivery system. COIC's pipe leads to a small drum screen that provides a means of bypassing fish from COIC's diversion flow back to the river (rm 4.2). The drum screen has been updated; however, the fish bypass system as a whole is presently not up-to-date and does not work effectively during low flow.

A maximum of 42 cfs of river water that does not enter COIC's water delivery system is transported through a 31 inch diameter buried pipeline approximately 5,200 ft to the hatchery. Before water enters the hatchery's rearing units it is either routed into a sand settling basin (normal operation) or to the outside screen chamber. The sand settling basin, on occasion, needs to be cleaned of sediment. The water is drawn down and any fish entrained are netted and transferred back to Icicle Creek.

From the sand settling basin, water is transported through the main pipeline to either the outside or inside screen chamber. The screens are composed of vertical static screen panels and are used to filter fish and debris from the hatchery water supply. Both screen chambers meet National Marine Fisheries Service (NMFS) standards for fish screening size for vertical screen panels (NMFS 1994). The area in the vicinity of the screens is monitored twice daily (once at the start and once at the end of the working day, typically 7:30AM to 4:00 PM). Observed fish are netted and returned to Icicle Creek below the spillway structure. The screens fish bypass returns do not work properly and are no longer used. Screened river water exiting the two chambers is used in the hatchery's rearing units and then enters the discharge system or is re-used in the adult holding ponds and/or the Foster Lucas ponds before entering the discharge system.

Maintenance of the gravity intake
Sediment settles in the hatchery's intake conveyance channel and intake building sump and needs to be removed once a year to maintain the depth of the channel. This activity typically occurs in late winter or early spring but may occur any time between November 1^{st} and June 1^{st}. The channel is approximately 100 ft long and 10 ft wide and the depth of the sediment to be removed varies annually. The sediment in the conveyance channel is removed through flushing. This is done by first reducing the amount of flow entering the channel by placing plywood boards at the entrance rack. These boards also increase the velocity of the water remaining in the channel which helps move the sediment more effectively. The slide gate at the intake is completely closed shutting off all water to the irrigation district and hatchery. Fresh and re-used well water is supplied to fish at this time and the irrigation district temporarily shuts off. At the downstream end of the channel a series of boards used to adjust the water level in the intake building are removed. Flow is increased through the conveyance channel and water and sediment from the channel exit the intake building where the boards are removed. The sediment settles in a pool which has formed below the intake building while the water and any fish continues to flow back to Icicle Creek. In one to two hours the channel is sufficiently flushed of accumulated sediment. Boards are put back in place, the slide gate is opened, and the plywood boards at the entrance rack are removed. During all activities that may increase turbidity in Icicle Creek, LNFH staff collect water samples to measure potential increases in turbidity to ensure compliance with Water Quality Standards for Surface Waters (WAC 173-201A). Additionally, a debris boom is secured approximately twenty yards upstream of the entrance rack to the conveyance channel to deflect leaves and debris from approaching the rack and entering the water conveyance channel.

Also, once a year, the diversion structure is covered with tarps secured with sand bags to prevent leaking through the boards. This is done during the low flow period in the summer to maintain the water surface elevations necessary to meet diversion needs. Tarps are removed in early fall when stream flow increases. Once or twice a year, between November 1^{st} and June 1^{st}, stream flow into the diversion structure's fish ladder is reduced and the boards within the ladder are removed to flush accumulated sediments. When this occurs, the fish ladder is inoperable for two to three days. The boards in the fish ladder are adjusted to optimize fish passage when it is necessary and safe. During all activities that may increase turbidity in Icicle Creek, LNFH staff collect water samples to measure potential increases in turbidity to ensure compliance with Water Quality Standards for Surface Waters (WAC 173-201A).

In 2008, a remotely operated video inspection of the upstream-most 1,457 ft of the hatchery's pipeline was conducted by the BOR. The overall condition of the inspected portion of the pipe was poor. Numerous transverse cracks were observed in the cement mortar lining. The cement mortar lining exhibited various stages of erosion from minor scouring to exposure of the steel cylinder along the pipe invert. It is evident from the back side of chunks of lining retrieved from the sand settling basin that the surface of the steel cylinder is corroded in some areas. The thickness of many of the chunks suggests a failure of the bond between the cement mortar lining and the steel cylinder. The areas of missing cement mortar lining observed during the inspection do not account for the number and relatively large size of the pieces of lining which have been deposited over the years in the sand settling basin. Therefore, the condition of the portion of the pipe that was not inspected is assumed to be similar, and possibly worse, than that of the inspected portion. This portion of the pipeline is scheduled to be inspected in April 2012 to determine the need for replacement.

2. Snow/Nada Lakes Supplementation Water Supply Reservoirs

During construction of the hatchery, it was recognized that stream flow and water temperatures in Icicle Creek might at times be insufficient to meet production demands. A supplementary water supply project in Snow and Nada lakes was developed and a water right of 16,000 acre feet (ac-ft) was obtained. These lakes are located approximately seven miles from the hatchery and about one mile above it in elevation. A one-half mile tunnel was drilled through granite to the bottom of upper Snow Lake and a control valve was installed at the outlet end of the tunnel. Water drains from Snow Lake to Nada Lake into Snow Creek, a tributary to Icicle Creek that enters at rm 5.5. Thus, supplemental flows from Snow Creek enter Icicle Creek one mile above LNFH's intake system. The Icicle-Peshastin Irrigation District (IPID) has rights to 600 ac-ft of natural flow from Snow Creek.

The lakes are accessed by helicopter or foot at least twice a year, typically in July and October, to open and close the control valve. More trips may occur to adjust releases from the lakes and to perform maintenance. LNFH limits its helicopter access to the lakes as much as possible. In the past five years, the lakes have been accessed by helicopter twice for maintenance and a safety inspection. Static-stilling well flow recorders at two locations help manage the reservoirs: (1) the outlet valve for upper Snow Lake and (2) the mouth of main tributary entering upper Snow Lake. Data are managed by the USFWS Region 1 Water Rights Division in Portland, Oregon.

Reports by Wurster (2006) and Montgomery Water Group (2004) describe water use from the supplementation reservoirs. Both reports indicate that in most years the reservoirs are capable of providing 50 cfs of supplemental flow from approximately early July to October with a reasonable expectation of refilling the withdrawn amount by July of the following year. Providing supplemental flows of 50 cfs, to ensure LNFH can withdraw it full water right from Icicle Creek during this time frame, benefits the Icicle Creek system by reducing water temperatures and increasing flow levels when flows are typically reduced due to upstream irrigation. This commitment equates to a release of nearly 7,000 ac-ft of storage, a volume recommended by Wurster (2006) with an estimated 60% probability that inflows to upper Snow Lake will meet or exceed the released volume. Events such as prolonged equipment malfunction or two or more consecutive years of drought would alter the release operations and may result in reinitiation of consultation.

Maintenance of Water Supply Reservoirs

The equipment and facilities at the lakes/reservoirs usually require minimal maintenance. Maintenance involves periodically (approximately a couple times per year) servicing the flow gauges, removing debris from the structures and flow meters, replacing batteries and conducting safety inspections when the valve is adjusted.

3. Well System

Groundwater provides the third major component of LNFH's water delivery system. The LNFH operates seven wells which produce the quality of water needed to sustain its fish production program. Five wells are located on the west bank of the hatchery channel and two are located near the hatchery's main entrance road. These wells draw water from two aquifers, one deep and one shallow. The deep-water aquifer is not influenced locally by surface water. Well 5 delivers water from this aquifer while Well 6 has the capacity to draw water from both aquifers. The shallow aquifer is influenced by surface water. Wells 1-4 and 7 draw water from the shallow aquifer. Recharge of the shallow aquifer is affected by how much surface water is present and, thus, percolates into groundwater, in the historical and hatchery channels. Water pumped from wells 4, 5, and 6 passes through an aeration chamber before entering the hatchery's pipeline system. Water pumped from wells 1, 2, 3, and 7 enters a series of aeration screens prior to entering the hatchery's pipeline system at the inside screen chamber. Well water is used to supplement and temper river water to meet production goals. Hatchery production could not be sustained year-around or for long periods of time on either river water or well water alone.

4. Water Discharge

Water diverted into LNFH's water delivery system is discharged into Icicle Creek at one of three locations: (1) at the base of the fish ladder (rm 2.8); (2) at the top of the fish ladder (used ~1 week during pre-smolt release); or (3) at the outfall for the pollution abatement ponds (~rm 2.7). The majority of river and well water used for hatchery operations returns to Icicle Creek near the base of the adult return ladder except during pond cleaning and maintenance activities when all water is routed through the pollution abatement ponds. All of the river water and groundwater used at the hatchery, minus any leakage and evaporation, is returned to Icicle Creek.

When maintenance of the pollution abatement ponds is required, the LNFH consults with the WDOE and the EPA to make sure appropriate regulations and standards are followed during sediment excavation and disposal. See the NPDES permit for more information.

Broodstock Collection

Spring Chinook salmon broodstock collection at the hatchery is managed to maintain the genetic integrity of the stock. This is accomplished by ensuring that the adult broodstock is randomly collected for spawning across the run in proportion to the rate at which they return. All broodstock used for production voluntarily enter the hatchery from May into July. Adults swim up the fish ladder and into one of two holding ponds. Each holding pond measures 15 x 150 feet (ft), and they are joined in the middle by an adjustable slide gate. The gate is opened and adults are allowed to enter the second pond during sorting, counting, etc. The holding ponds supply attraction water for the ladder. The broodstock collection target is 900 adult Chinook salmon at a gender ratio of 1:1. The number of adults spawned is based on the hatchery's release goal of 1.2 million pre-smolts and on density and flow indices, which relate to the amount of available water and space. Production levels could increase to previous levels of 1.625 million, in accordance with US v. Oregon production agreements, if the desired performance is not achieved at the 1.2 million production level.

In years with large adult returns, the fish ladder may be closed periodically for a few days to prevent overcrowding in the holding ponds while collecting broodstock. Of primary concern is the potential for significantly reduced dissolved oxygen levels which, if unchecked, can lead to fish kills. In addition, excessive numbers of fish in the holding pond exacerbate stress levels of fish (increasing oxygen demand) and increase the potential for lateral disease transmission. The strategy of occasionally closing the ladder also allows for surplusing of excess adults and for additional harvest opportunities by sport and tribal anglers.

Non-target fish of size encountered in the adult holding pond are netted and immediately returned to the spillway pool in Icicle Creek with the following exceptions: spawned adult steelhead are returned to the spillway pool (to continue downstream migration) and un-spawned adult steelhead are placed upstream of the hatchery as per consultation with NOAA Fisheries; and bull trout are handled and released according to protocols (Appendix D of the BA, see USFWS 2011) established between LNFH and the CWFO. These larger fish can be observed while sorting or counting which generally takes place weekly during broodstock collection. Smaller sized fish that fit between the crowder bars and avoid netting can remain in the holding pond until it is drained at the conclusion of the spawning season (late August). They exit to Icicle Creek via the fish ladder as the ponds are drained.

The adult holding ponds are supplied with a combination of surface water (Icicle Creek) and groundwater (well) to maintain optimal water temperatures (in the range of 55 ^{0}F) during holding. Flow into the holding ponds is managed to meet or exceed one gallon of inflow per fish per minute. Formalin (167 ppm for 1 hour) is administered to the holding ponds three days per week to combat fungal growth on the fish. The formalin (Parasite-S, Western Chemical) used in hatchery operations is U.S. Food and Drug Administration (FDA) approved for use on salmonids and the manufacturer's guidelines are followed. Antibiotics are administered via injection to the female brood one to two times prior to spawning to combat vertical transmission of bacterial kidney disease (BKD).

<u>Surplus / Excess Protocol</u>

If the number of salmon entering the adult holding ponds exceeds the number needed for production, the excess salmon are "surplused" to Native American tribes. There is a tiered process for distribution of federal surplus property. If tribes decline the surplus fish, then they are given to Trout Unlimited through a formalized agreement. The receiving groups assist in the excessing process under the close supervision of hatchery personnel. Prior to excessing, LNFH staff informs the individuals performing the work on proper identification and handling techniques of bull trout and steelhead. All fish species other than spring Chinook salmon will be returned to Icicle Creek by hatchery personnel.

Spawning

The first spawning date is mid-August and spawning is normally completed by Labor Day. Eggs are taken once per week. Ripe females are separated with an equal amount of males the day before spawning to expedite the spawning procedure. On the day of spawning a small number of fish are crowded into a lift system and then to an anesthetic vat. Once the fish are anaesthetized they are placed on a table where males and females are separated and sacrificed via a sharp blow to the head. Ripe females are bled prior to spawning. Fish carcasses are buried on LNFH lands.

Fish are randomly selected and mated as close to a 1:1 male/female ratio as possible. Typically the sex ratio for the returning adults is skewed 60/40 in favor of the females. However, equal numbers of males and females are separated and held during the spawning activities. If needed, males may be used twice. Jacks (age-3 males) are randomly included in the spawning population at a rate not to exceed 5% of total males used per USFWS Region 1 genetics guidelines. During years of low male returns, the hatchery may exceed the 5% jack limit.

Incubation

Eggs from one female are placed in individual incubator trays that receive three to four gallons per minute (gpm) of ground water from the fertilization to the eyed stage rearing period. If necessary during the incubation period (August through December), eggs are treated three days per week with 1,667 ppm of formalin for fungus control. During the eyed stage, eggs with moderate to high levels of BKD and mortalities are culled and the remaining eggs enumerated.

Rearing

Rearing facilities include the aforementioned adult holding ponds, forty-five 8 x 80 ft raceways, fourteen 10 x 100 ft covered raceways, and 122 fiberglass tanks. The hatchery also has 40 small and 22 large Foster-Lucas ponds which are no longer in use.

“Buttoned up” fry are moved from incubation trays to tanks inside the nursery building for their initial feeding in mid-December. Fry are fed starter feed for the first three months. In late February/early March, fry are moved outside to thirty, 8 x 80 raceways and remain there until the previous brood year is released (late April).

After release all empty rearing units are cleaned with high pressure water. Staff from the USFWS Columbia River Fisheries Program Office in Vancouver, Washington mark, inventory, and move all fish in May. All spring Chinook salmon receive an adipose fin clip and approximately 200,000 are implanted with a coded wire-tag (CWT). May is the optimal time to mark fish at this facility for a variety of reasons: 1) the fingerlings are about 100 fish/pound (lb), a good size for marking and handling; 2) fingerlings are near their maximum pond density and need to be moved; and 3) water temperatures are cool enough to facilitate successful handling.

After spawning, the two adult ponds are cleaned in preparation to receive fingerlings. Depending on the weather and surface water temperatures, sometime between December and March fish from 15 of the 8 x 80 raceways are moved to the two adult holding ponds. This action ensures the top two banks of 8 X 80 raceways are empty for the next years fry. Fish will remain in the adult ponds until release in April.

Fish are fed daily based on their size and the water temperature. Smaller fish are fed smaller amounts more often (6 to 8 feedings per day) and large fish are fed once or twice per day. Approximately 80,000 lbs of fish food are fed annually at a conversion rate of 1.2 lbs of fish feed to one lb of fish weight gain. A low phosphorus feed is used year round with the exception of fry in the nursery building.

Ponds are cleaned depending on the amount of feed expended, generally a few times per week. Cleaning entails sweeping the rearing unit with a course brush from the head end to the tail end. No cleaning agents are used and all water and waste is directed to the pollution abatement pond where waste materials settle.

Pre-smolt release

All 1.2 million spring Chinook salmon pre-smolts are force released directly from the rearing unit to Icicle Creek around the third week of April. However, an emergency fish release could occur at any time. Although an attempt is made to coincide the pre-smolt release with a high stream flow event, this facility is constrained by a spill window for Rock Island Dam negotiated with the Chelan Public Utility District (PUD).

The size of fish at release averages 18.2 fish/lb (1994-2005 range = 16.1 – 22.5 fish/lb). This size was determined to result in a fish which is in good health at the time of release, migrates to the ocean fairly rapidly, and generates adult escapement to sustain the program and provide harvest opportunities. After release all vacant rearing units are cleaned.

The average travel time from release to McNary Dam, for release years 1998 – 2003, is 27.2 days with a minimum travel time of 20 days in 1998 to a maximum time of 35 days in 2001. McNary Dam is approximately 204 miles from LNFH. The average survival from release to McNary Dam is 57.1% with a minimum survival of 50% in 2001 to a high of 64% in 2003 (Survival Under Proportional Hazards (SURPH) database 2004).

Fish Health Management

The primary objective of fish health management production programs at USFWS hatcheries is to produce healthy pre-smolts that contribute to the program goals of that particular stock. Another equally important objective is to prevent the introduction, amplification, or spread of certain fish pathogens which might negatively affect the health of both hatchery and naturally producing stocks.

The USFWS Fish Health Center (Olympia FHC) in Olympia, Washington provides for fish health at LNFH under the USFWS Fish Health Policy (http://www.fws.gov/policy/manual.html Part 713) and the "Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries," by the Integrated Hatchery Operations Team (IHOT 1996). These documents provide guidance for preventing or minimizing diseases within and outside of the hatchery. In general, movement of live fish into or out of the hatchery are approved in the U.S. v Oregon Production Advisory Committee forum and noted on the State of Washington Brood Document. If a fish transfer or release is not on the Brood Document, permits from the WDFW, the USFWS, and any other states through which the fish travel must be obtained and approved by co-managers. Fish health exams and certifications must be completed prior to any releases or transfers from the hatchery to minimize the risk of disease transmittance to other populations. Finally, any vehicle that transfers the fish or eggs is disinfected before being brought onto the station and after use at the hatchery; this also includes fish marking equipment.

Fish Health Examinations

Routine Examination: A Fish Health Specialist visits approximately once per month to examine juvenile fish at LNFH. Juvenile fish are sampled to ascertain general health on each stock and brood year. Based on pathological signs, age of fish, and concerns of hatchery personnel, the examining Fish Health Specialist determines the appropriate tests. Tests typically include microscopic examinations of the skin, gills, and internal organs. Kidneys (and other tissues, if necessary) are checked for the common bacterial pathogens by culture and/or other tests specific for the particular pathogen of interest. Blood may be examined for signs of infection and cellular or biochemical abnormalities. Additional tests for virus or parasites are done if warranted. The Fish Health Specialist may also examine fish which are moribund or freshly dead to ascertain potential disease problems in the stocks.

Diagnostic Examination: The Fish Health Specialist conducts diagnostic exams when needed or when requested by hatchery personnel. Moribund, freshly dead fish, or fish with unusual signs or behavior are examined for disease using necropsy and appropriate diagnostic tests.

Pre-release/Transfer Examination: LNFH staff notifies Olympia FHC at least six weeks prior to a release or transfer of fish from the hatchery. Tissue samples are collected on 60 fish of the stock being transferred or released. The pathogens screened for include: infectious hematopoietic necrosis virus (IHNV); infectious pancreatic necrosis virus (IPNV); viral hemorrhagic septicemia virus (VHSV); *R. salmoninarum*; *Aeromonas salmonicida*; *Yersinia ruckeri*; and under certain circumstances other pathogens such as *Myxobolus cerebralis* and *Ceratomyxa shasta*.

Adult Certification Examination: During spawning, tissues are collected from adult fish to ascertain viral, bacterial, and parasitic infections and to provide a brood health profile for the progeny. All females used as broodstock are assigned a number and tested for *R. salmoninarum*, causative agent of BKD. This number is also used to track the eggs. All female are ranked according to the level of risk they pose to potentially passing BKD to their progeny. Typically, the eggs from high and moderate risk females are culled. However, progeny from moderate risk fish may be kept to meet production targets. Eggs and fish from moderate risk parents are reared at lower densities and in separate rearing units.

Chemotherapeutant Use

Administration of therapeutic drugs and chemicals to fish and eggs reared at LNFH is performed only when necessary to effectively prevent, control, or treat disease conditions. All treatments are administered according to label directions in compliance with the FDA and the Environmental Protection Agency (EPA) regulations for the use of aquatic animal drugs and chemicals. EPA and FDA consider the environmental effects acceptable when the therapeutic compounds are used according to the label.

Erythromycin injections for spring Chinook salmon female broodstock are critical for management of BKD. Erythromycin treatment helps control horizontal transmission between adults in the holding pond and vertical transmission from the mother to its progeny. All female spring Chinook salmon held at LNFH are injected with erythromycin once or twice, usually in mid-July under an extra-label veterinary prescription. Injected carcasses are not used for stream nutritional enhancement or human consumption.

Adult spring Chinook salmon held in the holding ponds are administered a formalin treatment at least three times per week to control external fungus growth. The formalin (Parasite-S, Western Chemical) used in hatchery operations is FDA approved for use on salmonids and the manufacturer's guidelines are followed. The hatchery typically treats adult fish in the pond at 167 ppm for one hour using the flow through method. The manufacturers label recommends treating salmonids up to 170 ppm for water temperatures below and up to 250 ppm for temperatures above 50^0F. Water temperatures in the adult ponds during treatment are above 50^0F. Additional treatments may be administered upon recommendation from a Fish Health Specialist.

Periodically, the rearing fish are treated for a variety of fish diseases, both internal and external. For external treatment, the fish are provided a mild concentration of formalin or hydrogen peroxide for 15 to 60 minutes depending on the situation. For internal treatment, the fish are fed feed prepared with fish approved antibiotics for three to 10 days.

An iodine compound (approximately 1% iodine) is used to water harden and disinfect eggs after spawning. The eggs are disinfected in 130 ppm iodine in water buffered by sodium bicarbonate (at 0.01%) for 30 minutes during the water hardening process. In the event eggs are received from other hatcheries, they are also disinfected in the same manner prior to contact with the station's water, rearing units, or equipment.

Analysis of fish feed

USFWS Abernathy Fish Technology Center (FTC) provides routine quarterly proximate analysis of the fish food used at LNFH to ensure that it meets the feed manufacturer's specifications. If nutritional concerns arise, LNFH or Olympia FHC personnel consult with the Abernathy FTC's Fish Nutritionist.

Monitoring and Evaluation

USFWS's Mid-Columbia River Fishery Resource Office (MCFRO) provides monitoring, evaluation, and coordination services concerning LNFH production. These research activities are covered under a separate scientific permit (USFWS TE-702631, MCFRO-13) and are not specifically addressed in this BA. MCFRO staff monitors hatchery returns, straying rates, biological characteristics of the hatchery stock, fish marking, tag recovery, and other aspects of the hatchery program. They also maintain the database that stores this information. MCFRO cooperates with the hatchery, fish health and technology centers, and co-managers to evaluate fish culture practices, assess impacts to native species, and coordinate hatchery programs both locally and regionally.

As assessed by MCFRO, the average survival to adult (Columbia River return includes harvest and strays outside Wenatchee Basin) for completed CWT brood years 1979 – 1995 was 0.24% with a standard deviation of 0.17%. The minimum survival was 0.009% for brood year 1990 and maximum survival was 0.72% for brood year 1988. Preliminary information indicates that brood year returns (1996 – 2004) increased substantially with an average survival of 0.58% (st. dev. = 0.44%). CWT information provides contribution estimates to various marine and freshwater fisheries in addition to recoveries at hatcheries or spawning grounds throughout the Columbia Basin. Data compiled by MCFRO indicates, for return years 1999 – 2006, that approximately 41% of LNFH spring Chinook were recovered at the hatchery, 24% were harvested in treaty/ceremonial fisheries (23% Icicle Creek), 18% were captured in freshwater/Columbia River sport fisheries (10% Icicle Creek), 9% were recovered on Wenatchee Basin spawning grounds (Icicle and Peshastin creeks = 6%), and 8% were harvested in freshwater/Columbia River gillnet fisheries. Less than 1% was estimated to have been harvested in marine fisheries.

B. Term of the Proposed Action

The term of the proposed action is defined as beginning on the date this biological opinion is signed in 2011 and continuing into perpetuity, relying on reinitiation triggers to address changed conditions. This reflects one of the key points in Wild Fish Conservancy v. Salazar, and is intended to better capture the "entire agency action" and to avoid the appearance of an artificial division of operations into short terms so as to not undermine our ability to determine accurately the species likelihood of survival and recovery and the continued function of critical habitat.

C. Conservation Measures

Conservation measures are 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 by the federal agency and serve to minimize or compensate for project effects on the species under review. These may include actions taken prior to the initiation of consultation or actions which the federal agency has committed to complete in a biological assessment or similar document. Key conservation measures that are intended to minimize the effects of the proposed action to bull trout include:

1. Follow the protocol for handling and releasing bull trout (Appendix D of the BA, see USFWS 2011);
2. Inspecting, twice daily, all screens and racks associated with the water delivery system, and capture and release bull trout;
3. Monitoring of the sand settling basin to detect and remove bull trout entrained in the water delivery system;
4. Managing the sand settling basin water level so bull trout do not exit through the overflow weir (through the use of low and high water level sensors);
5. Supervising and providing fish identification training to all individuals that may handle bull trout (e.g., spawning, excessing, etc.);
6. Removing a center flashboard of the weir at structure 1 (water intake) and replacing with a v-notch board if the fish ladder is not operating efficiently during the summer (approximately late July through September) low stream flow period;
7. Release of flows from Snow and Nada Lakes to supplement stream flows and decrease high ambient water temperature;
8. Adaptive management of structure 2 and 5 to improve fish passage;
9. Use of low phosphorous foods to improve water quality; and
10. Managing flows to provide habitat benefits in the historic channel.

Appendix D (USFWS 2011) also specifies release location of bull trout captured as part of hatchery operations:

Capture Location	Release Location
Adult holding pond	In the pool below the spillway structure (rm 2.8)
Trap at structure 5	Upstream of structure 2 (rm 3.8)
Inside trash rack at intake diversion	Upstream of the intake diversion structure (rm 4.5) (prevent re-entrainment)
Screen chamber/sand settling pond	Upstream of the intake diversion structure (rm 4.5) (prevent re-entrainment)
Other	Closest, safe release location in Icicle Creek

D. Action Area

The implementing regulations for section 7 of the ESA define action area as "…all areas directly or indirectly affected by the proposed Federal action and not merely the immediate area involved in the action" (50 CFR 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment. For this consultation, the action area consists of the main LNFH facilities on the west bank of Icicle Creek near rm 2.8, all portions of Icicle Creek from its mouth to the historical barrier near rm 26 (above Leland Creek), and areas affected by water storage in Snow Lakes (Snow and Nada Lakes Basin), and Snow Creek between Snow Lakes and Icicle Creek.

II. ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND

DESTRUCTION/ADVERSE MODIFICATION DETRMINATIONS

A. Jeopardy Analysis

In accordance with policy and regulation, the jeopardy analysis in this Biological Opinion relies on four components: (1) the *Status of the Species*, which evaluates the bull trout's range-wide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of the bull trout in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the bull trout; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the bull trout; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the bull trout.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the bull trout's current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the bull trout in the wild.

Interim recovery units were defined in the final listing rule for the bull trout for use in completing jeopardy analyses. Pursuant to Service policy, when an action impairs or precludes the capacity of a recovery unit from providing both the survival and recovery function assigned to it, that action may represent jeopardy to the species. When using this type of analysis, the biological opinion describes how the action affects the recovery unit's functional relationship to both the survival and recovery of the listed species as a whole.

As discussed below under the *Status of the Species*, interim recovery units have been designated for the bull trout for purposes of recovery planning and application of the jeopardy standard. Per Service national policy (Director's March 6, 2006, memorandum), it is important to recognize that the establishment of recovery units does not create a new listed entity. Jeopardy analyses must always consider the impacts of a proposed action on the survival and recovery of the species that is listed. While a proposed Federal action may have significant adverse consequences to one or more recovery units, this would only result in a jeopardy determination if these adverse consequences reduce appreciably the likelihood of both the survival and recovery of the listed entity; in this case, the coterminous U.S. population of the bull trout.
The joint Service and National Marine Fisheries Service Endangered Species Consultation Handbook (USDI and USDC 1998), which represents national policy of both agencies, further clarifies the use of recovery units in the jeopardy analysis:

> "When an action appreciably impairs or precludes the capacity of a recovery unit from providing both the survival and recovery function assigned to it, that action may represent jeopardy to the species. When using this type of analysis, include in the biological opinion a description of how the action affects not only the recovery unit's capability, but the relationship of the recovery unit to both the survival and recovery of the listed species as a whole."

The jeopardy analysis for the bull trout in this Biological Opinion uses the above approach and considers the relationship of the action area and core area (discussed below under the *Status of the Species* section) to the recovery unit and the relationship of the recovery unit to both the survival and recovery of the bull trout as a whole. It is within this context that we evaluate the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

B. Destruction or Adverse Modification Analysis

This Biological Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this Biological Opinion relies on four components: (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitat for the bull trout in terms of primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat overall; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on bull trout critical habitat are evaluated in the context of the range-wide condition of the critical habitat, taking into account any cumulative effects, to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the PCEs to be functionally established) to serve its intended recovery role for the bull trout. Generally, the conservation role of bull trout critical habitat units is to support viable core area populations. Thus, the intended purpose of critical habitat, to support viable core areas, establishes a sensitive scale for relating effects of an action on the critical habitat unit or the critical habitat subunit to the conservation function of the entire designated critical habitat (70 FR 63898).

The analysis in this Biological Opinion places an emphasis on using the intended range-wide recovery function of bull trout critical habitat, especially in terms of maintaining and/or restoring viable core areas, and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

III. STATUS OF THE SPECIES

A. Listing Status

The coterminous United States population of the bull trout (*Salvelinus confluentus*) was listed as threatened on November 1, 1999 (64 FR 58910). The threatened bull trout occurs in the Klamath River Basin of south-central Oregon and in the Jarbidge River in Nevada, north to various coastal rivers of Washington to the Puget Sound and east throughout major rivers within the Columbia River Basin to the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Cavender 1978, Bond 1992, Brewin and Brewin 1997, Leary and Allendorf 1997).

Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation and alterations associated with: dewatering, road construction and maintenance, mining, and grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels; and introduced non-native species (64 FR 58910).

The bull trout was initially listed as three separate Distinct Population Units (DPSs) (63 FR 31647, 64 FR 17110). The preamble to the final listing rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs, plus two other population segments, into one listed taxon and the application of the jeopardy standard under section 7 of the ESA relative to this species (64 FR 58930):

> "Although this rule consolidates the five bull trout DPSs into one listed taxon, based on conformance with the DPS policy for purposes of consultation under section 7 of the Act, we intend to retain recognition of each DPS in light of available scientific information relating to their uniqueness and significance. Under this approach, these DPSs will be treated as interim recovery units with respect to application of the jeopardy standard until an approved recovery plan is developed. Formal establishment of bull trout recovery units will occur during the recovery planning process."

Thus, as discussed above under the *Analytical Framework for the Jeopardy and Adverse Modification Determinations*, the Service's jeopardy analysis for the proposed Project will involve consideration of how the Project is likely to affect the Columbia River interim recovery unit for the bull trout based on its uniqueness and significance as described in the DPS final listing rule cited above, which is herein incorporated by reference. However, in accordance with Service national policy, the jeopardy determination is made at the scale of the listed species. In this case, that is the coterminous U.S. population of the bull trout.

B. Current Status and Conservation Needs

A summary of the current status and conservation needs of the bull trout within these units is provided below. A comprehensive discussion of these topics is found in the Service's draft recovery plan for the bull trout (USFWS 2002a and 2004d).

The conservation and habitat needs of the bull trout are generally expressed as the need to provide the four Cs: cold, clean, complex, and connected habitat. Cold stream temperatures, clean water that is relatively free of sediment and contaminants, complex channel characteristics (including abundant large wood and undercut banks), and large patches of such habitat that are well connected by unobstructed migratory pathways are all needed to promote conservation of bull trout at multiple scales ranging from the coterminous to local populations. The recovery planning process for the bull trout (USFWS 2002 and 2004d) has also identified the following conservation needs for the bull trout: (1) maintain and restore multiple, interconnected populations in diverse habitats across the range of each interim recovery unit; (2) preserve the diversity of life-history strategies; (3) maintain genetic and phenotypic diversity across the range of each interim recovery unit; and (4) establish a positive population trend. Recently, it has also been recognized that bull trout populations need to be protected from catastrophic fires across the range of each interim recovery unit.

As described in Chapter 1 of the draft recovery plan for the bull trout (USFWS 2002a), the foundation of conservation efforts for the bull trout and the Service's recovery planning efforts stress the importance of maintaining or restoring the migratory life history form. This emphasis is based on: (1) consideration of the tenets of metapopulation theory, which stresses the importance of connected, genetically diverse populations that the migratory component facilitates; and (2) the inherent difficulty in monitoring the status and trend of the resident life history. Furthermore, the resident life history form is inherently difficult to monitor, so little is known about the population dynamics of this life history form (Al-Chokhatchy et al. 2005).

Specific details about important distinctions between the resident and migratory life history forms of the bull trout are described below.

Central to the survival and recovery of the bull trout is the maintenance of viable core areas (USFWS 2002a and 2004d). A core area is defined as a geographic area occupied by one or more local bull trout populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat, and in some cases in their use of spawning habitat. Each of the interim recovery units listed above consists of one or more core areas. About 114 core areas and 500 local populations are recognized across the United States range of the bull trout (USFWS 2002a and 2004d).

As noted above, in recognition of available scientific information relating to their uniqueness and significance, five segments of the coterminous United States population of the bull trout are considered essential to the survival and recovery of this species and are identified as interim recovery units: (1) Jarbidge River; (2) Klamath River; (3) Columbia River; (4) Coastal-Puget Sound; and (5) St. Mary-Belly River. Each of these segments is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

<u>Jarbidge River</u>

This interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawners, are estimated to occur within the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, angler harvest, timber harvest, and the introduction of non-native fishes (USFWS 2004a). The draft bull trout recovery plan (USFWS 2004a) identifies the following conservation needs for this unit: maintain the current distribution of the bull trout within the core area; maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area; restore and maintain suitable habitat conditions for all life history stages and forms; and conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of the bull trout. As noted in the draft recovery plan, an estimated 270 to 1,000 spawning fish per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (USFWS 2004a).

Klamath River

This interim recovery unit currently contains 3 core areas and 12 local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USFWS 2002a). Bull trout populations in this unit face a high risk of extirpation (USFWS 2002a). The draft bull trout recovery plan (USFWS 2002a) identifies the following conservation needs for this unit: maintain the current distribution of the bull trout and restore distribution in previously occupied areas; maintain stable or increasing trends in bull trout abundance; restore and maintain suitable habitat conditions for all life history stages and strategies; conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. As noted in the draft recovery plan, 8 to 15 new local populations and an increase in population size from about 3,250 adults currently to 8,250 adults are needed to provide for the persistence and viability of the 3 core areas (USFWS 2002a).

Columbia River

This interim recovery unit currently contains about 90 core areas and nearly 500 local populations. About 62 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The condition of the bull trout within these core areas varies from poor to good but generally all have been subject to the combined effects of habitat degradation, fragmentation and alterations associated with one or more of the following activities: dewatering; road construction and maintenance; mining, and grazing; the blockage or impairment of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species.

In addition to core areas and local populations, the current condition of the bull trout has also been expressed in terms of subpopulations. For bull trout, a subpopulation is considered to be a reproductively isolated group that spawns within a particular area of a river system. The spatial scale of bull trout subpopulations corresponds roughly to geographic sub-basins. The Service analyzed data on bull trout relative to subpopulations because fragmentation and barriers have isolated bull trout throughout their current range, and most monitoring data is compiled at the subpopulation scale. In 1998, the Service recognized 141 subpopulations of bull trout in the Columbia River DPS/interim recovery unit within Idaho, Montana, Oregon, and Washington (63 FR 31647).

The Service (63 FR 31647) rated each subpopulation as either “strong,” “depressed,” or “unknown” using criteria from Rieman *et al.* (1997a) with some modifications. A subpopulation was considered “strong” if 5,000 individuals or 500 spawners were likely to occur in the subpopulation, abundance appears stable or increasing, and all currently present life history forms are likely to persist. A "depressed" subpopulation has less than 5,000 individuals or 500 spawners, abundance appears to be declining, or a life history form historically present has been lost. If information about abundance, trend, and life history information was insufficient to classify the status of a subpopulation as either "strong" or "depressed", the status was considered "unknown" (63 FR 31647).

Generally, where status is known and population data exist, bull trout subpopulations in the Columbia River DPS/interim recovery unit are declining (Thomas 1992; Pratt and Huston 1993). Bull trout in the Columbia River Basin occupy about 45% of their estimated historic range (Quigley and Arbelbide 1997). Quigley and Arbelbide (1997) considered bull trout populations strong in only 13% of the occupied range in the interior Columbia River Basin. Rieman *et al.* (1997a) estimated that populations were strong in 6-24% of the sub watersheds in the entire Columbia River Basin. The few bull trout subpopulations that are considered "strong" are generally associated with large areas of contiguous habitats such as portions of the Snake River Basin in central Idaho, the upper Flathead Rivers in Montana, and the Blue Mountains in Washington and Oregon. Approximately 21% of the bull trout populations in the Columbia River DPS/interim recovery unit are threatened by the effects of poaching (63 FR 31647). The Service also identified subpopulations at risk of extirpation from naturally occurring events. At-risk subpopulations were: (1) unlikely to be reestablished by individuals from another subpopulation; (2) limited to a single spawning area; (3) characterized by low individual or spawner numbers; or (4) comprised primarily of a single life history form. In the Columbia River DPS/interim recovery unit, approximately 79 percent of all subpopulations are unlikely to be reestablished if extirpated and 50 percent are at risk of extirpation from naturally occurring events due to their depressed status (63 FR 31647). Many of the remaining bull trout subpopulations occur in isolated headwater tributaries, or in tributaries where migratory corridors have been lost or restricted. The listing rule characterizes the Columbia River DPS/interim recovery unit as generally having isolated subpopulations, without the migratory life form to maintain the biological cohesiveness of the subpopulations, and with trends in abundance declining or of unknown status. Recolonization of habitat where isolated bull trout subpopulations have been lost is either unlikely to occur (Rieman and McIntyre 1993) or will only occur over extremely long time periods.

The draft bull trout recovery plan (USFWS 2002a) identifies the following survival and recovery needs for the bull trout within the Columbia River interim recovery unit: maintain or expand the current distribution of the bull trout within core areas; maintain stable or increasing trends in bull trout abundance; maintain/restore suitable habitat conditions for all bull trout life history stages and strategies; and conserve genetic diversity and provide opportunities for genetic exchange. As noted above, it has also been recently recognized that bull trout populations need to be protected from catastrophic fires across the range of each interim recovery unit. Collectively, these criteria constitute the intended survival and recovery function of this interim recovery unit.

At a smaller scale, draft recovery criteria for the bull trout within the Entiat, Methow, and Wenatchee River basins (the action area for this consultation occurs in the Wenatchee River Basin), include the following: the area must contain at least 17 local populations; the area must have an estimated abundance between 6,322 to 10,246 migratory fish; the area must exhibit a stable or increasing population trend for at least two generations at or above the recovered abundance level; and migratory connectivity must be secure (USFWS 2004c). As discussed above, the draft recovery criteria emphasize the migratory life history form because of the unique contribution it provides to long-term persistence of the bull trout (USFWS 2002a). This interim recovery unit is especially important to the survival and recovery of the bull trout because it contains 90 of 114 (79%) of all core areas and 500 of 594 (84%) of all local populations within the coterminous U.S. range of the bull trout.

Updates to the 5-year review for the bull trout (USFWS 2008a) identified that rangewide, bull trout were determined to have an environmental specificity as a “narrow, specialist”. This ranking was primarily due to the widespread historical range of the species, and the generally common occurrence of many bull trout habitat parameters within the remaining distribution. Rangewide, bull trout were also determined to be moderately vulnerable to intrinsic factors (factors that exist independent of human influence). This determination was based primarily on the species’ relatively high potential reproductive rate and fecundity.

Within the Wenatchee Core Area, the status review found that adfluvial and fluvial migratory bull trout are present as well as the resident form of bull trout. The review also found a high degree of connectivity within the core areas with the lower bound being the watershed boundary and the upper bounds being natural barriers and headwaters. Population size for the Wenatchee Core Area was identified as between 250-1000 individuals.

The threats factor was determined to be “low severity threat for most or significant proportion of population, occurrences, or area. The severity of the threats was identified as “low”, the scope “moderate”, and the immediacy “high”. The short-term trend for the Wenatchee Core Area was identified as “Stable” indicating that the population, range, area occupied, and/or number or condition of occurrences is unchanged or remaining within a +/- 10% fluctuation.

All Core areas were divided into one of four risk factors: C1 (high risk), C2 (at risk), C3 (potential risk) and C4 (low risk). The Wenatchee Core area was identified in category C3 based on the factors identified in the paragraphs above.

Coastal-Puget Sound

Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this unit. This interim recovery unit currently contains 14 core areas and 67 local populations (USFWS 2004b). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this unit. With limited exceptions, bull trout continue to be present in nearly all major watersheds where they likely occurred historically within this unit. Generally, bull trout distribution has contracted and abundance has declined especially in the southeastern part of the unit. The current condition of the bull trout in this interim recovery unit is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, angler harvest, and the introduction of non-native species. The draft bull trout recovery plan (USFWS 2004b) identifies the following conservation needs for this unit: maintain or expand the current distribution of bull trout within existing core areas; increase bull trout abundance to about 16,500 adults across all core areas; and maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River
This interim recovery unit currently contains 6 core areas and 9 local populations (USFWS 2002a). Currently, the bull trout is widely distributed in the St. Mary River drainage and occurs in nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-mile reach of the North Fork Belly River within the United States. Redd count surveys of the North Fork Belly River documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (USFWS 2002a). The current condition of the bull trout in this interim recovery unit is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (USFWS 2002a). The draft bull trout recovery plan (USFWS 2002a) identifies the following conservation needs for this unit: maintain the current distribution of the bull trout and restore distribution in previously occupied areas; maintain stable or increasing trends in bull trout abundance; restore and maintain suitable habitat conditions for all life history stages and forms; conserve genetic diversity and provide the opportunity for genetic exchange; and establish good working relations with Canadian interests because local bull trout populations in this unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

C. Life History

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Fraley and Shepard 1989, Goetz 1989). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989, Goetz 1989), or saltwater (anadromous) to rear as subadults or to live as adults (Cavender 1978, McPhail and Baxter 1996, WDFW 1997). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they can spawn more than once in a lifetime), and generally migrate upstream during high flow in late spring and early summer. Both repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Fraley and Shepard 1989, Pratt 1992, Rieman and McIntyre 1996).

The iteroparous reproductive system of bull trout has important repercussions for the management of this species. Bull trout require two-way passage up and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and therefore require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be factors in isolating bull trout populations, if they do not provide a downstream passage route or the passage ladder does not accommodate smaller, weaker swimming fish.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length; and migratory adults commonly reach 24 inches or more (Goetz 1989). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

D. Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). Habitat components that influence 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; Sedell and Everest 1991; Pratt 1992; Rieman and McIntyre 1993, 1995; Watson and Hillman 1997). Watson and Hillman (1997) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), fish are not expected to simultaneously occupy all available habitats (Rieman et al. 1997).

Cold water temperatures play an important role in determining bull trout habitat. Bull trout are primarily found in colder streams (below 59 °F) and spawning habitats are generally characterized by temperatures that drop below 48 °F in the fall (Fraley and Shepard 1989, Pratt 1992, Rieman and McIntyre 1993).

Thermal requirements for bull trout appear to differ at different life stages. 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. 1997). Optimum incubation temperatures for bull trout eggs range from 35 to 39 °F whereas optimum water temperatures for rearing range from about 46 to 50 °F (McPhail and Murray 1979, Goetz 1989, Buchanan and Gregory 1997). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 46 to 48 °F, within a temperature gradient of 46 to 60 °F. In a study relating bull trout distribution to maximum water temperatures across a landscape, Dunham et al. (2003a) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 52 to 54 °F.

Although bull trout are found primarily in cold streams, occasionally these 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. 1997a). Factors that can influence bull trout ability to survive in warmer rivers include availability and proximity of cold water patches and food productivity (Myrick 2003). In Nevada, adult bull trout have been collected at 63 °F in the West Fork of the Jarbidge River and have been observed in Dave Creek where maximum daily water temperatures were 62.8 to 63.6 °F (Werdon 2000). In the Little Lost River, Idaho, bull trout have been collected in water up to 68 °F; however, bull trout made up less than 50 percent of all salmonids when maximum summer water temperature exceeded 59 °F and less than 10 percent of all salmonids when temperature exceeded 63 °F (Gamett 1999). In the Little Lost River study, most sites that had high densities of bull trout were in an area where primary productivity increased in the streams following a fire. Increases in stream temperatures can cause direct mortality, increased susceptibility to disease or other sublethal effects, displacement by avoidance (McCullough et al. 2001, Bonneau and Scarnechia 1996), or increased competition with species more tolerant of warm stream temperatures (Rieman and McIntyre 1993; Craig and Wissmar 1993 cited in USDI (1997); MBTSG 1998). Brook trout (*Salvelinus fontinalis*), which can hybridize with bull trout, may be more competitive than bull trout and displace them, especially in degraded drainages containing fine sediment and higher water temperatures (Selong et al. 2001; Leary et al. 1993). Recent laboratory studies suggest bull trout are at a particular disadvantage in competition with brook trout at temperatures greater than 12° C (McMahon et al. 2001; Selong et al. 2001).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989, Goetz 1989, Sedell and Everest 1991, Pratt 1992, Thomas 1992, Sexauer and James 1997, Watson and Hillman 1997). Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns (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 stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989, Pratt 1992, Pratt and Huston 1993). Pratt (1992) indicated that increases in fine sediment reduce egg survival and emergence.

Bull trout typically spawn from August to November during periods of decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, Pratt 1992, Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992), and after hatching, juveniles remain in the substrate. Time from egg deposition to emergence of fry may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992, Ratliff 1992).

Migratory corridors link seasonal habitats for all bull trout life histories. 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 or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may be reestablished by bull trout migrants. However, it is important to note that the genetic structure of bull trout indicates that there is limited gene flow among populations, which may encourage local adaptation within individual populations and reestablishment of extirpated populations may take a very long time (Spruell et al. 1999, Rieman and McIntyre 1993).

Migratory forms of the bull trout appear to develop when habitat conditions allow movement between spawning and rearing streams and larger rivers or lakes, where foraging opportunities may be enhanced (Frissell 1993). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River in Oregon (Baxter 2002). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. The benefits of the migratory strategy include greater growth in the more productive waters of larger streams and lakes, greater fecundity resulting in increased reproductive potential, and dispersing the population across space and time so that spawning streams may be re-colonized should local populations suffer a catastrophic loss (Rieman and McIntyre 1993, MBTSG 1998, Frissell 1999). In the absence of the migratory life form, isolated populations cannot be replenished when disturbance makes local habitats temporarily unsuitable, the range of the species is diminished, and the potential for enhanced reproductive capabilities are lost (Rieman and McIntyre 1993).

The importance of maintaining the migratory life-history form of the bull trout, as well as the presence of migratory runs of other salmonids that may provide a forage base for bull trout, is emphasized in the literature (summarized in USDI 2005; 70 FR 63898). The ability to migrate is important to the persistence of local bull trout populations (Rieman and McIntyre 1993; Rieman and Clayton 1997; Rieman *et al*. 1997a). Bull trout rely on migratory corridors to move from spawning and rearing habitats to foraging and overwintering habitats and back. Migratory bull trout become much larger than resident fish in the more productive waters of larger streams and lakes, leading to increased reproductive potential (McPhail and Baxter 1996). Migratory corridors are also essential for movement between local populations, as well as within populations. Local populations that have been extirpated by catastrophic events may become reestablished as a result of movements by bull trout through migratory corridors (Rieman and McIntyre 1993; MBTSG 1998). Corridors that allow such movements can support the eventual recolonization of unoccupied areas or otherwise play a significant role in maintaining genetic diversity and metapopulation viability.

E. Diet

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, macrozooplankton, 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). In coastal areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) in the ocean (WDFW 1997).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. In the Skagit River system of Washington, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migratory route (WDFW 1997). Anadromous bull trout also use marine waters as migratory corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett, 2005).

As fish grow, their foraging strategy changes, as their food changes in quantity, size, or other characteristics. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, mysids and small fish (Shepard et al. 1984, Boag 1987, Goetz 1989, Donald and Alger 1993). Bull trout that are 4.3 inches long or longer commonly have fish in their diet (Shepard et al. 1984), and bull trout of all sizes have been found to eat fish half their length (Beauchamp and Van Tassell 2001).

Migratory bull trout begin growing rapidly once they move to waters with abundant forage that includes fish (Shepard et al. 1984, Carl 1985). As these fish mature they become larger bodied predators and are able to travel greater distances (with greater energy expended) in search of prey species of larger size and in greater abundance (with greater energy acquired). In Lake Billy Chinook in Oregon, as bull trout became increasingly piscivorous with increasing size, the prey species changed from mainly smaller bull trout and rainbow trout for bull trout less than 17.7 inches in length to mainly kokanee for bull trout greater in size (Beauchamp and Van Tassell 2001).

Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. Bull trout likely move to or with a food source. For example, some bull trout in the Wenatchee River Basin were found to consume large numbers of earthworms during spring runoff in May at the mouth of the Little Wenatchee River where it enters Lake Wenatchee (Kelly-Ringel and De La Vergne 2008). In the Wenatchee River, radio-tagged bull trout moved downstream after spawning to the locations of spawning Chinook and sockeye salmon and held for a few days to a few weeks, possibly to prey on dislodged eggs, before establishing an overwintering area downstream or in Lake Wenatchee (Kelly-Ringel and De La Vergne 2008).

F. Reproductive Biology

Bull trout become sexually mature between 4 and 9 years of age, and may spawn in consecutive or alternate years (Shepard et al. 1984; Pratt 1992). Spawning typically occurs from August through December in cold, low-gradient 1^{st}- to 5^{th}-order tributary streams, over loosely compacted gravel and cobble having groundwater inflow (Shepard et al. 1984; Brown 1992a; Rieman and McIntyre 1996; Swanberg 1997; MBTSG 1998; Baxter and Hauer 2000). Surface/groundwater interaction zones that are typically selected by bull trout for redd construction have high dissolved oxygen, constant cold water temperatures, and increased macroinvertebrate production. Bull trout spawning sites frequently occur near cover (Brown 1992a).

Bull trout eggs hatch in winter or early spring, and alevins may stay in the gravel for up to 3 weeks before emerging. The total time from egg deposition to fry emergence from the gravel may exceed 220 days.

Bull trout post-spawning mortality, longevity, and repeat-spawning frequency are not well known (Rieman and McIntyre 1996), but the lifespan of the bull trout may exceed 10 to13 years (McPhail and Murray 1979; Pratt 1992; Rieman and McIntyre 1993). Adult adfluvial bull trout may live as long as 20 years, and may spend as long as 20 months in lake or reservoir habitat to gain adequate energy storage and develop gametes before they return to spawn again (67 FR 71236).

Migratory bull trout are highly visible during spawning due to their large size and location in relatively small streams during periods of low flow. Channel complexity and cover are important components of spawning habitat to reduce both predation risk and potential for poaching.

G. Population Dynamics

Bull trout are considered to display complex metapopulation dynamics (Dunham and Rieman 1999). The size of suitable habitat patches appears to play an important role in the persistence of bull trout populations, along with habitat connectivity and human disturbance, especially road density. Analyses of spatial and temporal variation in bull trout redds indicate a weak spatial clustering in patterns of abundance through time (Rieman and McIntyre 1996). These analyses showed that spatial heterogeneity in patterns of abundance was high, however, at a regional scale. These patterns suggest that maintenance of stable regional populations of the bull trout may require maintenance of connected patches of high quality habitat where dispersal and demographic support can occur readily among patches (Rieman and McIntyre 1996).

The importance of maintaining the migratory life-history form of the bull trout, as well as migratory runs of other salmonids that may provide a forage base for bull trout, is repeatedly emphasized in the scientific literature (Rieman and McIntyre 1993; MBTSG 1998; Dunham and Rieman 1999; Nelson et al. 2002). Isolation and habitat fragmentation resulting from migratory barriers have negatively affected bull trout by: (1) reducing geographical distribution (Rieman and McIntyre 1993; MBTSG 1998); (2) increasing the probability of losing individual local populations (Rieman and McIntyre 1993; MBTSG 1998; Nelson et al. 2002; Dunham and Rieman 1999); (3) increasing the probability of hybridization with introduced brook trout (Rieman and McIntyre 1993); (4) reducing the potential for movements in response to developmental, foraging, and seasonal habitat requirements (MBTSG 1998; Rieman and McIntyre 1993); and (5) reducing reproductive capability by eliminating the larger, more fecund migratory form from many subpopulations (MBTSG 1998; Rieman and McIntyre 1993). Therefore, restoring connectivity and restoring the frequency of occurrence of the migratory form will reduce the probability of local and subpopulation extinctions. Remnant populations, that lack connectivity due to elimination of migratory forms, have a reduced likelihood of persistence (Rieman and McIntyre 1993; Rieman and Allendorf 2001).

The bull trout has multiple life-history strategies, including migratory forms, throughout its range (Rieman and McIntyre 1993). Migratory forms appear to develop when habitat conditions allow movement between spawning and rearing streams and larger rivers or lakes, where foraging opportunities may be enhanced (Frissell 1997). For example, multiple life-history forms and multiple migration patterns have been recorded in the Grande Ronde River (Baxter

2002). Parts of this river system have retained habitat conditions that allow for the free movement of bull trout between spawning and rearing areas and the mainstem of the Snake River. Such multiple life-history strategies help to maintain the stability and persistence of bull trout populations in the face of environmental changes. Migratory bull trout may enhance the persistence of metapopulations due to their high fecundity, large size, and dispersal across space and time, which promotes recolonization of areas from which bull trout have been extirpated should resident populations suffer a catastrophic loss (Frissell 1997; Rieman and McIntyre 1993; MBTSG 1998).

Barriers to migration are an important factor influencing patterns of genetic variability in the bull trout (Spruell et al. 2003; Costello et al. 2003). Although barriers increase the vulnerability of isolated populations to stochastic factors, they also insulate these populations from the homogenizing effects of gene flow. If isolated populations were founded by ancestors with rare alleles, genetic drift, unimpeded by gene flow, can lead to fixation of locally rare alleles. These populations may subsequently serve as reservoirs of rare alleles, and downstream migration from isolated populations may be important in maintaining the evolutionary potential of metapopulations (Costello et al. 2003).

Lakes and reservoirs provide important refugia for bull trout that display the adfluvial life-history strategy. In general, lake and reservoir environments are relatively more secure from catastrophic natural events than stream systems (67 FR 71236). They provide a sanctuary for bull trout, allowing them to quickly rebound from temporary adverse effects to spawning and rearing habitat. For example, if a major wildfire burns a drainage and eliminates most or all aquatic life (a rare occurrence), bull trout sub-adults and adults that survive in the lake may return the following year to repopulate the burned drainage. This underscores the need to maintain migratory life forms and habitat connectivity in order to increase the likelihood of long-term population persistence.

H. Genetic and Phenotypic Diversity

Genetic diversity promotes both short-term fitness of populations and long-term persistence of a species by increasing the likelihood that the species is able to survive changing environmental conditions. This beneficial effect can be displayed both within and among populations. Within a genetically diverse local population of bull trout, different individuals may have various alleles that confer different abilities to survive and reproduce under different environmental conditions (Leary et al. 1993; Spruell et al. 1999; Hard 1995). If environmental conditions change due to natural processes or human activities, different allele combinations already present in the population may be favored, and the population may persist with only a change in allele frequencies. A genetically homogeneous population that has lost variation due to inbreeding or genetic drift may be unable to respond to the environmental change and be extirpated. The prospect of local extirpation highlights the importance of genetic diversity among local populations.

Recolonization of locations where extirpations have occurred may be promoted if immigrants are available that possess alleles that confer an advantage in variable environmental conditions. Extending this reasoning to the entire range of the species, reduction in rangewide genetic diversity of bull trout through the loss of local populations can reduce the species ability to respond to changing conditions, leading to a higher likelihood of extinction (Rieman and McIntyre 1993; Leary et al. 1993; Spruell et al. 1999; Hard 1995; Rieman and Allendorf 2001).

The amount of genetic variation necessary for a population to adapt to a changing environment can be estimated using the concept of effective population size (N_e). Effective population size is the average number of individuals in a population which are assumed to contribute genes equally to the succeeding generation. Effective population size provides a standardized measure of the amount of genetic variation that is likely to be transmitted between generations within a population.

Specific benchmarks for the bull trout have been developed concerning the minimum N_e necessary to maintain genetic variation important for short-term fitness and long-term evolutionary potential. These benchmarks are based on the results of a generalized, age-structured, simulation model, called VORTEX (Miller and Lacy 1999), used to relate effective population size to the number of adult bull trout spawning annually under a range of life histories and environmental conditions (Rieman and Allendorf 2001). Using the estimate that N_e for the bull trout is between 0.5 and 1.0 times the mean number of adults spawning annually, Rieman and Allendorf (2001) concluded that (1) an average of 100 adults spawning each year would be required to minimize risks of inbreeding in a population, and (2) an average of 1,000 adults is necessary to maintain genetic variation important for long-term evolutionary potential. This latter value of 1,000 spawners may also be reached with a collection of local populations among which gene flow occurs.

Bull trout populations tend to show relatively little genetic variation within populations, but substantial divergence among populations (e.g., Spruell et al. 2003). For example, Spruell *et al.* (1999) found that bull trout at five different spawning sites within a tributary drainage of Lake Pend Oreille, Idaho, were differentiated based on genetic analyses (microsatellite DNA), indicating fidelity to spawning sites and relatively low rates of gene flow among sites. This type of genetic structuring indicates limited gene flow among bull trout populations, which may encourage local adaptation within individual populations (Spruell et al. 1999; Healey and Prince 1995; Hard 1995; Rieman and McIntyre 1993).

Current information on the distribution of genetic diversity within and among bull trout populations is based on molecular characteristics of individual genes. While such analyses are extremely useful, they may not reflect variability in traits whose expression is dependent on interactions among many genes and the environment (Hard 1995, Reed and Frankham 2001; but see Pfrender et al. 2000). Therefore, the maintenance of phenotypic variability (e.g., variability in body size and form, foraging efficiency, and timing of migrations, spawning, and maturation) may be best achieved by conserving populations, their habitats, and opportunities for the species to take advantage of habitat diversity (Healey and Prince 1995; Hard 1995).

Local adaptation may be extensive in bull trout because populations experience a wide variety of environmental conditions across the species' distribution, and because populations exhibit considerable genetic differentiation. Thus, conserving many populations across their range is essential to adequately protect the genetic and phenotypic diversity of bull trout (Hard 1995;

Healey and Prince 1995; Taylor et al.1999; Rieman and McIntyre 1993; Spruell et al. 1999; Leary et al. 1993; Rieman and Allendorf 2001). If genetic and phenotypic diversity is lost, changes in habitats and prevailing environmental conditions could increase the likelihood of bull trout suffering reductions in numbers, reproductive capacity, and distribution.

Based on this information about the life history and conservation needs of bull trout, the Service concludes that each subpopulation or local population is an important genetic, phenotypic, and geographic component of its respective DPS/interim recovery unit. Adverse effects that compromise the persistence of a bull trout subpopulation or local population can reduce the distribution, as well as the phenotypic and genetic diversity of the DPS/interim recovery unit.

I. Global Climate Change

Global climate change has the potential to affect the baseline condition of bull trout habitat at all scales from the coterminous U.S. to the sub-watershed and action area. Available evidence also indicates climate change effects are reasonably certain to continue into the foreseeable future. Consequently, climate change could be addressed under multiple headings in this BO (e.g., rangewide status of the species, environmental baseline, and cumulative effects). Rather than dispersing our discussion of this important topic throughout the BO, we consolidate in this section our consideration of how climate change may alter baseline conditions across multiple scales through time.

Climate change is one of the most significant ongoing effects to baseline conditions for bull trout and their associated aquatic habitat throughout the state of Washington. Climate change, and the related warming of global climate, has been well-documented in the scientific literature (Bates et al. 2008; ISAB 2007). Evidence includes increases in average air and ocean temperatures, widespread melting of snow and glaciers, and rising sea level. Given the increasing certainty that climate change is occurring and is accelerating (Bates et al. 2008; Battin et al. 2007), we can no longer assume that climate conditions in the future will resemble those in the past.

Climate change has the potential to profoundly alter the aquatic habitat through both direct and indirect effects (Bisson et al. 2003). Direct effects are evident in alterations of water yield, peak flows, and stream temperature. Some climate models predict 10 to 25 percent reductions in late spring, summer, and early fall runoff amounts in coming decades. Indirect effects, such as increased vulnerability to catastrophic wildfires, occur as climate change alters the structure and distribution of forest and aquatic systems. Observations of the direct and indirect effects of global climate change include changes in species ranges and a wide array of environmental trends (ISAB 2007; Hari et al. 2006; Rieman et al. 2007). In the northern hemisphere, ice-cover durations over lakes and rivers have decreased by almost 20 days since the mid-1800s (WWF 2003). For cold-water associated salmonids in mountainous regions, where upper distribution is often limited by impassable barriers, an upward thermal shift in suitable habitat can result in a reduction in size of suitable habitat patches and loss of connectivity among patches, which in turn can lead to a population decline (Hari et al. 2006; Rieman et al. 2007).

Climate change is already affecting the frequency and magnitude of fires, especially in the warmer, drier regions of the west. To further complicate our understanding of these effects, the forest that naturally occurred in a particular region may or may not be the forest that will be responding to the fire regimes of an altered climate (Bisson et al. 2003). In several studies related to the effect of large fires on bull trout populations, bull trout appear to have adapted to past fire disturbances through mechanisms such as dispersal and plasticity. However, as stated earlier, the future may well be different than the past and extreme fire events may have a dramatic effect on bull trout and other aquatic species, especially in the context of continued habitat loss, simplification and fragmentation of aquatic systems, and the introduction and expansion of exotic species (Bisson et al. 2003).

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the snow pack diminishes, stream flow timing will change, and peak flows will likely increase in volume. Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). Data from long-term stream monitoring stations in western Washington indicate a marked increasing trend in temperatures in most major rivers over the past 25 years (WDOE 2007).

There is still a great deal of uncertainty associated with predictions of timing, location, and magnitude of climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007). Research indicates that temperatures in many areas will continue to increase due to the effects of global climate change. According to model predictions, average temperatures in Washington State are likely to increase between 1.7 °C and 2.9 °C (3.1 °F and 5.3 °F) by 2040 (Casola et al. 2005).

Bull trout rely on cold water throughout their various life stages and increasing air temperatures likely will cause a reduction in the availability of suitable cold water habitat. For example, ground water temperature is generally correlated with mean annual air temperature and has been shown to strongly influence the distribution of char species. Groundwater temperature can also be linked to bull trout selection of spawning sites and has been shown to influence the survival of embryos and early juvenile rearing of bull trout (Rieman et al. 2007). Increases in air temperature are likely to be reflected in increases in both surface and groundwater temperatures.

Migratory bull trout can be found in lakes, large rivers and marine waters. Effects of climate change on lakes are likely to impact migratory adfluvial bull trout that seasonally rely upon lakes for their greater availability of prey and access to tributaries. Climate-related warming of lakes will likely lead to longer periods of thermal stratification, forcing coldwater fish such as bull trout to be restricted to the bottom layers for greater periods of time. Deeper thermoclines resulting from climate change may further reduce the area of suitable temperatures in the deeper depths of lakes and intensify competition for food (WWF 2003).

Bull trout require very cold water for spawning and incubation. Suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. However, impacts on hydrology associated with climate change will cause shifts in timing, magnitude, and distribution of peak flows that are also likely to be most pronounced in these high elevation stream basins (Battin et al. 2007). The increased magnitude of winter peak flows in high elevation areas is likely to affect spawning and incubation habitat for bull trout and Pacific salmon. Although lower elevation rivers are not expected to experience as severe an impact from alterations in stream hydrology, they are generally not cold enough for bull trout spawning, incubation, and juvenile rearing.

As climate change progresses and stream temperatures warm, thermal refugia will be critical to ensure the persistence of bull trout and other species dependent on cold water. Thermal refugia are important for providing bull trout with patches of suitable habitat while allowing them to migrate through, or to make foraging forays into, areas with above optimal temperatures. Juvenile rearing may also occur in waters that are at or above optimal temperature, but these rearing areas are usually in close proximity to colder tributaries or other areas of cold water refugia (USEPA 2003).

Climate change is and will be an important factor affecting bull trout distribution and population dynamics. As distribution contracts, patch size decreases and connectivity is truncated; populations that are currently connected may become thermally isolated, which could accelerate the rate of local extinction beyond that resulting from changes in stream temperature alone (Rieman et al. 2007). In areas with already degraded water temperatures or where bull trout are at the southern edge of their range, they may already be at risk of impacts from current as well as future climate change. As these trends continue, the conservation role of bull trout populations in headwaters habitats may become more significant. Long-term persistence of bull trout may only be possible in these headwater areas that provide the only suitable habitat refugia.

While we expect future climate change impacts to occur to bull trout and its designated critical habitat, the scope of this analysis (considering the proposed action) is limited to what we can reasonably predict. We can speculate the frequency of rain-on snow event may increase with warmer air temperatures, or that overall water temperatures may increase (which may cause additional impacts in lower Icicle Creek), or Spring run-off may occur earlier (which may cause the upstream migration period of bull trout to occur earlier). While these general expectations seem fairly reasonable, we lack the precision to predict the likelihood, frequency, duration, or magnitude of these events (and their effects) at the action area scale. Most climate modeling is conducted at much larger scales, either continental or sometimes regionally. As a result, the impacts of climate change may best be addressed through our evaluation of the Environmental Baseline (for future section 7(a)(2) analyses) and reinitiation of existing consultations to address changed conditions. Until our ability to predict climate change impacts at smaller scales improves, we must rely on methodologies that provide outputs of what is reasonable certain to occur. Some listing and recovery actions (including 5-year reviews and recovery planning) may be better analyses to capture broader trends in climate change.

J. Consulted-on Effects

Projects subject to section 7 consultation under the ESA have occurred throughout the range of the bull trout. From the time of its listing in June of 1998 until August of 2003, the Service issued 137 biological opinions that address the effects of various Federal actions on the bull trout. All of these opinions included a determination that the proposed Federal action was not likely to jeopardize the continued existence of the bull trout, based on consideration of the range-wide and action area conditions and conservation needs of the bull trout, the effects of the action and any cumulative effects in the action area. An assessment of these actions is described in the Service's biological opinion for the Rock Creek Mine in Montana prepared by our Region 6 office (USFWS 2006c); this document is herein incorporated by reference.

The 137 biological opinions referenced above involve 24 different activity types (e.g., grazing, road maintenance, habitat restoration, timber sales, hydropower, etc.); 20 of these opinions involved multiple projects, including restoration actions for the bull trout. The geographic scale of projects analyzed in these biological opinions varied from individual actions (e.g., construction of a bridge or pipeline) within one basin, to multiple-project actions, occurring across several basins. Some large-scale projects affected more than one DPS/interim recovery unit of the bull trout. Overall, 124 of the 137 biological opinions (91 percent) applied to activities affecting bull trout in the Columbia River Basin interim recovery unit, 12 (9 percent) applied to activities affecting bull trout in the Coastal-Puget Sound unit, 7 (5 percent) applied to activities affecting bull trout in the Klamath River unit, and 1 (less than 1 percent) applied to activities affecting the Jarbidge and St. Mary Belly units.

For each of the 137 actions considered in the above biological opinions, the causes of adverse and any beneficial effects were identified as were the anticipated consequences for spawning streams and/or migratory corridors, if possible (in most cases, these consequences were known).

Actions whose effects were "unquantifiable" numbered 55 in migratory corridors and 55 in spawning streams. The Service also attempted to define the duration of anticipated effects (e.g., "short-term effects" varied from hours to several months) for each action.

Between August 2003 and July 2006, the Service issued 198 additional biological opinions on the effects of proposed Federal actions on the bull trout. All of these opinions included a determination that the proposed Federal action was not likely to jeopardize the continued existence of the bull trout, based on consideration of the range-wide and action area conditions and conservation needs of the bull trout, the effects of the action and any cumulative effects in the action area. Since July 2006, a review of the data in our national Tracking and Integrated Logging System (TAILS) reveal this trend has held true to date; no jeopardy opinions have been issued for the bull trout. Also, the Service has developed the Consulted-on Effects Database (COED), an internal online electronic effects and take data collection, storage and retrieval system for bull trout. This will provide a powerful tool to assess the rangewide status of bull trout; the COED system is currently being populated with detailed effects and take data from past Federal consultations and is scheduled for full implementation in the Fall of 2011.

IV. ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress. The action area is part of the Wenatchee River core area for the bull trout. For context, the status of the bull trout within the core area is discussed first followed by a discussion of bull trout status in the action area.

A. Wenatchee River Core Area Abundance and Distribution

The Wenatchee River Basin encompasses approximately 1,371 square miles (mi^2) in central Washington (NPPC 2001c, USFS 1999, WSCC 2001). Major tributaries are the White and Little Wenatchee Rivers, which drain into Lake Wenatchee (source of the Wenatchee River), the Chiwawa River, and Nason Creek. Additional tributaries to the Wenatchee River include Icicle Creek, Peshastin Creek, and Mission Creek.

Seven migratory local populations of the bull trout are known within the Wenatchee core area; they are located in: (1) the Chiwawa River (including Chikamin, Phelps, Rock, Alpine, Buck and James creeks); (2) the White River (including Canyon and Panther creeks); (3) the Little Wenatchee River (including Rainy Creek); (4) Nason Creek (including Mill and Henry Creeks); (5) Chiwaukum Creek; (6) Peshastin Creek (including Ingalls and Negro Creeks); and (7) Icicle Creek (including French, Jack and Leland Creeks). It is important to note that these local populations are so-named after the waterway where spawning is centered. Bull trout from local populations use a variety of waterways within their core area, and some use multiple core areas.

Adfluvial, fluvial, and resident forms of the bull trout currently exist in the Wenatchee River core area (WDFW 1998). The migratory form of the bull trout is the predominant life history form in all of the populations about which much is known. The majority of spawning and fry-rearing habitat is within U.S. Forest Service lands, including the Glacier Peak and Alpine Lake Wilderness areas. Data collection for bull trout redds has become standardized across this core area since about 2000, and since then the total number of redds detected in the Wenatchee River core area has fluctuated between about 312 and 738. The 10-year average since listing (1998-2007) is 484 redds (unpublished data compiled by the USFWS CWFO 2007). It is important to note that these numbers reflect redds made by migratory fish. There may be a small number of resident fish that make redds which are difficult to detect. Because resident bull trout are small (typically 6-12 inches), and fecundity and survival is directly related to size, the Service believes that redd counts for migratory spawners are a useful way to track changes in bull trout population abundance over time, and that this method provides an accurate estimate of the population at the core area scale. There may also be undetected migratory redds, but these are probably very few.

Records of historical bull trout data from the Wenatchee River basin are unavailable. It is believed that bull trout populations in the Wenatchee River basin were much larger than they are today. Bull trout populations likely declined when anadromous salmonid populations also declined (based on cannery output; see Lichatowich 1991), for many of the same reasons. In the Wenatchee River Basin the construction of a mill dam in Leavenworth (destroyed in about 1916) significantly impeded fish migration in the Wenatchee River. It is likely that the extirpation of anadromous and near extirpation of migratory salmonid life forms affected nutrient dynamics in the watershed and predator-prey relationships within the fish community, resulting in reduced primary and secondary productivity.

The Chiwawa River local population complex is the stronghold for bull trout in the upper Wenatchee River Basin (WDFW 1998). Rock Creek represents the strongest population in the Chiwawa River. Since 1995 annual surveys have documented between 176 and 555 redds in the Chiwawa River local population complex. The 10-year average since listing (1998-2007) is 388 redds in this local population, which is 80% of the average annual production in the core area (unpublished data compiled by USFWS CWFO 2007).

The combined Little Wenatchee River and White River annual redd counts have been between 22 and 134 since 2000. Below Lake Wenatchee additional spawning areas in the Wenatchee River core area include Nason, Chiwaukum, and Peshastin creeks. Limited redd surveys have detected up to 17 redds in Mill Creek (a tributary of Nason Creek), 23 to 42 redds in Chiwaukum Creek, and up to 9 in Ingalls Creek (a tributary of Peshastin Creek), where survey effort has been sporadic, in a given year (unpublished data compiled by USFWS CWFO 2007). In 2010, one migratory bull trout was radio-tracked into Etienne Creek (previously known as Negro Creek), a tributary of Peshastin Creek upstream of Ingalls Creek where only juveniles had been seen previously (B. Kelly-Ringel, USFWS, pers. comm.. 2011).

Data on the Icicle Creek population of the bull trout are limited prior to 2008, but it appears to be the smallest of all seven populations in this core area, and it is the only local population that has been reproductively isolated from the metapopulation for the majority of the time since about 1940. Information on hatchery operations and the amount of fish passage provided between 1940 when hatchery operations began until the 1990's is limited. Passage opportunities are assumed to have been limited or non-existent in most years. As described in the following sections, beginning in 2001, the LNFH changed hatchery operations to provide improved upstream passage conditions for bull trout. Over the past ten years, through adaptive management, the LNFH has increased the timing and duration for structures 2 and 5 remaining fully open. The current proposal would provide for these structures to remain open year round

except for 5 limited circumstances described in the summary of the project section. Available information indicates that migratory bull trout have been able to pass upstream of the LNFH, at least for short periods of time, in 2001, 2006, and 2007, and possibly in 2002 and 2004.

Systematic bull trout redd surveys (targeting redds constructed by migratory bull trout) did not occur in Icicle Creek until 2008. However, multiple age classes of resident-sized bull trout have been observed in upper Icicle Creek (upstream of Jack Creek) indicating that bull trout successfully spawn in the Icicle Creek Basin, as described later. For most of the time since 1940 when barriers at the LNFH likely prevented migratory bull trout access to spawning areas in Icicle Creek, all reproduction in the Icicle Creek bull trout local population likely depended on small, resident-only life history form.

Since 2008, several important advances in our understanding of the Icicle Creek population of bull trout have occurred. First, systematic redd surveys (for redds constructed by migratory bull trout) have been implemented in the upper Icicle, yielding 8 redds in French Creek in 2008 (Nelson et al. 2009), 3 redds in 2009 (Nelson et al. 2011), and 1 redd in 2010 (Kelly-Ringel 2011). No redds have been confirmed in other tributaries but an observation of a faded large redd near Chain Creek near rm 34 (rkm 48) in 2008 (N. Gayeski, pers. comm. in Nelson et al. 2009) suggests there are additional fluvial spawning areas in upper Icicle Creek. Second, radio-telemetry (Nelson et al. 2009 and 2011) confirm that bull trout use Icicle Creek for both foraging, migration, and overwintering (FMO) and spawning and rearing (SR) functions. This conforms to the general movement patterns and habitat use ES staff has observed in other bull trout local populations throughout Central Washington and the Columbia basin. It also suggests a small migratory component of Icicle bull trout still remains, and that when passage opportunities are provided at the LNFH, migratory bull trout can and do access their spawning tributaries (as their numbers and annual vs. alternate year spawning frequencies allow). Third, initial estimates of the resident component (i.e., juvenile, subadult, and non-migratory adult life history stages) have been calculated. Nelson (2007) estimated densities that range from 1.8 to 11.8 bull trout/100m^2, which exceed the minimum criteria of 1.5 per 100 m^2 used to determine areas critical to the maintenance of healthy populations of bull trout (Shepard et al. 1982). This supports the notion that habitat conditions in the upper Icicle are good, and despite limited opportunities for migratory bull trout passage since the LNFH was constructed, a resident form of bull trout has persisted through time. Providing passage opportunities in the lower Icicle, including at the LNFH, would likely advance the conservation needs of bull trout. And fourth, hybridization between bull trout and brook trout has been documented (Nelson et al. 2009), and elevates this as a risk factor to bull trout. The 2008 5-year review (USFWS 2008a) estimated that brook trout were anticipated to occur in 71% of the key streams for bull trout in the Wenatchee Core Area. For decades, brook trout have been stocked in a number of lakes and streams throughout Central Washington. Although that no longer occurs in waterways connected to occupied bull trout habitat, the legacy of this past program likely continues to impact bull trout through hybridization, competition, and predation.

B. Factors Affecting the Bull Trout's Current Condition in the Wenatchee River Core Area

The current condition of the bull trout in the Wenatchee River core area is attributed to several factors: dams, forest management activities, agricultural practices (including water withdrawals for irrigation), mining, residential development, and fisheries management activities. Connectivity among local populations has been impacted by dams, agricultural practices, roads, and dikes. Maintenance of life history diversity is likewise compromised by the factors that fragment populations; these factors are described below.

Dams and Agricultural Practices

In the late 1800's and early 1900's, dams were commonly constructed throughout the core area for a variety of purposes (water diversions for agriculture, splash dams for logging, small hydroelectric, etc.) and undoubtedly had significant impacts to fish. Some, such as Tumwater Dam (located in the Wenatchee River above the Icicle confluence) was created for one purpose (e.g., to power locomotives through the railroad tunnel at Steven's Pass) and now serves another (e.g., fisheries management). Another was a mill dam located in the Wenatchee River just below the confluence of Icicle Creek, which significantly impeded fish migration. After operation for over a decade, this mill dam was destroyed in 1916. Through time, many of these dams were also destroyed or no longer needed. Small dams still existing within the core area and continue to limit bull trout migratory movements and impact habitat quality due to associated water withdrawals and effects on fluvial processes. Irrigation diversions can result in passage barriers by creating structural blockages, reducing in-stream flow or even dewatering streams, and increasing water temperatures. Decreased stream flow and high temperatures can create barriers to upstream habitat and poor habitat conditions. High temperatures can result in negative effects to foraging and migration patterns. Irrigation diversions not directly located in bull trout spawning streams can remove in-stream flow and may impact important foraging and high water refuge habitat.

In Peshastin Creek, the diversion in the lower river, which was a barrier during low flows, was modified in late 2005 to improve passage during the summer. Within the upper Wenatchee River, there are several water diversions and a diversion dam; it is unknown whether these diversions meet NOAA Fisheries and Service screening criteria (USFS 1999). The Chiwawa Irrigation District water diversion is located at rm 3.6 on the Chiwawa River and can divert up to 33.3 cfs, but more commonly diverts 12 to 16 cfs (USFS 1999). The diversion is screened (updated in the mid 1990's), but it is unclear if the screen meets the NOAA Fisheries and Service fish screen criteria, or how the altered flow regime may affect rearing or sub-adult bull trout. The U.S. Forest Service and the Chiwawa Irrigation District currently monitor flows and temperatures above and below the diversion to determine impacts to aquatic habitat.

A diversion in the upper Chiwawa River in Phelps Creek is located within bull trout spawning and rearing habitat (USFS 1999). The Trinity water diversion is located approximately 0.75 miles upstream of the 8-foot high natural falls at rm 1.0, which blocks upstream fish passage. Bull trout have not been found in the area of the diversion headgate structure, but have been located spawning within the return channel from the settling ponds and in Phelps Creek below the falls. The Trinity diversion is currently being relicensed by the Federal Energy Regulatory Commission. It is unknown how these changes in in-stream flows affect rearing and spawning bull trout downstream in Phelps Creek.

Within Icicle Creek, diversions for irrigation, hatchery operations, and municipal use remove significant portions of water, sometimes the majority of total stream flow, during August, September, and October (USFWS 1992). Low flows in the lower reach are the result of natural conditions compounded by water diversions for municipal water supply, agricultural irrigation, and the LNFH (WDFW 1998). LNFH is providing supplemental flows (50 cfs) from Snow and Nada Lakes from July to October to provide additional flows during this low flow period and to provide colder water to benefit bull trout during this time frame. Wurster (2006) estimated a 60% probability that inflows to upper Snow Lake will meet or exceed the released volume.

Adequate fish protection devices and structures are lacking at Icicle Creek diversions. The IPID operates an irrigation diversion dam on Icicle Creek above LNFH at rm 5.7 that presents a temporary barrier to summer and fall migration when low flow trickles over the crest of the dam, which has no fish ladder. In low water years during late summer, the stream can be essentially dewatered for 100-feet directly downstream of the diversion, completely blocking all fish passage (USFS 1995). The fish exclusion screens at the IPID diversion do not currently meet NOAA Fisheries and Service criteria. Prior to the 2006 LNFH O&M Opinion, which required implementation of measures to improve fish passage at the hatchery intake at rm 4.5, the weir and water intake structures for the LNFH and COIC intake sometimes blocked fish passage at very low flows. The intake is improperly screened and entrains fish (USFWS 2002b). Screening of the LNFH and COIC intake is comprised of a grizzly rack (6 inch bar spacing) at the entrance of the conveyance channel and a fine rack (1 ½ inch bar spacing) in the intake building. Since 2010, from mid-July through September, LNFH staff may place a section of cyclone fence (plastic coated, 4 inch mesh) in front of the outer grizzly rack to prevent adult spring Chinook salmon from entering the conveyance channel. No fish are known to be impinged on the fence.

Between the time it was built in about 1940, and continuing thereafter until about 2001, the LNFH likely blocked or impaired upstream fish passage in several locations in Icicle Creek between rm 2.8-4.5. Brief exceptions occurred in 1993 and 1997. No large bull trout were observed above LNFH facilities during those years, and it is unknown whether surveys were attempted. In 2001, 2002, and 2004, some upstream passage was possible for short intervals, due to gate adjustments at hatchery structures. In each of the years listed above, migratory bull trout were observed passing the LNFH. Beginning in 2006, there have been changes in hatchery operations that provide more and predictable opportunities for upstream passage of bull trout at these facilities; several migratory bull trout were observed upstream of the LNFH in Icicle Creek in 2006 and 2007. Passage at the LNFH continued to be restricted in 2006 and 2007 for a portion of the year, including during portions of the bull trout's spawning migration period. In 2008-2010, adaptive management continued to increase upstream passage opportunities for bull trout. This appears to have been successful; reproduction by migratory bull trout has been documented in the upper Icicle by the discovery of 8 redds in French Creek in 2008 (Nelson et al. 2009), 3 redds in 2009 (Nelson et al. 2011), and 1 redd in 2010 (Kelly-Ringel 2011).

For many years it was unknown if the boulder falls area upstream of the hatchery at rm 5.6 was a natural barrier to fish passage. However, several migratory-size bull trout were observed during a snorkel survey above the boulder area on September 15, 2002, indicating that this obstacle is passable under some conditions (De La Vergne, J., pers. comm., USFWS, 2002). On September 9, 2004, during a brief spot-check of the same area, another migratory-sized bull trout was observed (D. Morgan, USFWS, pers. comm., 2004). For these reasons, this area is likely only a barrier to upstream passage of bull trout during certain flow conditions (low, and also very high), and that it is passable when stream flow is moderate or high.

Forest Management

Both direct and indirect impacts from timber harvest have altered habitat conditions in portions of the core area. Impacts from timber harvest management include the removal of large woody debris, reduction in riparian areas, increased water temperatures, increased erosion, and simplification of stream channels (Quigley and Arbelbide 1997). Bull trout are less likely to use streams for spawning and rearing in areas with high road densities and were typically absent at mean road densities above 1.7 miles per mi^2 (Quigley and Arbelbide 1997).

In the Wenatchee River, natural channel complexity and riparian conditions have been altered over time by past timber-related activities (WSCC 2001). These activities have resulted in reduced riparian and wetland connectivity, reduced high flow refuge habitat, reduced sinuosity and side channel development, increased bank erosion, reduced large woody debris, and reduced pool frequency. Road construction associated with timber harvest adjacent to streams or rivers has resulted in the straightening of stream channels (channelization), alteration of stream gradients, and an overall change in habitat type (USFS 1999).

High road densities within certain portions of U.S. Forest Service lands in the Wenatchee River Basin may contribute to habitat degradation. Areas of special concern where road densities are high include: the Lower Chiwawa River, Middle Chiwawa River, Lake Wenatchee, Lower White River, Lower Little Wenatchee River, Upper Little Wenatchee River, Lower Nason Creek, Upper Nason Creek, the headwaters of Nason Creek, Wenatchee River (Upper, Middle, and Lower portions), the lower Icicle Creek drainage, and Peshastin Creek (USFWS 2002b).

Road culverts in watersheds with bull trout can block or impede upstream passage (WSCC 1999, 2000, 2001; NPPC 2001a,b,c). Culverts may preclude bull trout from entering a drainage during spawning migrations, emigration of juveniles, and foraging activities, and may also limit access to refuge habitat needed to escape high flows, sediment, or higher temperatures. Specific culverts have been identified as passage barriers in the various parts of the Wenatchee River core area (USFWS 2002b).

Mining

Mining can degrade aquatic habitats used by bull trout by altering water chemistry (e.g., pH); altering stream morphology and flow; and causing sediment, fuel, and heavy metals to enter streams (Nelson et al. 1991, Spence et al. 1996). The U.S. Forest Service has issued a special use permit in the upper Chikamin Creek drainage for an exploratory mining operation. Bull trout spawn just downstream in Chikamin Creek and hold within the Chiwawa River for most of the year. Small-scale recreational gold mining occurs at placer claims in other the Wenatchee River core area, particularly in the Peshastin Creek watershed.

Residential Development

As described in the draft bull trout recovery plan (USFWS 2002b), the Wenatchee River core area is affected by residential development. Areas and habitat concerns include the following: the Wenatchee River downstream of Leavenworth (loss of side channels, bank revetment, and floodplain development); the Wenatchee River through the communities of Plain and Ponderosa (degraded water quality due to improperly functioning septic systems); Peshastin Creek (below the Ingalls Creek confluence, the natural channel and floodplain function has been disturbed due to channel constriction and confinement); Icicle Creek (lower portion of the river has been impacted from loss of riparian vegetation, bank hardening, and residential development); Nason Creek (lower Nason Creek has been impacted by channel confinement, removal of riparian vegetation, and reduction in large woody debris recruitment); the White River (below Panther Creek there has been loss of riparian and large woody debris recruitment); and Lake Wenatchee (shoreline development and associated loss of riparian vegetation, increased nutrient loading, and inadequate sewage treatment from old septic systems).

Numerous areas within this core area are experiencing a shift from an economy based on natural resources (agriculture, forestry, and mining) to an economy more dependent on industries associated with tourism, recreation, and general goods and services. Some increased population growth has occurred within the core area.

Fisheries Management

Past fisheries management included bounties and eradication efforts directed at bull trout. Current fisheries management have fewer direct impacts to bull trout, but effects likely occur through stocking of non-native species, harvest management, and effects on prey base. Problems with non-native species in the Wenatchee River core area are primarily brook trout (WSCC 1999, 2000, 2001). In the Wenatchee River, brook trout are present in the Chiwawa River including Chikamin and Big Meadow creeks (USFS 1999). The introduction of brook trout into Schaefer Lake in the 1940's was most likely the source population. Efforts to eradicate brook trout from Schaefer Lake have been unsuccessful. Previously stocked brook trout, which interbreed and compete directly with bull trout, are still present in upper Icicle Creek (USFWS 1997).

Fisheries management can also impact bull trout by promulgating fishing regulations that lead to the incidental harvest of bull trout and trampling of bull trout redds by wading anglers. Injury and mortality from incidental catch of bull trout and harvest as a result of misidentification still continues under existing fishing regulations (e.g., only 44 percent of surveyed Montana anglers correctly identified bull trout; Schmetterling and Long 1999). In experimental tests, a single wading event just before hatching can result in up to 43 percent mortality of eggs (Roberts and White 1992). Regulations that permit sport angling, including steelhead and Chinook fisheries in the Wenatchee River and Icicle Creeks, can result in incidental injury or death of bull trout.

Historical angler checks show a minimal incidence of bull trout harvested by trout anglers on Icicle Creek. However, Dan Davies (Kelly-Ringel, pers. comm., 2010) reports that in the 1980's numerous bull trout were caught near the French Creek confluence. State fishing regulations allowed for harvest of bull trout during those years. Also, Brown (1992b) stated that “even though a number of bull trout spawning streams on the Wenatchee National Forest have been closed for the past several years (since 1992) and bull trout seasons/ bag limits restricted, illegal harvest and outright vandalism (wanton killing and wastage of adult bull trout) has been observed with disconcerting regularity." Harvest of bull trout is currently prohibited on all stocks in the core area. However, many other species are targeted in sport and tribal fisheries in the area where bull trout may overlap. For example, in late 2007, for the first time in several years, there was a fishery in the Wenatchee River for hatchery-produced steelhead. It is unknown whether this activity resulted in any incidental catch of bull trout.

C. Wenatchee River Core Area Population Dynamics

The Wenatchee core area is a relative stronghold for bull trout in the upper Columbia River area. The number and distribution of bull trout in this core area, and its diversity of habitat, exceed those in the other core areas (Entiat and Methow) to which the Wenatchee populations may currently share migratory connectivity. This point is further discussed below. The bulleted list below summarizes some of the reasons why the Wenatchee core area is considered a stronghold.

- In the Wenatchee River core area there is good connectivity between most local populations (USFWS 2005a). However, low flow and physical barriers exist in Icicle Creek and Peshastin Creek for at least part of the year. The population of resident bull trout in upper Icicle Creek has been mostly isolated by man-made barriers at LNFH since about 1940 (Brown 1992b, USFWS 2005b, WDFW 1998) and by other natural, thermal, or low flow barriers. In recent years (2001, 2006, and 2007, and possibly 2002 and 2004), occasionally some migratory-size bull trout passed the LNFH. As described above in "Wenatchee Core Area Abundance and Distribution," spawning in the upper Icicle has occurred 2008-2010, indicating that recent changes to LNFH operations have provided improved passage opportunities.

- In the Wenatchee River core area, diverse life histories are expressed in all local populations. There are migratory bull trout (fluvial and/or adfluvial) throughout the system, although they are distributed unevenly. This is important because resident fish are the least fecund and most vulnerable life history form (Rieman and McIntyre 1993); local populations with few or no migratory bull trout are inherently more susceptible to human or stochastic events and less likely to recover after disturbance. Based on the existing abundance and diversity of life history forms, and the habitat quality and distribution, Wenatchee local populations are ranked in terms of their relative resiliency (in descending order): Chiwawa River, White River, Chiwaukum Creek, Little Wenatchee, Nason/Mill Creeks, Ingalls Creek, and Icicle Creek. The extremes of this ranking contrasts a large, well-connected Chiwawa local population (averaging about 329 migratory redds annually) with excellent habitat and a long history of productivity (i.e., most resilient) with the Icicle Creek local population (i.e., least resilient). The Icicle Creek local population, with recently improved passage conditions at LNFH, has only 3 years of documented spawning by migratory fish, is estimated to be of very low abundance (averaging about 4 migratory redds annually), but has good habitat in the upper watershed.

- Lake Wenatchee in the upper basin provides high quality FMO habitats (i.e., refugia) and thus greater potential life history diversity for local populations of the bull trout in the Chiwawa, Little Wenatchee, Nason, and White rivers (USFWS 2005a). Local populations in the lower basin (Chiwaukum, Icicle, and Peshastin creeks) are less likely to use Lake Wenatchee, showing a preference for the mainstem Wenatchee and Columbia Rivers for FMO habitat, based on radio-telemetry data from Kelly-Ringel and De La Vergne (2008). The Icicle Creek local population has been comprised of mostly a resident population, with only recent opportunities for the expression of its migratory life history form. Prior to 2008, spawning by migratory bull trout has not been observed in the upper Icicle Creek.

- Analysis of genetic samples from bull trout populations in the Wenatchee River core area is underway, but results are not available yet. Because at least five of the seven local populations in the core area are small (Ne < 100) they are believed to be at risk of deleterious genetic effects associated with small populations (Rieman and Allendorf 2001). The relatively large and stable Chiwawa River local population is an exception to this condition. In some years the Ne of the White River local population exceeds 100, but this population is variable (based on annual redd counts), and in other years it does not. Based on limited data, the Icicle Creek population is the smallest in the core area.

- Bull trout genetic exchange is assumed to occur infrequently with other core areas, based on genetic analyses from other core areas. There is no direct evidence of current genetic exchange between the Wenatchee River and other core areas; however migration monitoring suggests this may be possible (USFWS 2005a). Genetic exchange at this scale is assumed to be less frequent than gene flow among local populations within the Wenatchee River core area.

- The short-term population trend for the Wenatchee River core area is stable with high interannual variation; the Chiwawa River population represents a stronghold for the bull trout, and for that reason is likely to significantly influence the population trend for the entire core area (unpublished data compiled by CWFO 2006).

D. Bull Trout Status in the Action Area

Icicle Creek enters the Wenatchee River at town of Leavenworth. The Icicle Creek watershed is 214 mi^2 in size (136,960 acres) and is 87 percent National Forest land, with 74 percent of the watershed located in the Alpine Lakes Wilderness. The USFS manages their portion of the watershed as a Tier 1 Key Watershed under the Northwest Forest Plan (USFS 1995). Key watersheds are described in the North West Forest Plan Record of Decision:

> "Key watersheds [are] a system of large refugia comprising watersheds that are crucial to at-risk fish species and stocks and provide high quality water (page B-12). Refugia are a cornerstone of most species' conservation strategies. They are designated areas that either provide, or are expected to provide, high quality habitat. A system of Key Watersheds that serve as refugia is crucial for maintaining and recovering habitat for at-risk stocks of anadromous salmonids and resident fish species. These refugia include areas of high quality habitat as

> well as areas of degraded habitat. Key Watersheds with high quality conditions will serve as anchors for the potential recovery of depressed stocks. Those of the lower quality habitat have a high potential for restoration and will become future sources of high quality habitat with the implementation of a comprehensive restoration program (page B-18)."

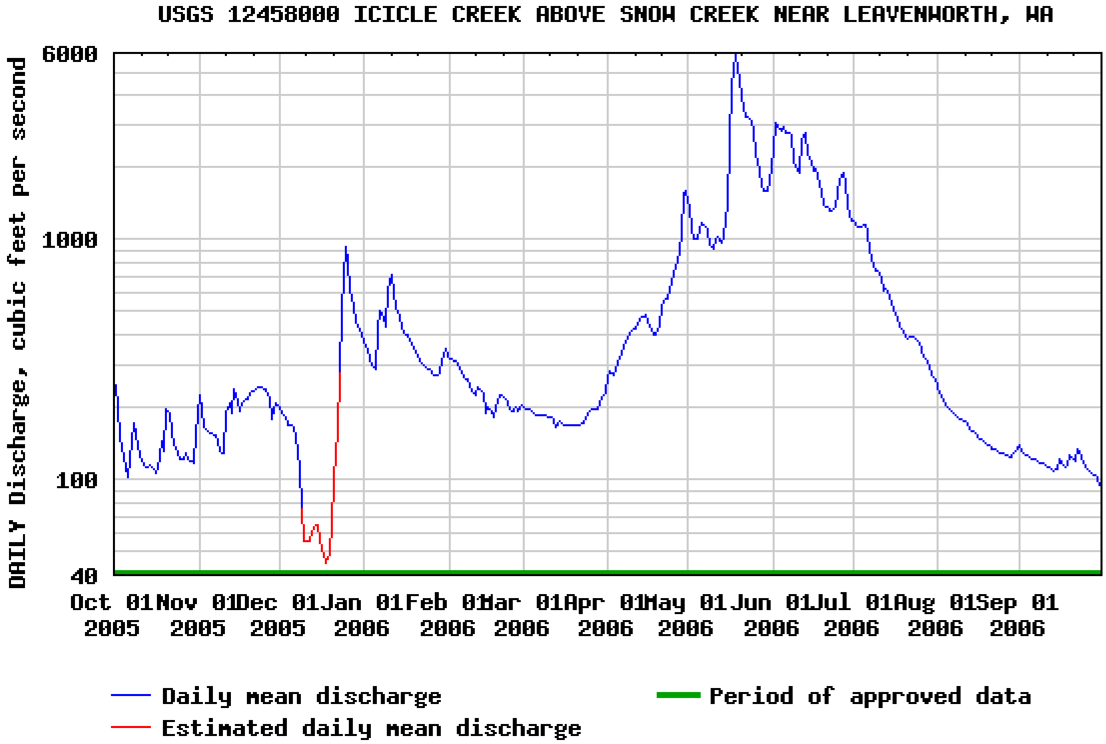
Icicle Creek is the largest sub watershed of the Wenatchee River, and provides 19 percent of low season flows (second only to the White River basin). It is 31.8 miles long from its headwaters at Lake Josephine, elevation 4,681 feet, near Stevens Pass to its confluence with the Wenatchee River, elevation 1,200 feet. The geology of the watershed controls the hydrologic processes. The area was glaciated, with steep slopes of cirque headwalls and failure escarpments that have very little water storage capacity. The storage capacity exists in the high elevation basins and in glacial till in the valley bottoms. Precipitation ranges from 120 inches near the Cascade crest to 20 inches near the mouth. Tributary streams in the watershed are generally very steep Rosgen A-type channels (USFS 1995).

A sample hydrograph from the 2006 water year is shown below (Figure 2). Note the peak runoff (about 6000 cfs) in mid-May which steadily decreased during June and early July as snowmelt runoff ended and the river transitioned to baseflow conditions. Although the peak flow was higher than normal, the timing and pattern of the graph is fairly typical over the last 15 years. Also note that during the month of July flow dropped from about 1200 cfs to about 250 cfs.

Water is stored and released from several high elevation lakes, and later diverted from lower Icicle Creek for irrigation, the LNFH, and city drinking water. These water withdrawals contribute to low stream flow and high water temperatures during the summer in the lower reaches of Icicle Creek. Rain-on-snow events are common in fall, and the hydrograph is typical of snow melt systems, with the peak runoff in late spring. Mean, minimum, and maximum flows in Icicle Creek at the USGS gauging station at rm 5.8 are 614, 44, and 14,100 cfs, respectively for the period of record from 1937 to 2005.

Wildfires are common in portions of the drainage. Since 1990, there were five fires greater than 500 acres each. These occurred in 1990, 1994, 2001, 2003, and 2004. In total, these 5 fires burned approximately 25,000 acres, or nearly 20 percent of the Icicle Creek watershed (unpublished Graphic Information System data provided by Pat Murphy, USFS; on file with CWFO). The USFS determined that these fires and suppression activities, which mostly occurred far from Icicle Creek and its major tributaries, did not change the environmental baseline for the bull trout in the action area (USFS 2004, USFWS 2004c). According to analysis by the USFS, the risk of fire occurrence in most of Icicle Creek is high (based on analysis of the frequency of lightning strikes in the mid and upper watershed), and according to computer simulation, in most areas fire behavior is be predicted to be severe crown fire (based on typical summer weather, stand characteristics, and terrain) (R. Harrod, USFS, pers. comm. 2008). Roughly 5 percent of the watershed has been impacted by logging (USFS 1995).

Figure 2. Water Year 2006 Icicle Creek hydrograph upstream from all diversions.



Landslides are also a fairly common phenomena in the Icicle watershed, with three occurring in the recent past. In June 1999, a landslide occurred on a flanking slope of a draw that was burned in 1994. The draw descends from Icicle Ridge about 6 miles up the drainage. The failure was approximately 120 ft wide and 300 ft long with a slide plane that was approximately 10-15 ft below the pre-failure surface, and began at an elevation of 4800 ft. Consequently, the resulting volume of material delivered to the valley bottom was many times greater than the initial failure. In May 2008, a landslide that originated on a spur road of the Doctor Bob road system (FS road 7605) blocked Icicle Creek, and the subsequent flooding removed a ½-mile portion of the Icicle Creek Road (FS road 7600). Most roads in Upper Icicle Creek pose little risk to landform processes; however there are some roads at heightened risk for failure. In particular, the Doctor Bob Road system has approximately 2 miles of road at mid- to high elevation in the watershed that shows evidence for potential failure: numerous small slumps, one failure that has delivered to Trout Creek, several failures that stopped before crossing the valley bottom to Trout Creek, and several current locations where side-cast cracking is present on this road segment. Currently, the Forest Service implemented an emergency closure order on April 1, 2011, to protect public safety following a landslide that swept trees, mud and boulders the size of cars onto the Icicle Creek Road. The landslide occurred above the Eight Mile Campground and swept tons of debris from the Lion Creek drainage down slope onto Icicle Creek Road. The paved road diverted most of the debris, preventing it from entering the campground or Icicle Creek.

Fish habitat in the majority of the watershed is in good condition. Upper Icicle Creek, where bull trout spawn, is relatively unaltered by human activity (WDFW 1998). According to the USFS Watershed Analysis, the majority of the fish habitat in the watershed is “in pristine state and very capable of producing fish" (USFS 1995). There are localized areas where the USFS access road and campgrounds impinge on the stream corridor and consequently stream shade, large woody debris (LWD), or pool frequency is reduced. As a percentage of total length of Icicle Creek, these areas are very small. The access road and campgrounds are located on the north side of the river. Due to the aspect of the valley (the river flows from west to east), these impacted areas have little effect on stream shade. Compared to other wilderness areas, the backcountry of the Alpine Lakes Wilderness Area is heavily used. Most of this activity is limited to July, August, and September, and occurs in areas that are far from bull trout habitat. Past (e.g., bull trout bounties, fish stocking) and present (e.g., sport angling which may incidentally injure or kill bull trout) fisheries management have impacted bull trout.

Historically upstream passage was blocked or impeded by structures at LNFH near rm 2.8, 3.8, and 4.5, and that prevent most migratory-sized fish from accessing most of the watershed (see Figure 1); as noted above, in 2002, 2004, 2006, and 2007, migratory bull trout were observed in Icicle Creek above LNFH structures and the Snow Creek boulder area during which time LNFH operation and maintenance activities were occurring. Since 2008, opportunities for bull trout passage have improved, and spawning of migratory fish in upper Icicle Creek has occurred in 2008-2010. There is a distinct difference between habitat quality in the upper and lower basin at rm 5.7, just above the uppermost irrigation diversion (Andonaegui 2001). Upstream of this point there are no water diversions or dams and anthropogenic disturbance activities are limited. Far above rm 5.7 is a waterfall, considered the historical fish barrier located near Leland Creek at rm 26 (Bryant and Parkhurst 1950).

The USFS (1994, 2000, 2004) and the USFWS (2004c) evaluated the baseline conditions in the watershed. In general, habitat indicators were rated as "properly functioning" in the watershed above the USFS boundary at about rm 5. There were some instances where, for example stream temperature (too high) or quality pool habitat (too low) did not meet the standards and guidelines in all places at all times, but most of these departures reflect natural conditions (USFS 2000). It is important to note that virtually all watersheds in the area, even those where anthropogenic impact is very low (White River) or those that are prolific fish producers (Chiwawa River) include some indicators that are not 100 percent "properly functioning". Yet these watersheds support healthy and diverse fish communities.

Based on substrate and gradient, there is abundant spawning habitat available in upper Icicle Creek, especially between rm 18 and rm 25. At the time the bull trout recovery plan (USFWS 2002a) was drafted, spawning by migratory bull trout was not known to occur in the upper Icicle so no specific abundance recovery criteria were established for Icicle Creek. The minimum recovery criteria for an individual local population is 50 migratory-sized redds (USFWS 2002a). To date, spawning in the Icicle Creek local population is known only to French Creek (Nelson et al. 2009, Nelson et al. 2011, and Kelly-Ringel 2011). No redds have been confirmed in other tributaries but an observation of a faded large redd near Chain Creek near rm 34 (rkm 48) in 2008 (N. Gayeski, pers. comm. in Nelson et al. 2009) suggests there are additional fluvial spawning areas in upper Icicle Creek. There is no known bull trout spawning in Icicle Creek below LNFH, and due to flow and temperature conditions that habitat is generally not suitable for bull trout spawning during the appropriate time of year. Stream temperature in upper Icicle Creek is suitable for spawning and rearing, but that cold water also limits growth rate, size at maturity, and fecundity of fish that exhibit the resident life-history phenotype (Rieman and McIntyre 1993). All of these factors limit the reproductive potential for the resident-type bull trout in Icicle Creek. Migratory fish do not have these same limitations and can move to more productive habitats where rapid growth is possible, and are therefore larger and inherently more fecund (Fraley and Shepard 1989; Goetz 1989).

Salmonid species present in the watershed include hatchery spring Chinook salmon, hatchery Coho salmon, steelhead, bull trout, non-native brook trout (*Salvelinus fontinalus*), westslope cutthroat trout (*O. clarki lewisi)*, redband trout (*O. mykiss gairdneri)*, and mountain whitefish (*Prosopium williamsoni)*. There are also native and non-native non-salmonids in Icicle Creek including dace (*Rhinichthys* spp.), lamprey (*Lampetra* spp.), sculpin (*Cottus* spp.), suckers (*Catostomus* spp.), and others. Recorded historical data from upper Icicle Creek prior to about 1930 are unavailable, which is also about 60 years after the peak of Columbia River salmon runs (based on cannery output; see Lichatowich 1991), and 25 years after the construction of a mill dam in Leavenworth (destroyed in about 1916) which significantly impeded migration in the Wenatchee River just below Icicle Creek. Based on three affidavits collected in 1942 by the BOR from longtime Leavenworth residents about anadromous runs in Icicle Creek before the mill dam, which is the only information the Service was able to locate, it is assumed that historical salmon runs were not large (BOR 1942, reproduced in Mullan et al 1992). The Service assumes there was not much human activity in the majority of the Icicle Creek watershed in the early 1900s, most of which was remote and only accessible by trail at that time. Whether or not there was significant spawning by steelhead in those days, which would have occurred in the spring when most of the watershed was snowbound and therefore especially difficult to observe, is unknown. Whatever the historic runs were, it is likely that the extirpation of anadromous and near extirpation of migratory salmonid life forms in upper Icicle Creek have affected nutrient dynamics in the watershed and predator prey relationships within the fish community, resulting in reduced primary and secondary productivity. It is likely bull trout population in Icicle Creek and the Wenatchee River experienced similar declines in the same time period as other migratory salmonids for the same reasons.

Recent survey work in mid and upper Icicle Creek indicates that the watershed has high salmonid productivity, as suggested by the roughly 800 rainbow trout observed per mile, most of which were 6 to 8” long (WFC 2007). The Service did not attempt an exhaustive review of fish densities in other areas, or data collection techniques, but based on a comparison to USFS data from 2006 and 2007 collected in Icicle Creek (the equivalent of up to 525 fish per mile), and particularly the Chiwawa River (up to 750 fish per mile), generally considered to be the most productive habitat in the Wenatchee River basin, the fish density in Icicle Creek is very high.

Although specific investigation of the interactions between bull trout and brook trout and rainbow trout (the latter two of which were planted for anglers up until 1992) has not been done, these introduced species are likely to depress survival and reproductive success of Icicle Creek bull trout. Brook trout hybridize with bull trout, and both brook trout and rainbow trout compete directly with resident bull trout for resources. It is likely that the absence or reduction in the number of large migratory bull trout in Icicle Creek has exacerbated these interaction effects in two ways. First, migratory bull trout are more fecund (Fraley and Shepard 1989; Goetz 1989), and presumably used to contribute the majority of each new cohort of the Icicle Creek bull trout.

Because they can have an order of magnitude more eggs than smaller resident fish and because (possibly until very recently) they were not able to access upper Icicle Creek to spawn, the consequences of competition with brook trout and rainbow trout was probably greater than it would have been otherwise. Second, the past stocking of rainbow trout in the watershed, which have less specific habitat requirements than bull trout and tend to out compete them for resources in areas where water temperatures are slightly above what is optimal for bull trout (such as much of mid Icicle Creek), is likely another significant pressure on the bull trout population trend in Icicle Creek. Large bull trout are better at competing directly with smaller resident rainbow and brook trout by physically dominating the best habitat, and by preying upon them; and indirectly by boosting the number of young bull trout in each generation so that at the local population level, hybridization represents a lower percentage of bull trout reproductive effort (Rieman and McIntyre 1993).

E. Bull Trout Distribution and Abundance in the Action Area

Bull trout are a permanent resident in the action area. Icicle Creek is considered to have the smallest local population of the bull trout (based on the abundance of migratory adults) in the Wenatchee River core area (USFWS 2005b). Although relatively little systematic survey work has been performed in mid and upper Icicle Creek, as described below, in the last few years more work has been completed and observations of bull trout remain limited. The Icicle bull trout population contains both resident and migratory fish. During most years since 1940, and particularly prior to about 2001, which was the first time that significant fish passage was intentionally provided at LNFH, only the resident form had access to spawning areas in upper Icicle Creek. In this way, this local population is different than other bull trout populations in the Wenatchee River Basin. Icicle Creek represents one of two bull trout populations in the lower Wenatchee River Basin about which little is known. Other than the Peshastin Creek local population, which is also located below Tumwater Canyon, all other bull trout populations in the Wenatchee River core area spawn and rear tens of miles upstream, where there is more diverse habitat and a larger prey base. Both of the lower basin populations are very small.

Since 1940 and the completion of structures at LNFH, up until about 2001, the Icicle Creek population has been the only bull trout population in the Wenatchee River Basin where only the resident life-history form could reproduce. Since 2001, there may have been greater opportunities for passage of bull trout above the LNFH, but the extent of bull trout passage during this period is uncertain. Beginning in 2006 the LNFH revised its operations (e.g., longer periods where structures 2 and/or 5 were open) so that upstream passage of the bull trout was possible at certain times of year. As described below in greater detail, large migratory-size bull trout were observed in Icicle Creek above all LNFH infrastructure in 2001, 2002, 2004, 2006, and 2007. Following more changes in operations 2008-2010 (e.g., lowering structure 2 as little as possible when required, not installing the picket gates at structure 5 in 2010, etc.), which provided improved passage opportunities, bull trout have been documented to spawn in the upper Icicle in 2008-2010 (Nelson et al. 2009 and 2011).

Snorkel surveys and radio telemetry monitoring revealed that migratory-sized bull trout use the lower portions of both Icicle and Peshastin creeks (unpublished data compiled by USFWS CWFO; USFWS 2005b). Limited spawning by migratory bull trout has been detected in Ingalls

Creek (Peshastin Basin), and resident-size fish have been detected in nearby Negro Creek (Haskins, J., pers. comm., USFS, 2005). Habitat conditions in Icicle Creek and Peshastin Creek are different than those in the upper basin where other local populations of bull trout exist. These differences include the absence of local lacustrine refugia and other selection pressures such as the lack of anadromous prey. These factors may have led to genetic and other differences between these two small populations and the other five local populations in the Wenatchee River core area.

There has been very little survey effort to locate bull trout in Icicle Creek above LNFH prior to 2008. In 1937, prior to the construction of LNFH, 12 juvenile bull trout were captured during surveys for anadromous fish in a downstream migration trap operated intermittently in the Icicle and Peshastin Canal at rm 5.7 (just upstream of the boulder area) from May through early October (Brennan 1938). In 1994 and 1995, several day snorkel surveys in the Icicle Creek watershed found a total of 11 small bull trout (generally 8” to 12” in length) in dispersed locations in Icicle Creek above the LNFH spillway and in the lower end of Jack Creek, an upper Icicle Creek tributary. Bull trout comprised less than 0.2 percent of all fish detected, and were found up to rm 24 (USFWS 1997). In 2002, one small (size unknown) bull trout was observed in Leland Creek, an upper Icicle Creek tributary (Morgan D., pers. comm.., USFWS, 2002). Fieldwork by Brown (1992b) located a few “juvenile” bull trout in French and Eightmile creeks, which are upper and mid-Icicle Creek tributaries, respectively. Kelly Ringel (1997) found seven adult bull trout in Icicle Creek between rm 14 and rm 26 and four in the lower two miles of Jack Creek while daytime snorkeling sample reaches. One bull trout was observed while snorkel surveying in French Creek (Kelly Ringel and Murphy 1999).

Prior to 2008, the only survey that specifically attempted to locate small resident bull trout in Icicle Creek was a consecutive four-night snorkel survey in 2004, which found 18 resident bull trout, mostly less than 8” long scattered throughout upper Icicle Creek as far downstream as rm 14, and in lower Jack Creek (USFWS 2005b). There have been a few opportunistic surveys as well. During a site visit in August 2005, one bull trout about 6” long was seen from the bank at the trash rack located at the water intake at rm 4.5 (personal observation by David Morgan, USFWS). During a day snorkel survey of the historic channel in June 2005, one bull trout about 8” in length was seen immediately downstream of structure 2 at rm 3.8 (personal observation by David Morgan, USFWS). In 2001 and 2005, a total of four dead bull trout were found on the trash rack at the LNFH intake at rm 4.5, two of which were 14” long (USFWS 2006b). We have no information on the actual cause of these mortalities.

In September 2002, three or four migratory-size bull trout (approximate lengths: 26”, 22”, 19”, and 13”), and a fifth in September 2004 (20”) were seen at approximately rm 6, above the LNFH and the Snow Creek boulder area (De La Vergne, J., pers. comm., USFWS, 2002; (personal observation by David Morgan, USFWS). In the summer of 2006, one migratory-size bull trout (22”) was observed in mid Icicle Creek near Johnny Creek campground at approximately rm 12. In August and September 2007, at least four migratory-size bull trout ranging from 19” to 24” were observed in mid Icicle Creek near Chatter Creek at approximately rm 15 as they attempted to jump the falls. In early October 2007, one migratory-size bull trout (22”) was observed in lower French Creek, a tributary in upper Icicle Creek, at approximately rm 20 (WFC 2007). It is unknown whether these fish spawned in upper Icicle Creek. The presence of these migratory-size bull trout in Icicle Creek above all LNFH structures and boulder areas, as observed in 2007 during the spawning season, suggests that at least occasionally conditions allow the upstream migration of bull trout into upper Icicle Creek.

In 2007, the MCFRO analyzed some of the data collected by the USFS in Icicle Creek in 2006 and 2007. The analysis focused on three surveys performed at two sites, each approximately 250 meters in length. A total of 124 bull trout were observed, ranging from 2” to 9” long; most fish were 3” to 5”. The density of small bull trout was, compared to what has been reported in the literature, high, indicating that French Creek may be a critical rearing area (Nelson 2007). It is also important to note that pockets of high density of juvenile bull trout, particularly the youngest age classes which have the lowest survivorship, such as most of those observed in French Creek, can be highly variable spatially and temporally (personal observation by David Morgan, USFWS, in Ingalls Creek and Mill Creek, 1996, and the Lost River in 2007; K. Halupka, pers. comm., 2007 in Deep Creek). Another aspect of the USFS data collected in 2006 and 2007 is that, in addition to the French Creek sites mentioned above, the USFS sampled 10 other sites in the mid and upper Icicle Creek watershed, eight of which detected zero bull trout. A total of five small bull trout were observed at the other two sites. Other data collected in mid and upper Icicle Creek in 2006 and 2007, mostly in the mainstem river, found a total of 54 bull trout less than 12” spread across roughly 25 miles of river surveyed, where they also found about 20,000 rainbow trout (WFC 2007).

Since 2008, several important advances in our understanding of the Icicle Creek population of bull trout have occurred. First, systematic redd surveys (for redds constructed by migratory bull trout) have been implemented in the upper Icicle, yielding 8 redds in French Creek in 2008 (Nelson et al. 2009), 3 redds in 2009 (Nelson et al. 2011), and 1 redd in 2010 (Kelly-Ringel 2011). No redds have been confirmed in other tributaries but an observation of a faded large redd near Chain Creek near rm 34 (rkm 48) in 2008 (N. Gayeski, pers. comm. in Nelson et al. 2009) suggests there are additional fluvial spawning areas in upper Icicle Creek. Second, radio-telemetry (Nelson et al. 2009 and 2011) confirm that bull trout use Icicle Creek for both FMO and SR functions. This conforms to the general movement patterns and habitat use ES staff has observed in other bull trout local populations throughout Central Washington and the Columbia basin. It also suggests a small migratory component of Icicle bull trout still remains, and that when passage opportunities are provided at the LNFH, migratory bull trout can and do access their spawning tributaries (as their numbers and annual vs. alternate year spawning frequencies allow). Third, initial estimates of the resident component (i.e., juvenile, subadult, and non-migratory adult life history stages) have been calculated. Nelson (2007) estimated densities that range from 1.8 to 11.8 bull trout/100m^2, which exceed the minimum criteria of 1.5 per 100 m^2 used to determine areas critical to the maintenance of healthy populations of bull trout (Shepard et al. 1982). This supports the notion that habitat conditions in the upper Icicle are good, and despite limited opportunities for migratory bull trout passage since the LNFH was constructed, a resident form of bull trout has persisted through time. Providing improved passage opportunities in the lower Icicle, including at the LNFH, would likely advance the conservation needs of bull trout. And fourth, hybridization between bull trout and brook trout has been documented (Nelson et al. 2009), and elevates this as a risk factor to bull trout. For decades, brook trout have been stocked in a number of lakes and streams throughout Central Washington. Although that no longer occurs in waterways connected to occupied bull trout habitat, the legacy of this past program continues to impact bull trout.

Snorkel surveys have also been conducted by the MCFRO from rm 5.6 downstream to the mouth of the Icicle for several years each summer to enumerate Chinook, bull trout, and other species. Most data are comparable 2006-present, but some additional information dates back to 2003. In their August 12, 2010 memorandum, the MCFRO summarizes bull trout observed during these snorkel surveys to date (Table 3).

Table 3. Summary of Bull Trout Observed during Annual Icicle Creek Summer Snorkel Surveys

		Aug 4	Aug 4	July 6	Aug 3	July 31	Aug 6	Aug 5	Aug 12	
Area	**RM**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Mean**
Mouth to Stump Hole	0-1	0	0	1	0	0	3	0	1	*0.6*
Stump Hole to Structure 5	1-2.8	0	55	4	7	9	11	7	20	*14.1*
Spillway Pool	2.8	75	125	12	8	16	4	74	1	*39.4*
Structure 5 to Structure 2	2.8-3.8	ns	ns	ns	10	1	64	57	43	*35.0*
Structure 2 to Intake	3.8-4.5	ns	ns	ns	1	0	0	9	3	*2.6*
Intake to Boulder Falls	4.5-5.6	ns	ns	ns	4	2	2	8	3	*3.8*
Boulder Falls to Gauge Station	5.6-6.0	ns	ns	ns	ns	ns	ns	2	0	*1.0*
Total		**75**	**180**	**17**	**30**	**28**	**84**	**157**	**71**	

ns = no survey conducted in this reach

While these summer snorkel surveys do not characterize year-round use, they provide useful insights to seasonal habitat use. The size of bull trout observed in these surveys in 2010 ranged from 130 to 650mm, indicating that juvenile, subadult, and migratory bull trout are present. When coupled with temperature data from 2005 through 2010 (Hall and Kelly-Ringel 2011), it appears bull trout may be seeking thermal refugia during FMO habitat use. Hall and KellyRingel (2011) estimated a mean high 7-day average daily maximum temperature (7DADmax) in Icicle Creek of 16.7 °C in the headwaters and 19.1 °C at the mouth.

Two exceptions occur within the operational influence of the LNFH: (1) At the Snow Creek confluence, where summer supplementation of water from Snow Lake cools Icicle Creeks mean high 7DADmax by 0.7 °C (range 0.3-1.0 °C); and (2) At the LNFH spillway pool, where returned river water is mixed with well water, decreasing the mean high 7DADmax about 2.4 °C. (range 2.0-3.2 °C). This suggests that summer temperatures (mean high 7DADmax) in the Icicle range from about 16-19 °C, higher than the >15 °C reported to limit bull trout distribution (Allan 1980, Brown 1992b, Fraley and Shepard 1989, Goetz 1991, BioAnalysts 2004). However, Howell et al (2009) reported migratory bull trout using waters with mean high 7DADmax of 16-18 °C, suggesting either a somewhat higher upper range of suitability, at least for short periods of time, or perhaps local adaptation. Nonetheless, most studies agree a 15 °C approximates a distributional threshold. This 15 °C bound is sometimes referred to as a "thermal barrier" since it limits bull trout distribution. However, the cooling influence of the LNFH operations appears to appreciably reduce stream temperatures below Snow Creek and especially at the spillway pool. Cooler stream temperatures may benefit bull trout by extending their season of use and amount of habitat availability.

Despite all the surveys conducted over the years, bull trout habitat use in Icicle Creek is only partially understood, and may be spatial limited and temporal in nature. Most bull trout are rearing in upper Icicle Creek, presumably near the spawning area(s), but some immature individuals are rearing and emigrating at least as far downstream as the historic channel, even in summer. Immature bull trout are known to move long distances both upstream and downstream (Muhlfeld and Marotz 2005). More immature bull trout are assumed to use habitats in lower Icicle Creek during cooler months, because water temperature in summer is higher in this area than bull trout typically prefer, and emigration may be more common in spring and fall (Fraley and Shepard 1989).

Many large migratory bull trout are commonly observed in the large pool in Icicle Creek just below the LNFH spillway from July through November. This pool is the location of the Yakama Nation Fishery for LNFH Chinook salmon. According to the final BA, most angling here occurs between late-May and mid-June. The final BA indicates that most snorkeling and bull trout observations in the spillway pool occur in August. The number of bull trout in the spillway pool varies from year to year, and will also reflect differences in calendar date, river conditions, survey effort, and whether gates and pickets at structures 2 and 5 were open and passable. For example, on July 31, 2007, a total of 16 bull trout were observed in the spillway pool (USWFS 2007a). Both structures 2 and 5 were open and probably passable on that date. How many of those 16 bull trout migrated past LNFH in 2007, is unknown.

Telemetry studies have shown that migratory bull trout have moved from the spillway pool to the Wenatchee and Columbia rivers (De La Vergne, J., pers. comm., USFWS, 2005; BioAnalysts 2002 and 2004). The Service assumes that when very large numbers of bull trout are present in the spillway pool, the majority of these fish are from other, larger local populations elsewhere in the Wenatchee River Basin, and they may be holding in the area due to cool water, depth cover, and increased feeding opportunities. Based on limited telemetry data and direct observation while snorkeling in the spillway pool, the Service estimates that up to 20% of the large migratory fish located in the spillway pool, which can be as many as about 20 individuals depending on the year, are likely part of the Icicle Creek local population. This estimate is based on professional judgment.

The precise number of bull trout in different reaches of Icicle Creek, and how that number varies by time of year, is not well known. It is likely that in portions of upper Icicle Creek, well upstream from all LNFH activities, juvenile and resident bull trout are present year-round. In lower Icicle Creek and the areas directly affected by LNFH activities, empirical data are limited, and most monitoring efforts have taken place in the summer. Approximately four large radio-tagged adult bull trout, which were tracked for up to four years, were detected in lower Icicle Creek, including the LNFH spillway pool, almost year round, with heaviest use in summer and fall (USFWS 2005a). As previously mentioned, snorkel surveys in the spillway pool have detected up to about 125 bull trout (mostly larger individuals) in the late summer. This concentration is likely because of the cooling effect of the LNFH effluent in the summer when groundwater is pumped and discharged to the river, which may encourage bull trout to linger, and by the blockage at structure 5 near the spillway pool which has sometimes coincided with snorkel surveys.

No other locations in lower Icicle Creek have ever recorded so many bull trout. Based on elevated water temperatures in most of lower Icicle Creek, and the bull trout's limited tolerance for warm water, the lowest number of small bull trout would be expected to be present near LNFH facilities in the summer. There may be a few pools near structure 2 and the water intake where small bull trout could find thermal refuge during the summer. In the spring and fall, consistent with the literature (Downs et al 2006; Muhlfeld et al 2003; Muhlfeld and Marotz 2005), a pulse of smaller fish would be expected to emigrate downstream past all of the LNFH facilities. The peak of upstream migration past the LNFH, or at least to the point where passage is not possible due to settings at structures 2 and 5, is expected to occur in the late spring and early summer, consistent with monitoring at Tumwater Dam as discussed below.

Because little information about the timing of bull trout migration in Icicle Creek is available, the likely timing of spawning migration is inferred based on the behavior of bull trout in nearby local populations. Tumwater Dam, located on the Wenatchee River about 5 river miles upstream from Leavenworth, provides a reasonable surrogate. Like the structures at LNFH, Tumwater Dam is located in the lower Wenatchee River Basin, and is near the mouth of a canyon that provides a bull trout migratory corridor to spawning habitat many miles upstream. The LNFH and Tumwater Dam are about 3 air miles apart. The hydrograph patterns for both Icicle Creek near the LNFH and the Wenatchee River near Tumwater are similar (the Icicle Creek discharge is less but the graph line tracks parallel to that at Tumwater Dam).

There is a strong correlation between stream discharge and fish passage at Tumwater Dam. Bull trout upstream migration consistently peaks about one month after the peak of the hydrograph, which varied between early May and late June during the period of record (1998-2009) (unpublished data available from the USFWS, CWFO). It is a reasonable assumption that bull trout at the LNFH and Tumwater Dam would naturally move past these locations at roughly the same time of year. Additional evidence supporting this assertion is found in the bull trout technical literature (Rieman and McIntyre 1993) and known movement patterns in the lower Wenatchee River Basin (BioAnalysts 2004, USFWS 2005a). In many systems, some migratory bull trout are known to begin migration out of lower basin locations in the spring, well before spawning occurs in late summer and early fall.

Spawning migration is the most critical movement necessary for the survival of bull trout populations. Although the precise timing and location of spawning are unknown in Icicle Creek, in other spawning areas in the Wenatchee River Basin, peak activity occurs in mid- to late September. It is uncertain whether fish typically move directly from overwinter habitat to spawning areas, whether some intermediate location is used as holding habitat, or whether this is highly variable. We assume that the phenology of the Icicle Creek bull trout population is similar to others in the Wenatchee River core area, meaning that most upstream migrant fish would attempt to move past LNFH primarily between late May and early September, with a distinct peak in the migration about one month after peak runoff.

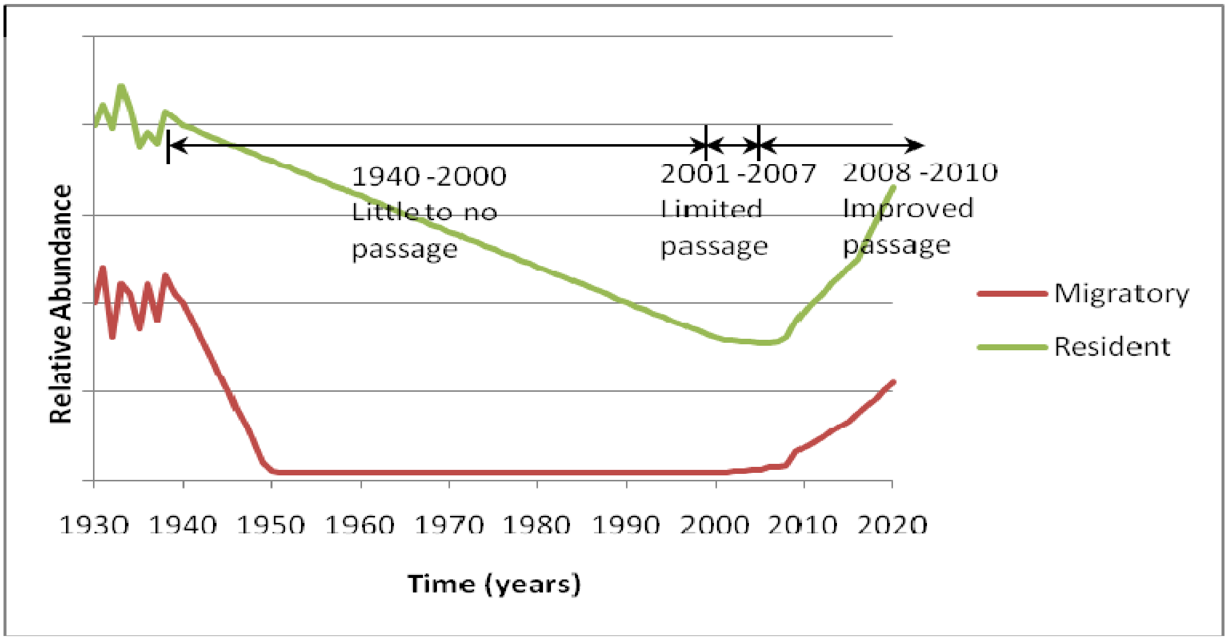
Spawning by migratory bull trout is known only to French Creek (Nelson et al. 2009), and spawning by resident bull trout likely also occurs there. Based on detections of multiple age classes of bull trout in upper Icicle Creek and tributaries such as Jack creek (Nelson 2007, USFWS 2005b), additional spawning may also occur in these areas and perhaps Leland Creek (WDFW 1998), but this has not been confirmed. Similarly, an observation of a faded large redd near Chain Creek near rm 34 (rkm 48) in 2008 (N. Gayeski, pers. comm. in Nelson et al. 2009) suggests there are additional fluvial spawning areas in upper Icicle Creek.

There is no known bull trout spawning in Icicle Creek below LNFH and migratory bull trout from the Icicle Creek population that are unable to pass upstream of LNFH either do not reproduce or reproduce elsewhere. Some proportion likely re-absorbs their eggs, but we have little data to quantify this further. Data collected in Montana indicate that 11 fish species, including the bull trout, which migrate to Milltown Dam do not spawn once their migration is impeded there, but instead absorb their eggs (Schmetterling and McEvoy 2000; Schmetterling 2003). Although we are uncertain of the frequency of egg absorption in Icicle bull trout that do not spawn, we know migratory bull trout are capable of long movements. Radio-telemetry studies in central Washington (BioAnalysts [2004] and Kelly-Ringel and De La Vergne [2008]) suggest that bull trout move between local populations and core areas so long as passage opportunities are provided. These data included movements between local populations and core areas during the spawning season into spawning habitat and suggests spawning, but actual spawning by these fish was not the purpose of these studies so this was not confirmed. The spawning migrations of bull trout from other populations, which may also be found in the spillway pool below LNFH at certain times of year, are not affected in this manner. Habitat below LNFH is not suitable for successful bull trout spawning and incubation due to elevated temperatures and other degraded habitat factors.

Systematic bull trout redd monitoring (of migratory fish) is used throughout the region to track population trends. Up until recently, migratory bull trout have not generally had access to upper Icicle and redd monitoring has not occurred there. Between construction of the hatchery and 2000, probably zero to few migratory bull trout were able to access upper Icicle spawning areas due to LNFH operations. Between 2001 and 2007, migratory bull trout have probably had increased opportunities to spawn in Icicle Creek with improved passage conditions, but still less than the period prior to 1940. It is unknown whether these opportunities resulted in success, but even periodic spawning connectivity by a small number of migratory individuals could have significant and beneficial genetic implications for the Icicle Creek population, although demographically it would not address other problems associated with small populations and the risk of extirpation (poaching, landslides, fires, etc.) described elsewhere in this Opinion. In 2007, the LNFH also implemented a new strategy to trap bull trout and pass them above the LNFH during their spawning migration, but none were trapped. As described earlier, systematic redd surveys began in 2008 and spawning by migratory fish has been documented 2008-2010 (Nelson et al. 2009 and 2011, Kelly-Ringel 2011). Although this appears to represent progress, we lack enough comparable data to estimate a population trend or to even characterize the Icicle local population with much precision. To detect any trend will require consistent data collection over a period of 10 years (about two bull trout generations).

Since we have limited data, the CWFO offers a conceptual population model to characterize the Icicle population in Figure 3. Here we suggest that prior to LNFH construction, the Icicle had a relatively large population (i.e., larger than present) with all history stages represented. After LNFH construction about 1940 through 2000, upstream passage opportunities for bull trout were very limited. During this period, the resident form persisted in the spawning and rearing habitats in the upper Icicle and likely declined in distribution and abundance, and most certainly experienced genetic drift due to its small population size (see Reiman and Allendorf [2001]). This conclusion is consistent with the literature which indicates that (1) resident populations of bull trout are less likely to persist over long time scales (Rieman and Allendorf 2001; Dunham and Rieman 1999; Rieman and Dunham 2000; Nelson et al. 2002; Morita and Yamamoto 2001) and (2) that genetic drift will likely occur when populations are small, isolated, and do not include a full expression of life history forms (Rieman and Allendorf 2001, USFWS 2002a). We also know through local examples that isolated populations can persist for long periods of time, albeit with reduced distribution and abundance (e.g., the Icicle and Early Winters local populations in the Upper Columbia; see USFWS 2002a). Between 2001 and 2007, migratory bull trout have probably had increased opportunities to spawn in Icicle Creek with improved passage conditions at LNFH, but still less than the period prior to 1940. Any successful reproduction was probably limited, but may have made important genetic contributions (since even periodic gene flow can retard some deleterious effects; see Rieman and Allendorf 2001) and provided improved short-term demographic performance due to the high fecundity of migratory fish (Rieman and McIntyre 1993, MBTSG 1998, Frissell 1999).

Figure 3. Conceptual Population Model for Icicle Creek Migratory and Resident Bull Trout.



Since 2008, passage conditions have improved at LNFH and consistent opportunities have allowed more connectivity than at any time since hatchery construction. However, few migratory fish returned to the upper Icicle to spawn in 2008-2010, probably as a result of over 70 years of near total isolation and decline in the abundance of the migratory form. Nonetheless, recently improved passage and 3 consecutive years of documented spawning by migratory bull trout (Nelson et al. 2009 and 2011, Kelly-Ringel 2011) should result in improved demographic and genetic performance for both migratory and resident life history forms. Although we cannot precisely document the population trend, we believe the past decline of both migratory and resident bull trout (1940-2000) moderated somewhat with periodic passage opportunities in 2001-2007, and improved passage opportunities and spawning in 2008-2010 may have resulted in a slight increase in abundance. We expect the relative abundance of both life history forms to increase with increased passage opportunities and spawning by migratory fish in future years, based on the information provided in the final BA. We believe that population performance (both demographic and genetic) is positively correlated with population size and connectivity, and large and connected populations suggest a higher likelihood of persistence over time.

It is not known how many migratory bull trout historically migrated annually past the LNFH location, or how many would normally be expected today if unimpeded passage had been provided since 1940 and the population size had not declined. Indications are that the number is much lower today due to the effects of over 70 years of blockage. An estimate can be made based on limited information on the extent of available spawning habitat in Icicle Creek and redd counts from a nearby watershed. Icicle Creek supports at least 7 miles of good spawning habitat, which the Service estimates could support about 50 redds, as previously described. At least 100 migratory bull trout would be needed to create 50 redds. Based on redd counts in Chiwaukum Creek, a watershed adjacent to Icicle Creek, where migratory bull trout redds have been monitored for the last several years in a 3-mile long index area, and the redd counts have varied from 23 to 42 (unpublished data on file at the CWFO), the Service concludes that 50 to 100 migratory bull trout in Icicle Creek is a reasonable estimate of what could be present annually if unimpeded passage were provided over a time period long enough for the population to respond (several generations).

F. Conservation Role of the Action Area in the Persistence of the Bull Trout in Wenatchee River Core Area

As discussed previously, about 80% of bull trout production in the Wenatchee River core area occurs in the Chiwawa River local population. Like all watersheds in the core area, the Chiwawa River Basin is subject to natural disturbance events, such as large fires and landslides, that could adversely affect the reproduction, numbers, and distribution of the bull trout population and its resiliency in that watershed. Because this watershed contains such a high percentage of the bull trout in the Wenatchee River Basin, a significant decline in the Chiwawa River local population would significantly reduce the prospects for persistence of bull trout at the core area scale.

To ensure bull trout persistence in core areas, the draft recovery plan for the bull trout identifies four conservation needs: (1) maintain the current distribution of the bull trout and restore its distribution in previously occupied areas; (2) maintain stable or increasing trends in the abundance of the bull trout; (3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies; and (4) conserve genetic diversity and provide opportunities for genetic exchange (USFWS 2002a).

The action area plays an important role in the conservation of the bull trout because it includes one of seven local populations of the bull trout in the Wenatchee River core area. Although migratory connectivity is generally good in six of the seven populations, based on their small population sizes and trends, five or six of these populations are currently at an increased long-term risk of extirpation due to their small size, which makes them less resilient to environmental change and increases the potential for deleterious genetic effects. Given the bull trout’s persistence in Icicle Creek for over 70 years in the face of passage barriers and other limiting factors in Icicle Creek such as irrigation diversions and non-native species, it is likely that in the short-term the risk of extirpation for the Icicle Creek population is moderately low.

The spatial distribution of the seven populations in the core area is such that most of them occur in the upper basin. Icicle Creek is one of only two populations in the lower basin. This may have resulted in distinct genotypic or phenotypic variation in this population, and it could insulate this population from disturbances in the upper basin that would affect most of the others. For example, radio telemetry suggests that migratory fish from these lower basin populations are likely to use the lower Wenatchee and Columbia rivers as overwinter habitat (USFWS 2005b). In contrast, Lake Wenatchee is heavily utilized by bull trout populations in the upper basin where fish from several local populations congregate as they overwinter, and changes in that habitat could affect all of those populations simultaneously (USFWS 2005b). Adverse effects to the lake could decrease the long-term stability of bull trout in the Wenatchee River core area. A population in the lower basin, such as the one in Icicle Creek, which does not rely on the lake could help to buffer the core area from such disturbances.

A recent local example demonstrates why this is significant. The Chelan Basin, about 25 air miles north of the Wenatchee River Basin, but it has been physically isolated from all other watersheds in the upper Columbia for thousands of years. In the first half of the 1900s, migratory bull trout were abundant in Lake Chelan, a massive lake with extensive tributary habitat that is essentially pristine. It is likely that there were several local populations that migrated out of those tributaries to the lake after spawning. Unfortunately, a combination of factors that affected Lake Chelan quickly eliminated all bull trout populations in that basin in the 1950s (USFS 2002). In the span of several years, bull trout in the Lake Chelan Basin, an area similar in size to the Wenatchee River Basin, went from numerous to zero (Brown 1984). Currently, the Service is attempting to reverse the decline of several lake-based bull trout populations in Montana, where the introduction of non-native lake trout has led to a precipitous decline of several bull trout populations in those lake systems (Meeuwing and Guy, 2007; Fredenberg, 2002).

The draft bull trout recovery plan (USFWS 2002a) and recovery team analyses (USFWS 2004c) recommends that all seven local populations of the bull trout in the Wenatchee River core area, including the one in Icicle Creek, be maintained/enhanced to maximize the chances for long-term persistence of bull trout in this core area. This recommendation is based on consideration of the bull trout's historic and current distribution in the core area, its life history needs, best available information on effective population size, environmental stochasticity, and the principles of conservation biology that emphasize that the more interconnected populations of a species there are distributed on the landscape, the better its chances are for persistence. With the exception of the Chiwawa River, these local populations are currently at an increased risk of extirpation due to their small size, although this risk should be ameliorated because migratory connectivity is good in all areas except Icicle Creek and to a lesser degree Ingalls Creek (a tributary of Peshastin Creek).

Icicle Creek is considered to be the smallest population in this core area, although no systematic surveys of this area have been conducted. Based on limited available information, and a rough assessment of the population trend in Icicle Creek described above, this population appears to be the most threatened within the core area primarily on the basis that migratory bull trout could not access spawning habitat in Icicle Creek due to year-round passage barriers at LNFH facilities in most years from 1940 to 2000, as well as other natural and human barriers. In 1993, 1997, 2001, 2005, 2006, and 2007, there were some changes in hatchery operations that provided some passage opportunities for at least short intervals. Since then, passage opportunities have further improved, yielding 3 consecutive years of documented spawning in the upper Icicle (2008-2010). Providing and further improving such access is likely to substantially enhance the viability of this local population by increasing reproduction (due to the presence of large migratory individuals that have higher fecundity than resident bull trout, and other advantages mentioned previously), facilitating the re-establishment of multiple life history forms in this local population, and minimizing the potentially deleterious genetic effects of inbreeding. Providing and further improving migratory connectivity would also provide a mechanism for "rescue effect" when the next large fires occurs in the upper Icicle Creek watershed, which, as previously mentioned, are expected to be large and severe. There are a variety of factors influencing the ability of a fish population to survive fires and post-fire disturbance including landslides, with one key being the extent of the distribution and connectivity of adjacent populations (Dunham et al. 2003b; Rieman et al. 2003; Howell 2006).

Bull trout populations are genetically more highly differentiated than populations of other salmonids. This may be due to local adaptation, low rates of gene flow, or genetic drift. Whatever the cause, genetic diversity is higher between, and lower within, local populations of bull trout. If one local population were lost, it is likely that new recruits into a watershed would possess a significantly different genotype, reflecting a different set of selection pressures or history of genetic drift, which makes its long-term survival under the new environmental regime less certain. It may be very difficult to establish a new population of bull trout in a watershed once the native population is lost (USWFS 2004a).

As described in the draft bull trout recovery plan (USFWS 2002a) and recovery team analyses (USFWS 2004c), the Wenatchee River core area is one of three core areas in the Upper Columbia River management unit (formerly known as a recovery unit). The draft plan describes recovery criteria for the management unit and, as appropriate, for each individual core area. Four draft recovery criteria have been defined for this management unit:

1. Distribution criteria will be met when bull trout are distributed across 19 local populations, including 7 in the Wenatchee core area;
2. Abundance criteria will be met when the estimated number of bull trout among all populations is between 4,210 and 5,969 migratory fish, including between 1,532 and 2,480 in the Wenatchee core area, and a minimum of 100 reproductive adults in each local population;
3. Trend criteria will be met when adult bull trout exhibit a stable or increasing trend for at least two generations (10 years) at or above the recovery abundance level in all core areas;
4. Connectivity criteria will be met when specific barriers to bull trout migration in the management unit have been addressed.

G. Role of the Action Area Relative to the Intended Survival and Recovery Function of the Columbia River Interim Recovery Unit

The Icicle Creek bull trout population contributes to the distribution, abundance, and genetic diversity of 7 bull trout populations in the Wenatchee River core area, which in turn contributes to the distribution, abundance, and genetic diversity of the 500 total bull trout populations in the Columbia River interim recovery unit.

The presence of this local population helps to dilute the risk of local extirpation due to of catastrophic fires or other large scale natural or anthropogenic environmental disturbance at the core area and larger scales. The bull trout population in Icicle Creek occurs within a designated Wilderness area, which affords a high level of protection from a land-use perspective.

This population is currently considered to be the smallest and most threatened of the seven local populations within the Wenatchee River core area on the basis that migratory bull trout could not access spawning habitat in Icicle Creek due to natural and human passage barriers, including LNFH facilities in most years from 1940 to 2000, with some exceptions in 1993, 1997, 2001, 2005, 2006, and 2007 in response to changes in hatchery operations that provided some passage opportunities. In 2008-2010 passage conditions at LNFH have been further improved and facilitated spawning in the upper Icicle these same years.

In most years since 1940, the contribution of the Icicle Creek bull trout population to abundance, distribution, productivity, spatial structure, and genetic diversity at the core area and recovery unit scales has been minimized due primarily to passage barriers, including at the LNFH. O&M at LNFH were modified to specifically improve fish passage beginning in 2001. More significant and predictable formal changes were implemented beginning in 2005 to 2007. Subsequent to these changes, a few migratory bull trout were observed upstream of the LNFH in or near spawning habitat in upper Icicle Creek in 2007. In 2008-2010 passage conditions at LNFH have been further improved and facilitated spawning in the upper Icicle these same years. These events had the potential to increase the contribution of the Icicle Creek population to the survival and recovery needs of the bull trout at the core area, recovery unit, and range-wide scales. The full contribution will not be realized until better connectivity between Icicle Creek and other bull trout populations in the core area is achieved. That connectivity would likely provide for a population increase, the re-establishment of multiple life history forms, and minimize the potentially deleterious effects of inbreeding within the Icicle Creek resident population of the bull trout. All of these changes will enhance the resiliency and viability of the core area.

As introduced in the "Status of the Species" section, the role of the migratory form of bull trout is largely demographic (since they are very fecund) and genetic (maintaining variability). Which role is more emphasized depends on many factors, including the current population abundance and its genetic structure. For example, a very small local population like the Icicle may have low distribution and abundance and be suffering from genetic drift. A single successful spawning year may provide a relatively large, short-term boost demographically, but may require several years of repeat spawning before population distribution and abundance shows an increase (due to high annual mortality of juveniles). However, genetic integrity can be maintained or restored with only periodic gene flow; thus in smaller populations, genetics may be a more immediate concern so long as the long extinction risk is low. As population size increases (due to consistent spawning), maintenance of the demographics is emphasized since gene flow at this point would be substantial.

Metapopulation resiliency is high when populations are connected to each other, and when populations are many and large (USFWS 2002a). Large populations with connectivity to other populations are obviously more resilient to disturbances and may support other local populations within and between core areas. Radio-telemetry efforts in the upper Columbia (BioAnalysts 2004) suggests that about 17% of a given local population may be comprised of migratory fish that long-range movements (>200km) within and between core areas. Although BioAnalysts (2004) did not document inter-local population or inter-core area spawning, these long-range movements within and between local populations in different core areas during the spawning season suggests it is entirely possible.

As described in the previous section, the draft Bull Trout Recovery Plan (USFWS 2002; USFWS 2004c) has four recovery criteria. Regarding the action area, the Icicle Creek bull trout population, and its contribution to recovery, when compared to the four criteria, the current situation is as follows:

1. Icicle Creek is one of seven extant populations in the core area, but the distribution of bull trout in Icicle Creek is not well-distributed;
2. Icicle Creek does not meet the minimum number of adults (nor does the core area), and all or nearly all of Icicle reproductive adults are resident, not migratory individuals;
3. Icicle Creek data does not exist to do an exact trend analysis, but based on the available information, the trend has likely been negative since 1940, but may have reduced its rate of decline (with potential spawning, periodically 2001-2007) or perhaps even begun to show a slight positive trajectory (since 2008) following improved passage conditions at LNFH (see Figure 3);
4. Icicle Creek was specified as a location with specific barriers at the LNFH that needed to be addressed in order to facilitate bull trout migration. Changes to LNFH O&M have been on-going since 2001 and have resulted in increased passage opportunities.

H. Factors Affecting the Species Environment in the Action Area

The following section will describe in detail the reasons and mechanisms affecting Icicle River bull trout in the action area. Previously consulted on effects in the Icicle Creek watershed is summarized in Appendix A for reference.

<u>Habitat Access and Migration Barriers</u>
The LNFH operates four structures that are impediments or barriers to bull trout migration in Icicle Creek: (1) a spillway at rm 2.8 which is the terminus of the hatchery channel that conveys most of the flow of Icicle Creek across the LNFH grounds; (2) a weir (referred to as structure 5) on the historic channel of Icicle Creek adjacent to the spillway; (3) a headgate (structure 2) at rm 3.8 that splits the flow between the LNFH channel and the historic channel of Icicle Creek; and (4) the LNFH water diversion intake at rm 4.5 at very low flows (see Figure 1). The past operations of these structures (prior to 2011) is described in detail for context, in the order they occur from downstream to upstream, in the following paragraphs.

The spillway is at the downstream end of the hatchery channel, and immediately upstream from the LNFH ladder. The hatchery channel was dug when LNFH was built in about 1939 so that the natural channel could be regulated and used for fish culture.[1] In order to accommodate Icicle Creek's higher flows, and to avert "blow-out" of those structures, the hatchery channel was built to convey most of Icicle's flow and to bypass the facilities installed in the historic channel. The spillway provides grade control; the length of the hatchery channel is shorter than the historic channel. The spillway is a smooth concrete ramp, roughly 20-feet high and 120-feet long. At its base the water surface elevation is again equal to the natural channel of Icicle Creek. There is a deep pool (referred to as "the spillway pool") at its base where water from the hatchery channel and water in the historic channel merge. Icicle Creek continues as a single-thread channel from

[1] In 1979, artificial production was discontinued in the historic channel. Instead, the main fish ladder into LNFH was built that year, and artificial production was transferred to ponds and raceways on an old floodplain terrace where they exist today.

this point downstream. Upstream fish passage is impossible at the spillway, which was not designed to pass fish.

Just upstream from the base of the spillway pool, in the historic channel of Icicle Creek, LNFH operates a second structure (structure 5) that traverses the historic channel. This structure is a weir, and in recent years it has blocked all fish passage both upstream and downstream for about 6 to 8 weeks every spring between March and the end of April when the pool upstream of this weir is used to acclimate Coho salmon pre-smolts.[2] Thereafter, the pickets are removed from this structure, allowing fish passage. In a slightly different configuration, pickets are installed later in May, and kept in place for about two months, removed in mid-summer, and then (in most years) are replaced for two or three months in the fall.[3] This weir blocks the passage of all large fish during LNFH spring Chinook salmon broodstock collection, which also facilitates the Yakama Nation fishery, and it blocks and/or traps all large fish during Coho salmon broodstock collection.

Continuing up the historic channel one mile to rm 3.8, the headgate (structure 2) is also a barrier to fish migration. This headgate is primarily operated to control the flow that is split between the historic channel of Icicle Creek and the LNFH channel. Originally the headgate was needed to protect the fish culture facilities in the historic channel that were later abandoned and partially removed. Currently it continues to affect the morphology of the historic channel because it restricts the amount of water that can flow in the historic channel. The rest is conveyed by the hatchery channel. An analysis done by the BOR suggests that the maximum flow that can be passed through structure 2 and into the historic channel is about 2,600 cfs (summarized by David Morgan, USFWS, and his pers. comm. with Montague, S., BOR, 2006), which is generally slightly less than the normal spring freshet.

Based on numerous personal observations (David Morgan, USFWS, between April 2003 and June of 2005), fish passage at the headgate was generally impossible because the radial gates were lowered such that they were nearly closed, and the concrete structure at the base creates impassable hydraulic conditions when the gates are in that position. When the gate is opened only slightly, or when the creek is high and water leaks around the gates even when they are closed, fish may be attracted to jump at the attractor flow, but they cannot pass. Even when open, upstream passage at the headgate (structure 2) may be impossible to difficult under high and low flow conditions. Too high a flow through the headgate may act as a “firehose” and pose a hydraulic barrier due to streamflows that exceed swimming capabilities. At too low a flow, bull trout make not have enough water volume to successfully ascend the headgate. The design of the headgate itself complicates passage, as this was not considered in its design. For example, when the gate was only open slightly during the summer of 2004, salmonids were observed repeatedly jumping and hitting the metal gate and/or concrete walls without passing through. One fish is known to have landed on a “shelf” in the gate door above the water surface where it

[2] In 2005 and 2006, Coho salmon were not acclimated in the side channel, and therefore passage was not barred in the early spring as it was in the past. Per an agreement (March 2006) between BPA, the Service, and the Yakama Nation, in the future Coho salmon will be acclimated in ponds and not in the channel, thus ensuring fish passage at Dam 5 in the spring until mid-May when it is erected for LNFH’s Chinook salmon broodstock collection.
3 In 2007, the coho salmon program did not install the pickets as they had in previous years. It is unknown whether this will also be the case in the future.

lodged and died (Rieman, D., local resident, pers comm. with David Morgan, USFWS, 2006). In 2001, a few days after the gate was opened wide in early July, bull trout and other fish were observed swimming through the gate at structure 2 (USFWS 2006a). According to the LNFH, the gate was also opened for part of the summers of 1993, 1997, and 2005. There is no record of fish passage at structure 2 in 1993. One large adult salmon was observed immediately upstream of structure 2 in 1997 (USFWS 2001b). In 2005 a few large bull trout were observed a short distance upstream of structure 2 (Bambrick, D., NMFS, pers. comm. with David Morgan, USFWS, 2005). Other than these four times, other opportunities for fish passage are believed to have been extremely rare during the time interval from about 1940 until 2006. Beginning in 2008, additional modifications of O&M facilitated passage of migratory bull trout past the LNFH and spawning was documented in 2008-2010 in the upper Icicle (Nelson et al. 2009 and 2011, Kelly-Ringel 2011).

The fourth and final structure at LNFH that affects fish movement is the intake structure at rm 4.5. This structure is approximately 6-feet high and spans Icicle Creek from bank to bank, which is about 75-feet wide at this location. Since the dam is a chevron shape, it is about 150-feet from bank to bank. This structure is known to pass large fish during higher flows (USFWS 2001c), but for most of the year it can prevent or inhibit upstream fish passage. In recent years, no fish ladder was in place because the original design filled with sediment. The ladder location is sub-optimal because it is too far downstream of the structure itself, and may not have adequate attractor flow to entice fish into it instead of proceeding upstream to the face of the structure. In August 2006, LNFH installed some weirs in the original ladder to improve passage. The flow velocity and elevation difference between each pool and weir appear passable (personal observation by David Morgan, USFWS), assuming fish can find the ladder entrance to use them. Although the structure itself is not higher than fish can jump under certain circumstances, there is no pool area along the face of the structure to facilitate a jump over it, because a concrete footing extends downstream. At moderately low flows, this footing appears to prevent hydraulic conditions needed to facilitate a big leap by a fish over the structures crest. During very low flow, the structures crest is “checked up” by LNFH using tarps, sandbags, and other methods to ensure enough water is diverted until flow increases.

Phase 1 of the Icicle Creek restoration project, completed in the summer of 2003, removed structures 3 and 4, which were located in the historic channel between structures 2 and 5. Removing structures 3 and 4 allowed some natural sediment transport to occur in the area where these structures used to be, and has initiated a beneficial response in channel morphology, primarily by reducing the width to depth ratio of the stream in that reach (D. Morgan, USFWS, pers. obs. 2006). However, the removal of these structures did not affect fish passage because they were already filled with sediment and did not cause barriers to fish movement.

Most of the time since 1940, migratory bull trout have generally been limited to the lower 2.8 miles of Icicle Creek due to structures at LNFH that block all or nearly all upstream fish passage in Icicle Creek at the hatchery. Based on a stream survey in 1935 (described in Bryant and Parkhurst 1950), anadromous fish had access to 24 miles of Icicle Creek.[4] In 1937, juvenile

[4] The text and map in this survey do not agree on the barrier location. The map places the barrier at ~RM30 (just above the Leland Creek confluence). A USFS survey (1994b) concluded: “Bedrock canyon at approximate RM 26.4 is a series of chutes/falls and cascades with an average gradient of 28 percent. Believe this is the historical barrier to anadromy where

steelhead/rainbow trout, “Dolly Varden”, and Pacific lamprey were captured in a trap on the Icicle Irrigation District irrigation ditch near rm 5.7 (Brennan 1938). This report does not provide a clear indication whether this meant that anadromous fish were accessing the area or not. These “Dolly Varden” were what we now call bull trout. This trap was operated only briefly in the spring and summer of 1937, presumably sampling fish moving downstream only, and it collected 12 bull trout between 6” to 10” long.

In 2001, shortly after structure 2 was intentionally opened for a few weeks during an experiment by LNFH, 8 medium and large bull trout (12” to 24” long) were found during a snorkel survey between structure 2 and the boulder falls area (USFWS 2001b). In 2002 and 2004, a total of four or five migratory-size bull trout were found above the boulder cascades in a large pool near rm 5.9. These fish were 26”, 22”, 20”, 19”, and 13” in length. The larger individuals were very large-bodied (i.e. muscular, not cigar-shaped) and colorful, similar to migratory bull trout seen elsewhere in the Wenatchee basin (De La Vergne, J., pers. comm., USFWS, 2006). The observations of migratory-size bull trout above the boulder area were both opportunistic samples.

As previously described, in 2006 and 2007 about 5 migratory-size bull trout were observed in the middle and upper reaches of Icicle Creek above the boulder areas. Apparently under some conditions fish passage is possible at both the structures in the historic channel at LNFH (structure 5 at rm 2.8 and structure 2 at rm 3.8), plus the intake structure at rm 4.5, the boulder area near the Snow Lakes parking lot near rm 5.6, and three or four other boulder areas upstream from there. The Snow Creek boulder area appears to be a combination of natural substrate (worn, rounded, presumably native river rock) plus side-cast material from the adjacent road which was built in the 1930s and improved in the 1960s (angular, car-sized boulders, some with drill holes as if from blasting activity). Visually, the boulder area appears to be a barrier for most of the year, beginning in mid-summer as flow decreases, which occurs generally sometime in July. The Service assumes it is only passable during relatively high flows in late spring and early summer, and possibly during rain-on-snow runoff that occur periodically at other times. Only the earlier period would coincide with bull trout spawning migration. This is likely also the case with other boulder areas in mid and upper Icicle Creek, which are located downstream of the habitat where bull trout are believed to spawn in upper Icicle Creek. Based on a variety of information (described above) and a coarse-scale analysis of spawning habitat in Icicle Creek (USWFS 2001a), the CWFO of the Service concludes that migratory bull trout need to pass all of these areas in order to successfully reproduce in Icicle Creek.

The MCFRO attempted to evaluate fish movement in Icicle Creek, including at the boulder area at rm 5.6, using radio telemetry (USFWS 2001c). In 1999 and 2000, the MCFRO radio-tagged about 15 spring Chinook and 20 steelhead each year. In 2000, 5 bull trout were also radio-tagged. All anadromous fish were collected in the ladder system at LNFH. Bull trout were collected in the spillway pool at rm 2.8 using hook and line. All fish were released above the main spillway. No fish were detected above the boulder area. More recent radiotelemetry efforts (Nelson et al. 2009 and 2011) have also not documented radio-tagged fish ascending all

previous reports have located it at RM 24.” If this is correct, this barrier eliminated or nearly eliminated migratory access to about 23.5 miles of habitat.

LNFH structures, but this may reflect the small sample size in these studies. Nelson et al (2009 and 2011, Kelly-Ringel 2011) have confirmed untagged bull trout spawn in the upper Icicle.

All of the Chinook salmon and nearly all of the steelhead were produced at LNFH (only four steelhead had adipose fins). It is possible that these fish would have little inclination to move above the LNFH infrastructure; instead they would be more likely to home in on and return to the ladder at LNFH where they were originally collected, or perhaps to the Snow Lakes Creek attractor flow, which enters Icicle Creek below the boulder area. The five bull trout were not tagged or released until mid to late-August which coincides with the period when flows in Icicle Creek are very low. Indeed, none of the bull trout moved above the LNFH intake structure at rm 4.5, which is known to be a passage barrier during low flow, as was the case for most of August that year (USFWS 2001c).

The final feature known to affect upstream fish migration in Icicle Creek is the IPID/City irrigation diversion at rm 5.7, which was built in 1915. In 1935, this structure was identified as a barrier during irrigation season (Bryant and Parkhurst 1950). As described later, this diversion also adversely affects in-stream flow, and that can affect fish passage opportunities for fish, in the event that they were able to pass LNFH, which exists downstream of this diversion. Based on site visits since 2003, the 1935 survey appears to be accurate, and that it would be passable at high flows, similar to the LNFH structures (Morgan D., pers. comm., USFWS, 2006). Most of the time since 1940, migratory fish were unable to access this area due to LNFH structures downstream, although that has improved somewhat in the last few years due to modifications in LNFH operations aimed at improving fish passage.

Typical operations at the spillway and at structures 2 and 5 limit the potential for fish passage into upper Icicle Creek, particularly at certain times of year. Until recently, except for a few instances when it was opened more than the usual practice, structure 2 has rendered passage out of the upper end of the historic channel impossible most of the year. Generally, structure 5 blocks all adult fish passage for portions of the year. Other areas in Icicle Creek just upstream from LNFH become seasonal barriers to upstream migration once river flow drops (generally sometime in July; see Figure 1). Therefore, determining whether a bull trout can successfully migrate from lower to upper Icicle Creek and potentially spawn with its source population that same year depends on the following three factors: (1) Was the fish able to pass upstream at structure 5, structure 2, and the intake at LNFH?; (2) If so, did passage occur during the spring/summer reproductive migration period?; and (3) If so, did passage at LNFH structures happen prior to low summer flows which “activate” other barriers in Icicle Creek just upstream from LNFH? These questions will be considered in detail in the following sections.

Most of the time since 1940 small bull trout from the upstream resident population could emigrate freely from Icicle Creek via the spillway at the end of the LNFH channel, but those individuals, were they to survive and grow to migratory size in the lower Wenatchee or Columbia rivers, could not return to the source population. If the situation in Icicle Creek resembles a similar situation reported at an impassable dam in Montana (Schmetterling and McEvoy 2000; Schmetterling 2003), these fish do not spawn once their migration is impeded, and therefore these fish do not contribute to some other local population. This situation has improved somewhat in the last few years after the LNFH made some operational changes that allows for some fish passage opportunities.

One final element related to migration barriers that likely impact bull trout in the action area is the fishery at LNFH for salmon produced by the hatchery; this fishery peaks between mid-May and early-June annually. This is also the time of year when bull trout are co-mingled with the salmon targeted by the fishery in the spillway pool. The Chinook salmon that are the target of the fishery are concentrated here because of the attractor flow from the LNFH fish ladder in this pool, and because they cannot migrate upstream. There is a very high concentration of fish (dozens to hundreds) and fishermen (up to half a dozen) in this small area. Although the anglers, who self-report to the Yakama Tribe, indicated that bull trout have never been caught (Parker, S., YIN, pers. comm. with David Morgan, USFWS, 2006), it is likely that some bull trout are hooked and injured or killed in this fishery. The number of individuals directly affected in this manner is unknown. The Service assumes that all or nearly all bull trout are released, but it likely some of these fish die later from hooking injury. The Service is unaware of independent or systematic attempts to obtain information about the effects on bull trout that likely result from the fishery at LNFH for hatchery-produced fish.

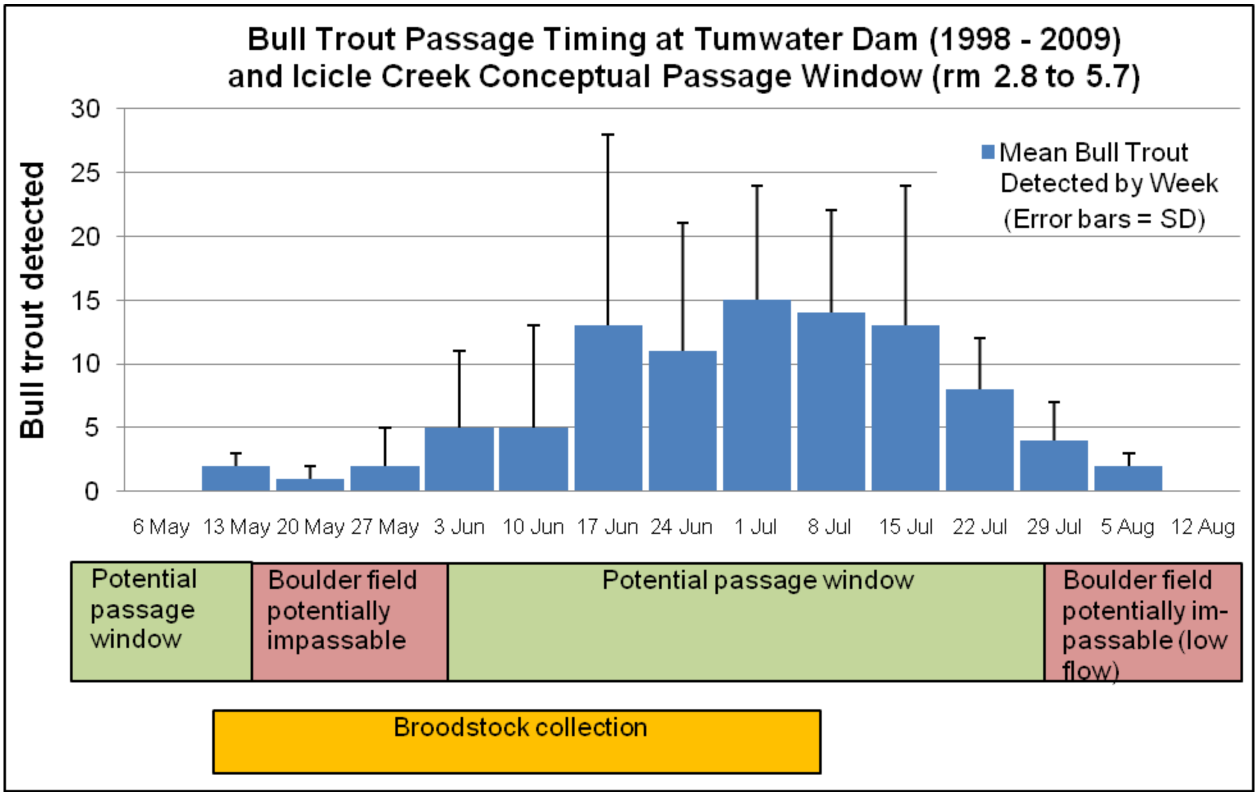
The boulder falls area (rm 5.6) is another factor affecting habitat access and migration. As previously described, it visually appears to be a barrier under a range of flows but bull trout have demonstrated the ability to ascend this feature. We believe that it may be a barrier during very high (typically several weeks in May-June) and low flows (beginning in July), so upstream passage of migratory bull trout is dependent not only on human actions and impediments, including LNFH O&M, but the flow conditions that year.

Review of bull trout passage timing at Tumwater Dam (1998-2009), our surrogate for Icicle Creek migration timing, coupled with data from the USGS Icicle Creek Gauge Station (1998-2009) above Snow Creek, suggests a limited opportunity for upstream passage of migratory bull trout given all factors affecting habitat access and migration. When the biological urge for upstream migration occurs (which varies across the range of the species from May-September, but typically peaks in June and July), bull trout must negotiate all natural and human impediments to passage (including flow conditions). In Icicle Creek, we considered LNFH operations, including the brood stock collection period which may result in closure of structures 2 and 5 in some circumstances, the water intake structure at rm 4.5, the boulder falls area at rm 5.6, and the IPID/City irrigation diversion at rm 5.7 as key impediments to upstream passage. Considering the estimated migration timing of bull trout and hydrograph data for 1998-2009 (unpublished data compiled by the USFWS CWFO 2011), and the key impediments to upstream passage, we formulated a conceptual model to describe the potential passage window in Icicle Creek between rm 2.8 and 5.7 (Figure 4).

Development of this conceptual model required several assumptions: (1) although streamflow will vary annually, we presented dates we believe that represent a typical year; (2) the precise peak flow conditions at the boulder falls area at rm 5.6 that may prevent passage are unknown, but we estimate that in most years this occurs between mid-May to mid-June; (3) the precise low flow conditions at the boulder falls area at rm 5.6 that may prevent passage are unknown, but we estimate that in most years this occurs about the 3rd week of July; and (4) the flows required for passage at the boulder area at rm 5.6 are similar to that required at the IPID diversion at rm 5.7.

We made these assumptions based on review of bull trout passage timing at Tumwater Dam (1998-2009) and data from the USGS Icicle Creek Gauge Station (1998-2009) above Creek (unpublished data compiled by the USFWS CWFO 2011), the timing and location of all observations of bull trout in or near rm 2.8-5.7, and professional judgment. This was required to characterize the window of passage opportunities in lower Icicle Creek given that this is the central point of this BO. However, we have incomplete knowledge of the actual timing of several events.

Figure 4. Bull Trout Passage Timing at Tumwater Dam (1998 - 2009) and Icicle Creek Conceptual Passage Window (rm 2.8-5.7).



This evaluation suggests a maximum potential window of passage of about 7 weeks, excluding those times when there are closures of structures 2 and 5 during broodstock collection. Under previous LNFH operations for broodstock collection, structure 2 was lowered and 5 was closed through the entire broodstock collection period (May 15 through July 7) and only allowed for about 3 weeks of passage opportunities. As described in the proposed action, the new operational approach would only close structures 2 and 5 if more than 50 Chinook pass above structure 5 during broodstock collection, so we expect further improved passage conditions beginning in 2011. More analysis on the expected frequency, duration, and impact of this occurring will be described in the effects section.

Reductions in Flow and Alterations of Flow Regime

There are two water diversions in Icicle Creek that influence fish access to upper Icicle Creek, one at rm 5.7 and another at rm 4.5. Both diversions restrict fish passage because of their physical structure and water withdrawal.

Water in Icicle Creek is over-allocated. Four water users divert up to 174 cfs from lower Icicle Creek (see Tables 4 and 5 below). Water rights at the diversion at rm 5.7 total just over 120 cfs. The IPID uses its water right of just over 117 cfs generally from mid-April through late September or October. The City of Leavenworth diverts from a separate intake on the opposite bank; its water right is about 3 cfs year-round. The other diversion is at rm 4.5, where total water rights at two diversions equal 54 cfs. The LNFH uses 42 cfs of water year-round while the COIC uses 12 cfs of water generally from May through September. Thus, year-round, up to 45 cfs are withdrawn, and generally from May through September up to 174 cfs may be withdrawn.

Table 4. Diversion rates from lower Icicle Creek (in cfs).

	Diversion Timing			
Water User	**Year-round**	**Irrigation Season (Apr – Oct)**	**Diversion Location (rm)**	**Maximum Diversion Rate**
LNFH	42		4.5	
IPID		117	5.7	
City of Leavenworth	3		5.7	
COIC		12	4.5	
Total	45	129		174

It appears that less than the full water right of 117 cfs is actually diverted by the IPID (USGS 1992) because the hatchery channel is not big enough to deliver this amount downstream of the screen. Data collected in the early 1990s indicated that the IPID diverted a maximum of about 100 cfs downstream of the overflow spillways near the screen (Montgomery Water Group, Inc. 2004b). There is a small amount of water added to baseflow below the USGS gauge (see discussion below). Flows are typically very low in lower Icicle Creek for several months each year. In 7 of the last 8 years, the total amount of water in Icicle Creek as measured (often well under 100 cfs) just upstream from these diversions is less than the sum of these water rights (174 cfs) for at least a portion of the late summer irrigation period. In 2005, flow was exceptionally low. During late September measured flow at the USGS gauge above all intakes was as low as 60 cfs (provisional data provided by USGS; available from CWFO).

Table 5. Average monthly flows in Icicle Creek for the period of record (water years 1936-1971 and 1994-2004) measured at USGS gauge 12458000 (in cfs).

Month	**CFS**
January	276

February	293
March	289
April	669
May	1,693
June	1,910
July	881
August	268
September	162
October	240
November	376
December	338

Some of the water taken out of Icicle Creek is supplemented by water released from Snow Lakes (actually three impounded natural lakes). The LNFH has a water right for 16,000 acre-ft from Snow Lakes. That water enters Icicle Creek via Snow Creek at rm 5.4. This confluence is between the IPID diversion and LNFH's diversion, and it is downstream of the USGS stream gauge located at rm 5.9. The period of record for flow data from Snow Lakes is 1998-2005, but data are incomplete for most years. Based on the raw flow data, releases from Snow Lakes varied between 15 and 45 cfs. Generally releases were less than 30 cfs. The initial date of water release varies from late June to early September, and releases end from late September to mid-October. This contrasts with the natural runoff pattern for Snow Lakes, which would be a snowmelt pattern with peak discharge in late spring followed by a gradual decrease. The natural baseflow of Snow Lakes appears to be about 3-5 cfs (unpublished flow data). Water released from Snow Lakes provides less water to Icicle Creek during most of the year than what would occur under a natural regime (as the Snow Lakes are filling up and storing water). However, the water released augments flow in lower Icicle Creek with more than the natural flow for the short reach before it is taken out at LNFH's intake at rm 4.5 during a time of year when flows are critically low (USFWS 2004b, 2005d). The IPID also releases water (generally less than 5,000 acre-feet per year) from storage reservoirs similar to Snow Lakes, but all or nearly all of that water enters Icicle Creek upstream of the USGS gauge at rm 5.9.

Water temperature is generally inversely related to flow. Therefore, diversions probably lead to increased stream temperature during the summer months. Icicle Creek is on the 1998 Washington State Clean Water Act section 303(d) list for flow alteration (it has too little in-stream flow), and for exceeding water temperature standards (it is warmer than 15 °C). Water temperatures may at times exceed this standard in Icicle Creek, even before the water reaches LNFH facilities. The lower end of the historic channel is probably warmer than normative due to the flow restrictions at structure 2 and the high width to depth ratio caused by structure 5.

Hall and Kelly-Ringel (2011) collected temperature data throughout Icicle Creek and found that expected downstream warming occurs, with a mean high 7-day average daily maximum (7DADmax) of 16.7 °C (range 15.6-17.8 °C) at the headwaters, and 19.1 °C (range 18.1-20.7 °C) at the mouth. Two exceptions occur within the operational influence of the LNFH: 1) At the Snow Creek confluence, summer supplementation of water from Snow Lake cools Icicle Creeks mean high 7DADmax by 0.7 °C (range 0.3-1.0 °C). 2) At the LNFH spillway pool, returned river water is mixed with well water, creating an off-channel pool with a high 7DADmax that is, on average, 2.4 °C (range 2.0-3.2 °C) cooler than immediately upstream.

Another consideration is habitat availability (amount and quality) as it relates to streamflow. Not only does operation of the headgate present itself as an impediment to passage, it also regulates the flow split between the hatchery and historical channels. From information described in the final BA, we summarize the potential habitat effects in the Icicle Creek historical channel during flow manipulation in Table 6.

Table 6. Flow manipulation conditions and potential habitat effects in the historical channel.

Condition	Response	Potential Habitat Effects
1. During high flow events (i.e., streamflow is one foot from decking of structure 5)	Lower structure 2, minimizing high flows in the historical channel and increasing the flow in the hatchery channel	- moderation of peak flows and channel/habitat processes - reduced development of and access to off-channel habitats
2. During low flow events (<300 cfs in the Hatchery channel)	Lower structure 2, increasing flow in the hatchery channel and improving groundwater well recharge	- reduced base flow - increased summer water temperatures - reduced habitat availability
3. Maintenance of structure 5	Lower structure 2, minimizing flows in the historical channel	- reduced base flows - reduced habitat availability
4. Pre-smolt release	Lower structure 2, maximizing flows in the hatchery channel and facilitating emigration	- reduced flow - reduced habitat availability

Each of these events (or conditions) has potential habitat effects in the historic channel. Generally, habitat quality and quantity is inversely related to streamflow. High flows typically occur during Spring runoff and Winter rain-on-snow events (event timing varies with the hydrograph). Moderation of peak flows in the historical channel likely reduces the magnitude of normal habitat-forming features (e.g., pool development, large woody debris and sediment transport), channel condition and dynamics (e.g., channel migration, floodplain connectivity, etc.), and may promote a more “steady-state” environment.

According to the BA, peak flows are regulated to protect structure 5 and prevent downstream flooding and undesired bank erosion on private lands. Low flow events may require closure of structure 2 to divert more water into the hatchery channel to recharge groundwater wells. This typically occurs in the late summer and winter (lasting 15 days or more per event). Maintenance of structure 5 typically occurs in the fall and winter (up to 1 week per event) and may require the closure of structure 2 to provide for safe working conditions in the historical channel. During pre-smolt release (typically the 3rd week of April for a duration of up to 10 days), structure 2 may be lowered to facilitate downstream emigration.

Groundwater Pumping and Surface Diversion Water Supply System

The LNFH has a well system component of its water supply system that is used in conjunction with its surface water diversion. Well water moderates the temperature of the water used in the hatchery, warming it in winter, cooling it in summer, and it adds to the volume of water available for operations. The system involves 7 wells. One of these wells draws completely from the deep aquifer, and has no influence on the shallow aquifer. A second well can draw from both. The other 5 wells draw water from the shallow aquifer only, which influences and is influenced by surface water. These 5 wells pull water that percolates into the ground from the hatchery channel (which has a higher elevation than the historic channel) and the historic channel. Due to this connection between surface flow and groundwater, typically only two or three wells are used simultaneously, and it is necessary to rotate wells because as water levels drop, pumping at a given well becomes unsustainable. Wells are given several weeks to recharge and then they are used again. The maximum combined sustainable yield from all wells is roughly 6,000 gallons per minute (gpm), or 13 cfs (GeoEngineers, Inc. 1995). Of this amount, about 11 cfs comes from the shallow aquifer. Based on the connection between these wells and stream flow, it is assumed that this amount is affecting Icicle Creek (by reducing streamflow) between approximately rm 3.8 (where the well field begins) and rm 2.8 (the outfall where water is returned to Icicle Creek).

The LNFH water intake system is inadequately screened. The existing system consists of miles of pipes, and several chambers, ponds, screens, and valves where bull trout were killed in 2001, 2005, and 2007. Once fish enter the system at rm 4.5, they are removed by capturing them with a net; they may be removed from the intake structure, or if they pass through the system and emerge in the sand settling basin, they may be removed there. For a variety of reasons (including a lack of automated cleaning, approach velocity distribution issues, fish bypass malfunctions, and other problems), the intake system does not comply with NOAA Fisheries or WDFW regulatory criteria, and does not minimize fish injury or death. The intake system was designed over 70 years ago before there were effective standards for fish protection.

Species Interactions

Brook trout are present in the Icicle Creek watershed as well as other areas in the Wenatchee River watershed. The stocking programs for brook trout were discontinued several years ago. The presence of brook trout suggests that hybridization with the bull trout as well as increased competition for habitat and forage may occur (Rieman and McIntyre 1993). In 2007, two fish with a blend of color patterns suggesting that they were hybrids and entered the LNFH intake, moved through the underground pipeline, and were collected alive in the sand settling basin. The Service collected fin clips for genetic analysis, inserted a radio tag into one of them. Confirmation of hybridization and movement patterns of this bull trout x brook trout are described in Nelson et al. (2011).

Icicle Creek was also stocked with rainbow trout until 1992. Direct competition between rainbow and bull trout could limit the latter because when they overlap in areas where temperatures are not ideal for bull trout, rainbow trout are dominant (Dunham, Rieman, and Chandler 2003a; Haas 2001). This situation could apply in the lower and middle sections of Icicle Creek where, during midsummer, water temperature can exceed the thermal optimum for bull trout for several weeks. In the upper portion of the watershed, where most resident bull trout have been found in Icicle Creek, water is slightly cooler, and in these areas rainbow trout dominance is less likely to be a problem, although as noted elsewhere, rainbow trout are numerous here as well. Water temperatures recorded during surveys in 1995 and 2004 in upper portions of the watershed generally had lower minimum and maximum daily temperatures than areas several miles downstream (USFWS 1997, USFWS 2005b). Rainbow trout density was still higher than bull trout in these areas, but bull trout are generally outnumbered by other species in all systems; and in this system, bull trout are, or were until very recently, limited to resident-only life history, which inhibits population growth (Rieman and McIntyre 1993).

Follow-up work is needed to test these hypotheses and to assess how the now discontinued stocking program for brook trout and rainbow trout in upper Icicle Creek may have affected bull trout in that watershed. It is important to note that many river systems in the Wenatchee River Basin have been affected by brook trout and rainbow trout stocking. Nevertheless, in some of those areas bull trout are numerous, for example, in the Chiwawa River, which appears to be the local stronghold for bull trout. In Icicle Creek, the local population of the bull trout is likely very small, so that demographic and genetic risks are already very high even without the stress of competition from other trout species. Because this population was until recently physically and genetically isolated from all other bull trout populations in the core area, and now has improved but still limited connectivity, the threat posed by brook trout and high-densities of rainbow trout in Icicle Creek is heightened compared to other drainages with more robust populations of bull trout, or those with unrestricted connectivity.

Surplus Protocol

When more adult Chinook salmon enter the ladder at the LNFH than are needed for the annual artificial production quota (about 1000 fish), the extra fish are given to local Native American tribes and Trout Unlimited. These extra fish are considered Federal property and are excessed to the Bureau of Indian Affairs as part of a 1982 interagency agreement (S. Aiken, USFWS tribal liaison, pers. comm. with David Morgan, USFWS, 2006). Chinook salmon and any other species that ascend the ladder at that time of year, including bull trout, are confined in a series of two holding ponds at the LNFH. With so many Chinook salmon in the pond, it may not be possible to isolate and remove a bull trout prior to processing the Chinook salmon. During processing, the water in the pond is drawn down, the fish are crowded, and one or two people enter the pond. The Chinook salmon are caught by hand and killed with a blow to the head or other means. Generally, the receiving groups conducting this activity are under the supervision of LNFH personnel, who remove bull trout and steelhead as they encounter them, and return them to Icicle Creek.

Prior to 2006, LNFH staffs have not kept specific records of bull trout presence or absence during the surplus/excess operations. According to earlier drafts of the BA, “few if any” bull trout are present in the pond in any given year. On one occasion a bull trout was killed during the surplus process with a blow to the head (Croci, S., pers. comm., USFWS, 2006). Since 2006, annual reports required by the 2006 and 2008 BO’s report no bull trout have been encountered during surplus operations.

Sport Angling

In 2007, the Service learned that a few large bull trout were observed in a pool below Chatter Creek bridge on Icicle Creek, a location which is both conspicuous and accessible to anglers (K. Beardsley, pers comm. with David Morgan, USFWS, 2007). The fishing regulations set by WDFW do not allow anglers to keep bull trout anywhere in the Wenatchee River Basin. However, the Service is aware of numerous anecdotes of large bull trout being poached in other small streams near cascades during their spawning migration. Recently, the Service suggested to WDFW that as a precautionary measure, new fishing regulations should be issued for Icicle Creek that would include seasonal closures in certain areas (Service 2007b). Regulations now end the trout fishing season in Icicle Creek at the end of September (rather than the end of October) to protect bull trout spawning.

Release of Effluent into Icicle Creek

The LNFH operates under NPDES Permit No. WA0001902. EPA regulates these discharges pursuant to sections 101, 301, 304, 308, 401, 402, and 403 of the Clean Water Act (33 U.S.C. §1251 *et seq*.). Discharge limitations were established for settleable solids, total suspended solids, temperature, total residual chlorine, and total phosphorus. Monitoring requirements include the discharge limitation parameters; flow, ammonia, and pH, and drug and chemical application reporting is also required. For a more detailed description of the proposed action, please see the Project BA (USFWS reference 13260-2011-I-0056).

The effects of this discharge relate to water quality. Bull trout are very sensitive to environmental contaminants and require high water quality for their habitats (USFWS 2002a). Several 303(d) impaired waters are present in the Action Area for multiple parameters, including temperature, dissolved oxygen, pH, PCBs, fecal coliform, and ammonia-N (WDOE 2008a). This degraded condition has likely caused bull trout to modify their habitat selection spatially and temporally.

Effects of the action are anticipated to be both positive and negative. Negative effects involve the discharge of various contaminants that can degrade water quality directly or by interaction with other parameters (e.g., dissolved oxygen may decrease with increased discharge of phosphorus and temperature). The effects of the action may also be positive in that effluent limitations are more restrictive and may lead to an improved environmental baseline.

A small number of water quality samples have been collected in Icicle Creek for polychlorinated biphenyls (PCBs) and similar compounds. Some of these chemicals are detectable in very low concentrations (generally below the most conservative standards used anywhere in the U.S.), and in some instances detections were registered both upstream and downstream of the LNFH. Paint applied to fish-holding tanks, which were taken off-line in 2005, had elevated levels of PCBs. Samples collected from the top layer of sediments in the pollution abatement pond at the LNFH did not have significantly elevated levels of PCBs (USFWS 2005d). The fish food used at the LNFH is a source of very small amounts of PCBs. Because the fish feed is derived from marine sources, it is impossible to completely eliminate all of the PCBs. The PCB levels found in the feed used today are not expected to cause bioaccumulation problems (Hansen, J., pers. comm., USFWS, 2006).

Antibiotics, formalin and other chemicals used in fish culture at the LNFH are administered in accordance with pertinent FDA and EPA regulations. Use of approved chemicals is not expected to cause toxicity in receiving waters when applied according to directions (WDOE 1989).

I. Characterization of the Environmental Baseline: Matrix of Pathways and Indicators

Since the 2008 BO, the Service has begun the development of the Consulted-on Effects Database (COED). Its core organizing principle is based on the Matrix of Pathways and Indicators (MPI or "Matrix"; see USFWS 1999). The Matrix evaluates both population and habitat conditions in terms of seven broad classes of habitat features (pathways), each of which has a related set of specific metrics (indicators) that are rated based on their functional condition. Baseline conditions for each indicator are described on a relative scale of functionality ("functioning appropriately," "functioning at risk" or "functioning at unacceptable risk").

The Matrix evaluates population pathways and indicators at the 4th field subbasin scale (i.e., in the case of the proposed action, the Wenatchee Core Area metapopulation) and habitat pathways and indicators at the 5th or 6th field watershed scale (i.e., in the case of the proposed action, the Icicle watershed). Additional evaluation of population characteristics at the watershed scale provides a useful evaluation for understanding the context of the action area to the entire metapopulation. The following characterizes the baseline condition in terms of Matrix parameters, summarizing information provided in the BA, sections A-E of the Environmental Baseline, and other sources. Table 7 summarizes indicator conditions. For more details on the rationale for assessing baseline condition, see the Project BA.

Population Characteristics

Population size of the Wenatchee core area is "functioning at risk" based on redd survey trends (1998-present) of all seven local populations, local habitat capacity, and life history stage representation. In Icicle Creek, the local population is considered "functioning at unacceptable risk" due to small size (i.e., counting only migratory adults) and the limited representation of the migratory life history stage. *Growth and survival* is considered "functioning at risk" for the core area based on population trends and apparent resiliency following short-term disturbances. In Icicle Creek, the local population is "functioning at unacceptable risk" due to the low number of migratory adults. However, it should be noted that data are limited and until recently were not systematically gathered. Despite near complete isolation for most of the last 70 years, the resident bull trout in Icicle Creek have persisted, although population distribution and abundance is poorly understood. See section "E. Bull Trout Distribution and Abundance in the Action Area" and Figure 3 for more information. *Life history diversity and isolation* is considered "functioning at risk" for the core area since the migratory form is present to varying degrees in all local populations and are relatively well-connected to other local populations (with the exception of the Icicle local population). In the Icicle, the local population is "functioning at unacceptable risk" due to the limited migratory form and relative isolation from other local populations resulting from LNFH operations, the IPID diversion at rm 5.7, and natural seasonal barriers such as the boulder field at rm 5.6. *Persistence and genetic integrity* is considered "functioning at risk" for the core area since connectivity between most populations is present, despite some habitat fragmentation. However, most fish production in the core area relies on the strength of the Chiwawa population. Competition with nonnative fish species is known to occur, with some documentation of hybridization. Samples to determine the genetic baseline of the core area have been collected, but the analysis is not yet complete. In Icicle Creek, the local population is "functioning at unacceptable risk" due to its relative isolation, and hybridization has been documented (Nelson et al. 2011). Brook trout probably do influence bull trout populations and facilitate if not cause local extinctions, but threats probably vary strongly with environmental conditions (Reiman et al. 2006). Bull trout in smaller streams could be more vulnerable than those in larger streams (Reiman et al. 2006).

Water Quality

Temperature in Icicle Creek in "functioning at unacceptable risk" due to high temperatures that exceed water quality standards, thermal barriers, and multiple 303(d) impaired water for temperature (WDOE 2008a) in the lower Icicle. The upper Icicle is functioning much better and does not have any 303(d) listings, but does periodically exceed 15 °C during the summer. Forward looking infrared radar (FLIR) data recorded temperate over 15 °C from the mouth of the Icicle to rm 13. A recent summary of Icicle Creek temperature data from 2005 through 2010 (Hall and Kelly-Ringel 2011) suggested a mean high 7-day average daily maximum (7DADmax) of 16.7 °C in the headwaters and 19.1 °C at the mouth. Two exceptions occur within the operational influence of the LNFH: (1) At the Snow Creek confluence, where summer supplementation of water from Snow Lake cools Icicle Creeks mean high 7DADmax by 0.7 °C (range 0.3-1.0 °C); and (2) At the LNFH spillway pool, where returned river water is mixed with well water, decreasing the mean high 7DADmax about 2.4 °C (range 2.0-3.2 °C). *Sediment* (in spawning and incubation areas) in Icicle Creek is "functioning at risk" based on data from Wolman pebble counts and other surveys. Estimates of the amount of substrates less than 2mm in size range from 0-15% (Kelly-Ringel 1997) in the lower Icicle, and eight of ten samples less than 2mm in size range from 0-13.8% in the upper Icicle (USFS 2008). *Chemical contamination and nutrients* is considered "functioning at unacceptable risk" due to multiple 303(d) impairments in the lower Icicle. These include dissolved oxygen, pH, in-stream flow, fecal coliform, total polychlorinated biphenyls (PCBs), and ammonia-N (WDOE 2008a). But again, the upper Icicle is generally properly functioning for *chemical contamination and nutrients*.

Habitat Access

Physical barriers is considered "functioning at unacceptable risk" due to barriers that do not allow passage over a range of flows. Seasonal, manmade obstacles associated with the LNFH (rm 2.8 – 3.8, and rm 4.5) to fish passage have been present in Icicle Creek since the early 20th century (Bryant and Parkhurst 1950). However, structures 3 and 4 were removed by LNFH restoration actions in 2007. Structures 2 can also be a hydraulic barrier under certain flow conditions. At higher flows, Icicle Creek "fire hoses" over the concrete sill; at lower flows, there can be insufficient water for fish to pass upstream. Also, several substantial, natural obstacles to fish passage occur in Icicle Creek, such as the boulder field at rm 5.6. Between LNFH operations and natural barriers, the upstream passage window can be very limited depending on stream flow volume and timing of peak/base flows. The *Physical barriers* indicator also includes thermal barriers. Hall and Kelly-Ringel (2011) estimated a mean high 7-day average daily maximum (7DADmax) in Icicle Creek of 16.7 °C in the headwaters and 19.1 °C at the mouth. Two exceptions occur within the operational influence of the LNFH: (1) At the Snow Creek confluence, where summer supplementation of water from Snow Lake cools Icicle Creeks mean high 7DADmax by 0.7 °C (range 0.3-1.0 °C); and (2) At the LNFH spillway pool, where returned river water is mixed with well water, decreasing the mean high 7DADmax about 2.4 °C (range 2.0-3.2 °C). This suggests that summer temperatures (mean high 7DADmax) in the Icicle range from about 16-19 °C, higher than the >15 °C reported to limit bull trout distribution (Allan 1980, Brown 1992b, Fraley and Shepard 1989, Goetz 1991, BioAnalysts 2004). However, Howell et al (2009) reported migratory bull trout using waters with mean high 7DADmax of 16-

18 °C, suggesting either a somewhat higher upper range of suitability, at least for short periods of time, or perhaps local adaptation. Nonetheless, most studies agree a 15 °C approximates a distributional threshold. This 15 °C bound is sometimes referred to as a "thermal barrier" since it limits bull trout distribution. However, the cooling influence of the LNFH operations appears to appreciably reduce stream temperatures below Snow Creeks and especially at the spillway pool. Cooler stream temperatures may benefit bull trout by extending their season of use and amount of habitat availability.

Habitat Elements

Substrate embeddedness (in rearing areas) is "functioning at unacceptable risk." High sediment loads occur and historically occurred in Icicle Creek. All of the dominant land types in the Icicle Creek watershed have high sediment delivery hazards, and background hill slope erosion rates for the watershed are high and estimated to total over 4,500 tons/year (USFS 1995). Sediments are filling pools and embedding channel substrates. Visually assessed substrate embeddedness in the lower reaches of Icicle Creek exceeds 30%. However, the upper Icicle appears to be largely within its natural range of variability. *Large woody debris* is "functioning at risk." Lower reaches of the Icicle watershed do not meet standards, due in part to development. Upper reaches meet or exceed standards, especially in wilderness. *Pool frequency and quality* is "functioning at unacceptable risk." All stream survey data collected in the lower Icicle shows pool frequency to be low, and data on quality are scant. High sediment in the watershed is undoubtedly a key contributor to indicator condition. *Large pools* is "functioning at risk" with all reaches containing a few large (>1 meter deep) pools. *Off-channel habitat* is "functioning at risk." The Icicle has some ponds, oxbows, and other off-channel habitat, but some reaches are disconnected from off-channel habitat due to development and roads. Recent restoration actions by the LNFH and Forest Service, have improved this condition. *Refugia* is "functioning at risk." Icicle Creek contains habitat capable of supporting strong and significant fish populations, but these habitats are not well connected and are not currently used to their potential.

Channel Condition and Dynamics

Average wetted width/maximum depth is "functioning at risk." Channel width/depth ratios in lower Icicle Creek are increasing and entrenchment ratios are decreasing in response to increases in sediment supply and bank instability, decreases in riparian vegetation structure and function, and changes in flow regime. Reaches in upper Icicle Creek are functioning adequately except in areas where roads and bridges confine the stream channel and where riprap has been placed. Five specific areas, at road mile 4.6-5.1, 9.9-10.1, 10.7-10.8, 13.6-14.1, and Ida Campground, exist where the road system has confined the stream channel and has cut off the floodplain. *Streambank conditio*n is "functioning at risk." Urbanization, agriculture, and road building in the lower part of Icicle Creek have reduced the riparian zone in structure and function. Eleven percent of the riparian vegetation along the lower portion of Icicle Creek, below LNFH, has been removed for housing developments (WRWSC 1998). Bank stability in the upper Icicle is good, with only one reach showing more than 10% of its length as having less than 90% stability. *Floodplain connectivity* is "functioning at risk." Hydrologic connectivity in several areas in the lower Icicle is impaired by development and roads, and in some locations riprap and dikes have been further confined Icicle Creek. As previously mentioned, road and campground construction in the upper Icicle has confined the stream channel.

Flow/Hydrology

Change in peak/base flows is “functioning at unacceptable risk.” Icicle Creek is over-allocated, has multiple diversions which have reduced the amount of water in Icicle Creek, and it is designated as a 303(d) impaired water for instream flow. Flows are also manipulated by structure 2, which can substantially alter the amount of water in the hatchery and historical channels. *Increase in drainage network* is “functioning at risk.” Moderate increases in active channel length are associated with the road networks (e.g., Chelan county and Forest Service), which route water into ditches and cross drains.

Watershed Conditions

Road density and location is “functioning at risk.” Road density in lower Icicle Creek exceeds 3 miles per square mile, and there are many valley bottom roads (USFS 1995). The historic channel area on the LNFH grounds has several roads and trails near it. Road density for the entire watershed is 0.4 miles per square mile and ranges from 0 to 1.2 miles per square mile in each of the eight subbasins (USFS 1995). Specific areas where roads are adjacent to the stream and degrade habitat function are at road miles 9.9-10.1, 10.7-10.8, 13.6-14.1 and Ida Campground. *Disturbance history* is “functioning at risk.” Extensive development and road construction in the lower Icicle and moderate amounts of logging (over 6,000 acres or about 5% of the watershed), suggest an intermediate amount of human disturbance. However, the majority of the total area of the Icicle drainage is wilderness, and thus fairly intact. The *riparian conservation area* indicator (also referred to as the *riparian reserve* indicator) is considered “functioning at risk.” More than 11% of the vegetation along lower Icicle Creek has been removed (WRWSC 1998). In upper Icicle Creek, riparian reserves are more than 80% intact (USFS 1995). There are site specific areas where roads are adjacent to the stream (at road mile 9.9-10.1, 10.7-10.8, 13.6-14.1 and Ida Campground), riprap is used for bank protection, streambank vegetation is lacking, noxious weeds have accumulated, and banks have high erosion potential. *Disturbance regime* is “functioning at risk.” Wildfires in the upper Icicle in (especially 1994, 2001, and 2004) have burned about 25,000 acres (20%) of the watershed, and landslides (notably 1999, 2008, and 2011), suggest a moderate amount of environmental disturbance.

Integration

Overall, the condition of the Icicle Creek watershed is “bimodal;” while the lower portion (below rm 5.7) has been substantially degraded and generally was assessed to be in poor condition, the upper portion (above rm 5.7) of the watershed is generally in good condition. Because we assess matrix habitat indicators at the watershed scale, these extremes tend to moderate each other suggest an intermediate “functioning at risk” conclusion. However, some indicators are more potent than the others, such as *physical barriers*. Without access to habitat, quality is relatively less important. Combining habitat pathways with the “functioning at risk” population pathway, the Icicle Creek watershed as a whole is “functioning at risk.”

Table 7. Matrix of Pathways and Indicators: Summary of the Environmental Baseline.

Pathway (bold) and Indicator	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Population Characteristics			
Population Size		**X**	
Growth and Survival		**X**	
Life History Diversity & Isolation		**X**	
Persistence and Genetic Integrity		**X**	
Water Quality			
Temperature			**X**
Sediment		**X**	
Chemical Contamination/Nutrients			**X**
Habitat Access			
Physical Barriers			**X**
Habitat Elements			
Substrate Embeddedness			**X**
Large Woody Debris		**X**	
Pool Frequency and Quality			**X**
Large Pools		**X**	
Off-Channel Habitat		**X**	
Refugia		**X**	
Channel Conditions and Dynamics			
Wetted With/Max. Depth Ratio		**X**	
Streambank Condition		**X**	
Floodplain Connectivity		**X**	
Flow/Hydrology			
Changes in Peak/Base Flows			**X**
Drainage Network Increase		**X**	
Watershed Conditions			
Road Density and Location		**X**	
Disturbance History		**X**	
Riparian Conservation Areas		**X**	
Disturbance Regime		**X**	

J. Summary of Environmental Baseline for the Bull Trout

The upper Icicle Creek watershed is a Wilderness Area, where management activities are very limited and conditions mimic natural processes, or those activities have no appreciable effect on bull trout habitat. In mid-Icicle Creek there are a few locations where the Icicle Road impinges on the creek. Recent fires and suppression actions, landslides, and land management activities that occurred in the watershed, mostly in high-elevation areas, were not sufficient in intensity or extent to significantly change the condition of bull trout habitat. In contrast, the lower Icicle Creek watershed is degraded as a direct result of management actions and other human activities, including those associated with the operation and maintenance of the LNFH, which can restrict or prevent, depending on the time of year, fish migration in lower Icicle Creek.

The bull trout is a permanent resident in the action area. An evaluation of all the available information indicates that Icicle Creek supports the smallest local population in the Wenatchee core area; that the overall population trend has likely been negative between 1940-2000, moderated somewhat between 2001-2007, and may have increased slightly between 2008-2010, yet remains very small; and that the population is the most vulnerable to extirpation of all populations in the Wenatchee core area. Maintenance and expansion of the Icicle Creek local population of bull trout is largely dependent on restoring the migratory life history form, which is likely to enhance the viability of this local population by reducing competition, demographic, distributional, and genetic risks.

Icicle Creek contains both resident and migratory fish, but only the former has had consistent access to spawning areas in upper Icicle Creek between 1940 and 2007. Spawning by migratory bull trout is known only to French Creek (Nelson et al. 2009 and 2011, Kelly-Ringel 2011), and spawning by resident bull trout likely also occurs there. Based on detections of multiple age classes of bull trout in upper Icicle Creek and tributaries such as Jack creek (Nelson 2007, USFWS 2005b), additional spawning may also occur in these areas and perhaps Leland Creek (WDFW 1998), but this has not been confirmed. Similarly, an observation of a faded large redd near Chain Creek near rm 34 (rkm 48) in 2008 (N. Gayeski, pers. comm. in Nelson et al. 2009) suggests there are additional fluvial spawning areas in upper Icicle Creek. This suggests the current distribution and abundance of bull trout in Icicle Creek is only a fraction of its historic levels. Inbreeding depression, genetic drift, and other consequences of very small population size are a significant concern for this population.

Based on the best available information, we believe as many as 125 bull trout may use the spillway pool, 64 may use the historical channel, 16 attempt to make upstream migration above LNFH infrastructure, and 9 may be in the vicinity of the water intake any given year. These estimates are based on bull trout observations (see Table 3) and documentation of spawning (i.e., 8 redds in 2008 made by 8 pair [16 individual] bull trout). This information is important to evaluating the risk of exposure of bull trout to elements of the action that could affect bull trout, and will be described in detail in the effects section below (Section VII). Although we do not have a complete understanding of bull trout distribution, abundance, and movement patterns (and acknowledge substantial variability between years), this is our best estimate.

V. Status of Critical Habitat

This Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat within 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the Act and the August 6, 2004, Ninth Circuit Court of Appeals decision in Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service (No. 03-35279) to complete the following analysis with respect to critical habitat.

Critical habitat is defined in section 3(5)(A) of the Act as "the specific area within the geographic area occupied by the species on which are found those physical or biological features essential to the conservation of the species, and that may require special management considerations or protection, and specific areas outside the geographical area occupied by a species at the time it is listed, upon determination that such areas are essential for the conservation of the species." The Act defines conservation as the procedures necessary to bring about the eventual recovery and delisting of a listed species.

A. Legal Status and History

The Service published a final critical habitat designation for the coterminous United States population of the bull trout on October 18, 2010 (70 FR 63898), replacing the previous final critical habitat designation published in 2005; the 2010 final rule became effective on November 17, 2010. A justification document was also developed to support the rule and is available on our website (http://www.fws.gov/pacific/bulltrout). The scope of the designation involved the species' coterminous U.S. range, as listed on November 1, 1999 (50 FR 63898), which includes the Jarbidge River, Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River interim recovery units (previously known as distinct population segments)[5]. Rangewide, the Service designated critical habitat in five states in a combination of reservoirs/lakes and streams/shoreline (Table 8). Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing (SR), and 2) foraging, migration, and overwintering (FMO). Some critical habitat is unoccupied and is designated to provide for connectivity or for potential local populations as described in the Services draft recovery plan.

The 2010 revision increases the amount of designated bull trout critical habitat by approximately 76 percent for miles of stream/shoreline and by approximately 71 percent for acres of lakes and reservoirs compared to the 2005 designation.

The 2010 rule also identifies and designates as critical habitat approximately 1,323.7 km (822.5 miles) of streams/shorelines and 6,758.8 ha (16,701.3 acres) of lakes/reservoirs of unoccupied habitat to address bull trout conservation needs in specific geographic areas in several areas not occupied at the time of listing. No unoccupied habitat was included in the 2005 designation. These unoccupied areas were determined by the Service to be essential for restoring functioning

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[5] The Service's 1999 coterminous listing rule (50 CFR Part 17, pg. 58910) and five year review (USFWS 2008, pg. 9) identified six draft recovery units. Until the bull trout draft recovery plan is finalized, the current five interim recovery units will be used for purposes of section 7 jeopardy analysis and recovery planning. The adverse modification analysis does not rely on recovery units but on the newly listed critical habitat and its units/subunits and waterbodies.

migratory bull trout populations based on currently available scientific information. These unoccupied areas often include lower main stem river environments that can provide seasonally important migration habitat for bull trout. This type of habitat is essential in areas where bull trout habitat and population loss over time necessitates reestablishing bull trout in currently unoccupied habitat areas to achieve recovery.

Table 8. Stream/shoreline distance and reservoir/lake area designated as bull trout critical habitat by state.

State	Stream/Shoreline Miles	Stream/Shoreline Kilometers	Reservoir /Lake Acres	Reservoir/ Lake Hectares
Idaho	8,771.6	14,116.5	170,217.5	68,884.9
Montana	3,056.5	4,918.9	221,470.7	89,626.4
Nevada	71.8	115.6	-	-
Oregon	2,835.9	4,563.9	30,255.5	12,244.0
Oregon/Idaho	107.7	173.3	-	-
Washington	3,793.3	6,104.8	66,308.1	26,834.0
Washington (marine)	753.8	1,213.2	-	-
Washington/Idaho	37.2	59.9	-	-
Washington/Oregon	301.3	484.8	-	-
Total	19,729.0	31,750.8	488,251.7	197,589.2

Critical habitat includes the stream channels within the designated stream reaches and has a lateral extent as defined by the bankfull elevation on one bank to the bankfull elevation on the opposite bank. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. If bankfull elevation is not evident on either bank, the ordinary high-water line must be used to determine the lateral extent of critical habitat. The lateral extent of designated lakes is defined by the perimeter of the waterbody as mapped on standard 1:24,000 scale topographic maps. The Service assumes in many cases this is the full-pool level of the waterbody. In areas where only one side of the waterbody is designated (where only one side is excluded), the mid-line of the waterbody represents the lateral extent of critical habitat.

In marine nearshore areas, the inshore extent of critical habitat is the mean higher high-water (MHHW) line, including the uppermost reach of the saltwater wedge within tidally influenced freshwater heads of estuaries. The MHHW line refers to the average of all the higher high-water heights of the two daily tidal levels. Marine critical habitat extends offshore to the depth of 10 meters (m) (33 ft) relative to the mean low low-water (MLLW) line (zero tidal level or average of all the lower low-water heights of the two daily tidal levels). This area between the MHHW line and minus 10 m MLLW line (the average extent of the photic zone) is considered the habitat most consistently used by bull trout in marine waters based on known use, forage fish availability, and ongoing migration studies and captures geological and ecological processes important to maintaining these habitats. This area contains essential foraging habitat and migration corridors such as estuaries, bays, inlets, shallow subtidal areas, and intertidal flats.

Adjacent shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes, and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the aquatic environment.

The final rule continues to exclude some critical habitat segments based on a careful balancing of the benefits of inclusion versus the benefits of exclusion. Critical habitat does not include: (1) waters adjacent to non-Federal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (Act), in which bull trout is a covered species on or before the publication of this final rule; (2) waters within or adjacent to Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated that inclusion would impair their relationship with the Service; or (3) waters where impacts to national security have been identified (75 FR 63898). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant Critical Habitat Unit (CHU) text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. See Tables 9 and 10 for the list of excluded areas. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation. Because exclusions reflect the often complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

Table 9.—Stream/shoreline distance excluded from bull trout critical habitat based on tribal ownership or other plan.

Ownership and/or Plan	Kilometers	Miles
Lewis River Hydro Conservation Easements	7.0	4.3
DOD – Dabob Bay Naval	23.9	14.8
HCP – Cedar River (City of Seattle)	25.8	16.0
HCP – Washington Forest Practices Lands	1,608.30	999.4
HCP – Green Diamond (Simpson)	104.2	64.7
HCP – Plum Creek Central Cascades (WA)	15.8	9.8
HCP – Plum Creek Native Fish (MT)	181.6	112.8
HCP–Stimson	7.7	4.8
HCP – WDNR Lands	230.9	149.5
Tribal – Blackfeet	82.1	51.0
Tribal – Hoh	4.0	2.5
Tribal – Jamestown S’Klallam	2.0	1.2
Tribal – Lower Elwha	4.6	2.8
Tribal – Lummi	56.7	35.3
Tribal – Muckleshoot	9.3	5.8

Tribal – Nooksack	8.3	5.1
Tribal – Puyallup	33.0	20.5
Tribal – Quileute	4.0	2.5
Tribal – Quinault	153.7	95.5
Tribal – Skokomish	26.2	16.3
Tribal – Stillaguamish	1.8	1.1
Tribal – Swinomish	45.2	28.1
Tribal – Tulalip	27.8	17.3
Tribal – Umatilla	62.6	38.9
Tribal – Warm Springs	260.5	161.9
Tribal – Yakama	107.9	67.1
Total	3,094.9	1,923.1

Table 10. Lake/Reservoir area excluded from bull trout critical habitat based on tribal ownership or other plan.

Ownership and/or Plan	Hectares	Acres
HCP – Cedar River (City of Seattle)	796.5	1,968.2
HCP – Washington Forest Practices Lands	5,689.1	14,058.1
HCP – Plum Creek Native Fish	32.2	79.7
Tribal – Blackfeet	886.1	2,189.5
Tribal – Warm Springs	445.3	1,100.4
Total	7,849.3	19,395.8

B. Primary Constituent Elements for Bull Trout

Within the 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 our 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, we have determined that the following PCEs are essential for the conservation of bull trout.

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.
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.
3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
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.

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.
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.
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.
8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
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.

Note that only PCEs 2, 3, 4, 5, and 8 apply to marine nearshore waters identified as critical habitat. Also, lakes and reservoirs within the CHUs also contain most of the physical or biological features necessary to support bull trout, with the exception of those associated with PCEs 1 and 6. Additionally, PCE 6 does not apply to FMO habitat designated as critical habitat. Also, although PCE 9 applies to both the freshwater and marine environments, currently no non-native fish species are of concern in the marine environment, though this could change in the future.

Activities that cause adverse effects to critical habitat are evaluated 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; USFWS 2004d, Vol. 1. pp. 140-193, Vol. 2. pp. 69-114).

C. Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (75 FR 63898). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. The CHUs generally encompass one or more core areas and may include FMO areas, outside of core areas, that are important to the survival and recovery of bull trout.
Thirty-two CHUs and 78 associated subunits within the geographical area occupied by bull trout at the time of listing are designated under the 2010 rule. Twenty-nine of the CHUs contain all of

the physical or biological features identified in this final rule and support multiple life-history requirements. Three of the mainstem river units in the Columbia and Snake River basins contain most of the physical or biological features necessary to support the bull trout's particular use of that habitat.

The primary function of individual CHUs and subunits is to maintain and support core areas, which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993, p. 19); 2) provide for persistence of strong local populations and, in part, provide habitat conditions that encourage movement of migratory fish (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Hard 1995, pp. 314-315; Healey and Prince 1995, p. 182; MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Hard 1995, pp. 321-322; MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

To determine what should be designated as critical habitat for bull trout, the Service identified specific areas that contain the physical and biological features essential to bull trout conservation, considering distribution, abundance, trend, and connectivity needs. The objective was to ensure the areas designated as critical habitat would effectively serve the following recovery goals:

- Conserve opportunity for diverse life-history expression
- Conserve opportunity for genetic diversity
- Ensure bull trout are distributed across representative habitats
- Ensure sufficient connectivity among populations
- Ensure sufficient habitat to support population viability (e.g. abundance, trends)
- Consider threats to the species
- Ensure sufficient redundancy in conserving population units

The Bull Trout Final Critical Habitat Justification document (USFWS 2010) provides the rationale for the designation of areas to meet the conservation needs of bull trout, including the uniqueness of some CHUs. For example, the Olympic Peninsula and Puget Sound CHUs are the only CHUs that support amphidromous[6] bull trout and are unique to the Coastal-Puget Sound population segment. These two CHUs contain marine nearshore and freshwater habitats, outside of core areas, that are used by bull trout that seasonally migrate from one or more core areas. These habitats contain physical and biological features that are critical to adult and subadult foraging, overwintering, and migration, and are essential for the conservation of this unique life history.

6 Amphidromous species leave the marine environment and return seasonally to fresh water as subadults, sometimes for several years, before returning to spawn (Brenkman and Corbett, 2005, p. 1075).

<u>Activities that May Affect PCEs</u>
The final rule (75 FR 63898) states that "A variety of ongoing or proposed activities that disturb or remove primary constituent elements may adversely affect, though not necessarily 'adversely modify' bull trout critical habitat as that term is used in section 7 consultations." Actions that may destroy or impact critical habitat could occur within the waterbody and/or on lands adjacent to or upstream of waterbodies designated as critical habitat. Activities that have been identified as directly and/or indirectly affecting bull trout critical habitat PCEs include but are not limited to the following: mining, agriculture, grazing, water use, flood control, bank stabilization and other instream construction work, recreation, transportation development, road maintenance, timber harvest, dams, and the introductions of nonnative invasive. These activities may affect bull trout critical habitat by altering the water chemistry, creating instream barriers (both permanent and temporary), increasing water temperature, reducing the food base, and precluding natural stream and hydrologic functions.

D. Current Critical Habitat Condition Rangewide

Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71240). The condition of bull trout critical habitat varies from good to poor across its range. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (63 FR 31647 and 64 FR 17112).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PCEs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: (1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7); (2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; MBTSG 1998, pp. ii - v, 20-45); (3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, p. 857; Rieman et al. 2006, pp. 73-76); (4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and (5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

E. Effects of Climate Change on Bull Trout Critical Habitat

One objective of the final rule designating critical habitat for the bull trout was to identify and protect those habitats that provide resiliency for bull trout use in the face of climate change. Over a period of decades, climate change may directly threaten the integrity of the essential physical or biological features described in PCEs 1, 2, 3, 5, 7, 8, and 9. Protecting bull trout strongholds and cold water refugia from disturbance and ensuring connectivity among populations were important considerations in addressing this potential impact. Additionally, climate change may exacerbate habitat degradation impacts both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes). For additional information, see the previously described Status of the Species (Section *I. Global Climate Change*).

F. Consulted-on Effects for Critical Habitat

The Service has formally consulted on the effects to bull trout critical habitat throughout its range. Section 7 consultations include actions that continue to degrade the environmental baseline in many cases. However, long-term restoration efforts have also been implemented that provide some improvement in the existing functions within some of the critical habitat units. For additional information, see the previously described Status of the Species (Section *J. Consulted-on Effects*). Although the Status of the Species describes effects over somewhat different areas and time periods than critical habitat (due to the differences in the scope of various final rules for critical habitat as compared to the coterminous listing of bull trout), the Status of the Species characterization should provide an indication of the overall rangewide condition for critical habitat. A more precise assessment of the rangewide baseline and effects is forthcoming through the Service's COED database.

VI. Environmental Baseline of Critical Habitat

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with these consultations.
The action area is part of the Upper Columbia River Basin critical habitat unit (Unit 10), as designated by the Service's October 18, 2010, final rule (75 FR 63898). This CHU is comprised of the Methow, Entiat, and Wenatchee Rivers critical habitat subunits (CHSU), each designated to support their respective core areas. For context, a general characterization of the overall status of the entire critical habitat unit is discussed first, followed by a description of Wenatchee River subunit. Lastly, we describe in detail the status of the critical habitat in the action area and the factors affecting critical habitat in the action area.

A. Environmental Baseline for the Upper Columbia CHU

The Upper Columbia River Basins CHU is comprised of the three CHSUs in central and north-central Washington on the east slopes of the Cascade Range and east of the Columbia River between Wenatchee, Washington, and a small segment of the lower Chelan River. The CHU includes portions of Chelan and Okanogan Counties in Washington. A total of 931.8 km (579.0 mi) of streams and 1,033.2 ha (2,553.1 ac) of lake surface area in this CHU are designated as critical habitat. The subunits within this unit provide spawning, rearing, foraging, migratory, connecting, and overwintering habitat.

In 2006, the Service characterized bull trout habitat statewide as part of completing a HCP for Washington's Forest Practices (FWS ref: 1-3-06-FWI-0301). Although no critical habitat was designated in the Upper Columbia at this time, the HCP analysis characterizing habitat conditions are likely similar for critical habitat since many of the same indicators (e.g., water quality, habitat access, sediment) were considered. Characterization of the baseline for bull trout can inform the baseline condition of critical habitat.

Overall, the general habitat conditions in the Wenatchee, Entiat, and Methow CHSU show a similar pattern; lower reaches of each CHSU are fairly degraded, likely influenced by the high degree of development, roads, forestry, agriculture, irrigation diversions, grazing, mining, and other infrastructure and land management. These reaches may also have 303(d) listed impairments of water quality, with temperature and instream flow being fairly common. In contrast, the upper reaches of each CHSU are generally of higher quality and have less anthropogenic impacts, although there is substantial variation across the CHSU's. For example, some SR habitats are predominately in wilderness and in excellent condition, whereas others may be in an area with high densities of forest roads and are degraded.

B. Environmental Baseline for the Wenatchee CHSU

The Wenatchee River Basin encompasses approximately 1,371 square miles (mi^2) in central Washington (NPPC 2001c, USFS 1999, WSCC 2001). Seven migratory local populations of the bull trout are known within the Wenatchee core area, and are supported by the Wenatchee CHSU; they are located in: (1) the Chiwawa River (including Chikamin, Phelps, Rock, Alpine, Buck and James creeks); (2) the White River (including Canyon and Panther creeks); (3) the Little Wenatchee River (including Rainy Creek); (4) Nason Creek (including Mill and Henry Creeks); (5) Chiwaukum Creek; (6) Peshastin Creek (including Ingalls and Negro Creeks); and (7) Icicle Creek (including French, Jack and Leland Creeks). Critical habitat is designated in the mainstem Wenatchee River, Peshastin and Ingalls Creeks, Icicle Creek, Chiwaukum Creek, Nason and Mill Creeks, Little Wenatchee River, White River, Chiwawa River, Lake Wenatchee, and several tributaries of these waterbodies.

The Wenatchee CHSU supports one of the largest populations of bull trout and some of the most connected habitat in the Upper Columbia River Basins CHU. It includes the mainstem Wenatchee River from its confluence with the Columbia River and tributaries up to their headwaters at the crest of the Cascade Range. The Wenatchee drainage flows east and drains into the Columba River at Wenatchee, Washington. This CHSU is essential for conservation of upper portions of the draft Upper Columbia River Recovery Unit. It contains adfluvial, fluvial, and resident life history forms and has one of three allucustrine populations in this CHU.

The bull trout this CHSU supports are unique in numbers, range, distribution, and genetics (see the critical habitat justification document, USFWS 2010). Key FMO habitats provide connectivity for the expression of multiple life history forms. Bull trout in this CHSU use multiple tributaries to spawn and Lake Wenatchee, multiple tributaries, and the Columbia River as FMO. The largest local population, the Chiwawa River, has individuals that migrate upstream to the Lake Wenatchee and back downstream to spawn. Populations of bull trout in this CHSU rely heavily on FMO habitat in Lake Wenatchee and the connectivity to and from the Columbia River for foraging and overwintering. Lake Wenatchee and the surrounding glacial geology may provide climate change refugia, due to the depth or the lake and the extent of hyporheic flows.

The Environmental Baseline for bull trout was described in Section IV and summarizes the status of the species and the factors affecting the species environment in the action area. Here, we generally describe the current condition of each PCE of critical habitat in the Wenatchee CHSU by each PCE, acknowledging there can be substantial variation between watersheds.

- *PCE 1: Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.*

  In snow-dominated systems such as the Wenatchee, hyporheic flows are an important source of water, especially during low and baseflow conditions. Although hyporheic flows are likely a small proportion of total streamflow, they are often much cooler than surface waters and may provide cold water refugia in localized areas. In the summer months, a number of reaches of multiple waterways (Wenatchee mainstem, Peshastin Creek, Ingalls Creek, Icicle Creek, Chiwaukum Creek, Nason Creek, Little Wenatchee and Chiwawa Rivers) show degraded temperature and instream flow conditions by their 303(d) impairments (WDOE 2008a). But the majority of areas important to bull trout most of the year generally have good water quality and quantity, with the exception of Icicle, Peshastin, and Ingalls Creeks. Floodplain connectivity is moderate, with multiple roads, railroad grades, and the other features that have disconnected the hydrologic linkage of off-channel areas with the main channel and overbank-flow maintenance of wetland function and riparian vegetation and succession. This can reduce the connections between relatively cooler hyporheic flows with surface waters. However, a number of oxbow and side channel reconnection restoration projects have occurred in recent years. In addition, monitoring has shown over 20% of migratory bull trout known to the Wenatchee basin use the lower Icicle during the summer, likely to exploit foraging conditions and thermal refugia. Despite the extent of seasonal 303(d) impairments (WDOE 2008a) of instream flow or temperature criteria in the basin and the moderate degree of floodplain connectivity, it would appear that PCE 1 is functioning fairly well overall.

- *PCE 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.*

  The Wenatchee basin is relatively intact in terms of migratory connectivity. Although numerous smaller barriers and impairments exist (e.g., weirs, culverts, road and railroad grades), only two significant physical barriers exist in the Wenatchee basin: the LNFH and Tumwater Dam. Each can be operated such that upstream fish passage is relatively unimpaired or completely blocked. Downstream passage at LNFH may also be impaired depending on the timing of duration of annual operations (e.g., closure of Structure 2 to recharge groundwater wells), but this impact is less of a concern than upstream passage. Downstream passage at Tumwater Dam is limited to movement over the concrete apron of the spillway, when flows are adequate. Tumwater Dam was never designed with downstream passage in mind, and most retrofits have considered only improvements in upstream passage. Some of these improvements (e.g., installing baffles on the spillway to improve ladder attraction flows) may have actually created additional hazards for downstream fish passage by increasing the likelihood of injuries (e.g., uncontrolled collisions with these baffles as they slide down the spillway). Other minor impediments to passage include weirs at Dryden and in the lower Chiwawa River, but issues with passage have largely been addressed. Overall, PCE 2 is functioning fairly well across the CHSU.

- *PCE 3: An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.*

  We have no direct information regarding this PCE, but may infer its functionality through evaluating the general condition of riparian areas, water quality/quantity, and overall habitat complexity. The condition of riparian areas and habitat complexity generally improves in the upper portions of the watershed, as the influences of development, agricultures uses, and other human management decreases. The exception may be commercial forestry, which can be locally important in evaluating habitat condition and generally is focused in the mid- to upper- elevation areas in the CHSU. In some watersheds, roads are located nearly parallel with waterways (e.g., US 97 and Peshastin Creek, US 2 and the Wenatchee River) and degrade riparian function, as well as channel dynamics and habitat complexity. Similarly, forest road location and density can be significant in some watersheds. As described above, water quality and quantity is seasonally degraded in some locations. It is important to note that moderately increased water temperatures can actually improve stream productivity (and lead to improved forage conditions), but if water temperatures are too elevated, overall productivity and foraging opportunities may be degraded. Other areas appear to provide consistent high quality foraging opportunities (e.g., Lake Wenatchee and upper tributaries) and may serve as refugia in many respects. Monitoring has shown over 20% of migratory bull trout known to be present in the Wenatchee basin use the lower Icicle during the summer, likely to exploit foraging conditions and thermal refugia. At the scale of the CHSU, PCE 3 is likely functioning fairly well.

- *PCE 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. Many of the features or outcomes associated with development and land management (e.g., roads, weirs, loss of wetlands and riparian areas) impair habitat complexity. Roads and development impinge on stream channels, and riprap and levees designed to protect property and reduce flooding simplify habitat complexity and alter hydrologic function. This in turn can alter, especially when in-water structures are involved, sediment deposition patterns, large woody debris transport, and pool development. A variety of restoration activities have occurred in recent years and have including reconnection of off-channel habitats, improved road maintenance, culvert replacement, road relocation, and installation of large woody debris. Many of these projects have occurred in the lower and middle portions of the watershed, where conditions were most limiting. Overall, PCE 4 is functioning fairly well.

- *PCE 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.*

  Several waterways in this CHSU are 303(d) listed with temperature impairments. Generally these occur in the lower portions of the mainstem Wenatchee and key tributaries (Peshastin Creek, Ingalls Creek, Icicle Creek, Chiwaukum Creek, Nason Creek, Little Wenatchee and Chiwawa Rivers). While some of these impairments are likely the result of direct over-utilization (e.g., surface water diversions) and habitat degradation (especially of riparian function), some may reflect natural conditions (e.g., Little Wenatchee and Chiwawa Rivers) in some areas to a degree, since little management and development pressures are present. Monitoring has shown over 20% of migratory bull trout known to the Wenatchee basin use the lower Icicle during the summer, likely to exploit foraging conditions and thermal refugia. The condition of this PCE is marginal and likely influences the spatial and temporal habitat use by fish.

- *PCE 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 overall condition of this PCE in spawning areas is generally good, with most spawning areas located in wilderness of other areas subject to little development or management pressures. Rearing areas, however. are larger and extend into other habitats beyond that used for spawning. Here conditions are more variable, and are influenced by the specific hydrologic, geologic, and other processes governing the watershed. Some areas (e.g., Nason Creek) are comprised of fairly poor rearing habitat, a result of extensive management and habitat degradation, a flashy hydrograph, a high sediment load, and limited habitat complexity. Substrate embeddedness in Nason Creek is high, and has yielded very few bull trout redds (unpublished data compiled by the USFWS, 2007) and has limited rearing use. This may also be a result of nearby Lake Wenatchee providing high quality rearing habitat, although this is provided by its large amount of stable habitat and forage base rather than substrate quality. Similarly, Icicle Creek rearing areas have high substrate embeddedness, especially below rm 5.7, and many pools have been at least partially filled in this high sediment watershed. Overall PCE 6 is functioning fairly well.

- *PCE 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.*

  This PCE is marginal, despite the few physical manipulations (Tumwater Dam and the LNFH). Surface water diversions for agricultural, residential, and other purposes are extensive. Multiple waterways are 303(d) listed for in-stream flow impairments (WDOE 2008a) and include the Icicle and Peshastin Creeks, and the Wenatchee River. While no reaches are known to completely dewater, except perhaps at the IPID in the Icicle at rm 5.7, base flows are degraded to varying degrees. While much the CHSU resembles a natural hydrograph in its timing (since the basin is largely unregulated), it is reduced in terms of total streamflow. Overall the condition of this PCE is marginal, due primarily to reductions in base flows.

- *PCE 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 CHSU. In spawning areas, water quality and quantity is generally good; in rearing areas, conditions are somewhat degraded; but in the lower portions of the CHSU, conditions can be marginal. This follows the general trend that habitat quality increases as you move up the watershed. In the summer months, a number of reaches of multiple waterways (Wenatchee mainstem, Peshastin Creek, Ingalls Creek, Icicle Creek, Chiwaukum Creek, Nason Creek, Little Wenatchee and Chiwawa Rivers) show degraded temperature and instream flow conditions by their 303(d) impairments (WDOE 2008a). In these lower portions of the CHSU, the condition of this PCE is marginal and likely influences the spatial and temporal habitat use by fish. But some areas can be locally important. Monitoring has shown over 20% of migratory bull trout known to the Wenatchee basin use the lower Icicle during the summer, likely to exploit foraging conditions and thermal refugia. But in the upper portions of the CHSU, the condition of water quality and quantity is generally good. Overall, PCE 8 is functioning fairly well (a moderate assessment) given the variable conditions across the entire CHSU.

- *PCE 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.*

  A variety of non-native fish have been stocked throughout the CHSU 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 in throughout the CHSU and likely have negative effects to bull trout including competition, hybridization, and predation. Hybridization between brook and bull trout has been documented in the Icicle (Nelson et al. 2009) and this radio-tagged hybrid moved a considerable distance into the Columbia River (Nelson et al. 2011). So while we know that negative non-native interactions are occurring, we have few data to describe the magnitude of this effect. Until we have more information to quantify the degree of this impact, we assume this PCE to be functioning fairly well at the scale of the CHSU.

Overall, the functionality of all PCEs across the Wenatchee CHSU is moderate, with considerable variability within and between watersheds. Some areas, typically the upper portions of watersheds, are functioning well; while some portions of the lower watersheds are functioning only marginally, at least during some parts of the year. A more specific assessment of PCE function follows, as we have a more precise ability to quantify baseline conditions as the scale decreases.

C. Status of Critical Habitat in the Action Area

Critical Habitat designation was depicted based on being occupied at the time of listing and/or containing the physical or biological features essential to the conservation of the species, and may be determined to require special management considerations or protection. Critical habitat designations identify, to the extent known and using best scientific and commercial data available, habitat areas that provide essential life-cycle needs of the species (areas on which are found the physical or biological features laid out in the appropriate quantity and spatial arrangement for the conservation of the species).

In many cases, no data specific to the PCEs, especially that at the same scale of the CHU or CHSU, has been collected; our best available information may be qualitative or report similar data collected for other purposes. To assist this analysis, we use the "Crosswalk" (Appendix B), which shows the relationship between the PCEs of critical habitat and the Matrix habitat indicators. Many of the physical, chemical, and biological features of the PCEs of critical habitat correspond to Matrix habitat parameters. Thus, the Service has embraced the existing analytical process of the Matrix to inform our critical habitat analysis. Additional information that is relevant to the PCE was provided were it existed.

To characterize the status of critical habitat in the action area, we used the Matrix assessment of the Icicle Creek watershed (see the Environmental Baseline, section "*I. Characterization of the Environmental Baseline: Matrix of Pathways and Indicators*"). This encompasses the action area, which has been described as the main LNFH facilities on the west bank of Icicle Creek near rm 2.8, all portions of Icicle Creek (including both the hatchery and historical channels) from its mouth to the historical barrier near rm 26 (above Leland Creek), and areas affected by water storage in Snow Lakes (Snow and Nada Lakes Basin), and Snow Creek between Snow Lakes and Icicle Creek. Using the crosswalk (Appendix B) to evaluate the Matrix parameters in the Icicle Creek watershed, we provide the following summary of the status of critical habitat in action area in Table 11.

Using the terminology of the Matrix, 5 of 9 PCEs are "functioning at unacceptable risk." Evidence suggesting the extent of degradation of PCE 1 (springs, seeps, and groundwater) is demonstrated by the over-allocation of Icicle Creek streamflow, excessive embeddedness of lower reaches (impacting hyporheic flows), and multiple 303(d) listed impairments. The fact that groundwater well withdrawals exceed aquifer recharge (requiring periodic closure of structure 2) is also an important consideration in this "functioning at unacceptable risk" ranking. Substantial impacts to the migratory corridor (from both human activities and natural conditions) is the lower Icicle has been previously described in great detail, and suggests only a very narrow window of opportunity for upstream passage of migratory bull trout.

Table 11. Status of Critical Habitat in the Action Area

PCE	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
PCE 1 - Springs, Seeps, Groundwater			X
PCE 2- Migratory Corridors			X
PCE 3 - Abundant Food Base		X	
PCE 4 - Complex Habitats		X	
PCE 5 - Temperature			X
PCE 6 - Substrate		X	
PCE - 7 Hydrograph			X
PCE 8 -Water Quality/ Quantity			X
PCE 9 - Nonnative Species		X	

This suggests an unambiguous "functioning at unacceptable risk" ranking for PCE 2 (migratory corridors). PCEs 5 (temperature) and 8 (water quality/quantity) are heavily influenced by a number of 303(d) listed impairments, including the instream flow, temperature, dissolved oxygen, pH, PCB, fecal coliform, and ammonia-N parameters. These impairments are severe enough that they likely influence bull trout behavior and habitat use, at least during some periods of each year. PCE 7 (hydrograph) is considered "functioning at unacceptable risk" in the action area, despite the fact that the overall watershed indicator ranking in the Environmental Baseline (see section *I. Characterization of the Environmental Baseline: Matrix of Pathways and Indicators*) was considered as "functioning at risk." This more degraded ranking at the action area scale reflects (1) the smaller scale of the action area as compared to the entire Icicle Creek watershed and (2) the high relative importance of the hydrograph in the action area to the species (especially in terms of its temporal and spatial habitat use by bull trout). All other PCEs showed some degree of degraded function, but were also influenced by the general good quality habitat above rm 5.7. Similar to the assessment in the Environmental Baseline, this suggests an intermediate "functioning at risk" ranking for the remaining PCEs.

Critical Habitat designation within Icicle Creek includes both SR and FMO habitats. SR habitat supports essential spawning and rearing habitat for the Icicle local population for both resident and fluvial life history forms. FMO habitat supports habitat for fluvial populations of bull trout, and may be used by bull trout from multiple core areas. Critical habitat is designated in the mainstem Icicle Creek and associated tributaries (including French, Jack, and Leland Creeks) which contain essential spawning and rearing habitat for bull trout.

The role of critical habitat in the action area is two-fold: (1) from the mouth of Icicle Creek upstream to rm 6.7, critical habitat is intended to provide FMO habitat functions; and (2) upstream of rm 6.7, critical habitat is intended to provide SR habitat functions. This delineation was based on current and potential habitat use of Icicle Creek by bull trout, and does reflect some uncertainty regarding actual habitat use. It is important to note that the mutually exclusive categories of SR and FMO likely are used by different life history stages in different ways. For example, SR habitat may be used by migratory bull trout not just for spawning, but also for foraging. While spawning may not occur throughout the entire segment of SR, the entire area may be important to rearing juvenile and sub-adult bull trout (hence the combined term, SR, encompassing one of the most critical aspects of their life history). Juvenile and subadult bull trout may also use FMO habitat for rearing, whether their movements to these areas were a result of volitional emigration or their inability to remain in their natal reach due to peak flows if refugia is limited (see Downs et al. 2006). Small resident bull trout, with their more limited physiological tolerates of elevated temperatures, more specific habitat needs, and limited swimming ability, typically rear (i.e., grow to sexual maturity) fairly close to their natal stream.

D. Factors Affecting Critical Habitat in the Action Area

Many of the same factors described in the Environmental Baseline (see section *H. Factors Affecting the Species Environment in the Action Area*) likely affect the condition and functionality of critical habitat in the action area in a similar manner. Activities associated with habitat access and migrations barriers, reductions in flow and altered flow regimes, groundwater pumping and surface diversion water supply systems, species interactions, surplus protocol, sportfish angling, and release of effluent are ongoing and impact critical habitat in the action area. For more information, see the Environmental Baseline.

VII. Effects of the Action

The Service's section 7 regulations define "effects of the action" as "the direct and indirect effects of an action on the species together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline" (50 C.F.R. 402.02). "Indirect effects" are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur.

A. Introduction and Project Elements (PE)

To assess potential Project effects, and provide continuity with the Matrix characterization of the environmental baselines for the bull trout and its critical habitat, the Service will continue the use of the Matrix (USFWS 1999) as our analytical framework. Within this framework, we consider proximity, distribution, timing (duration, frequency), type, intensity, and severity of effects in order to evaluate the degree of effect resulting from project implementation (USDI and USDC 1998, pp. 4-22 to 4-24). The Service typically expresses degree of effect in terms of impacts to individual fish and fish populations and deviations of habitat indicators in the MPI from their baseline condition. The effects to critical habitat are similarly analyzed through the use of the crosswalk (Appendix B).

To begin our analysis of effects, we typically deconstruct projects into separate elements that trigger different impact mechanisms. The proposed action is complex, with a wide range of activities occurring every year. To simplify our analysis, we will reorganize the proposed action into functional groups (Project elements).

In the section "Description of the Proposed Action" (*A. Summary of the Proposed Action*), we summarized the Project elements as (1) water supply system, (2) BSC and rearing of juvenile fish, and (3) release of these juvenile fish (pre-smolt spring Chinook). We then described "associated actions" including a variety of maintenance activities, monitoring, and flow manipulations to facilitate hatchery operations, and then identify the pollution abatement ponds O&M and burial of hatchery-spawned salmon carcasses. This summary was largely copied from our 30-day letter responding to the LNFH request for formal consultation (in which we determine whether or not the BA has all the information we need to complete formal consultation) and was used as the proposed action to complete informal consultation on terrestrial species (USFWS reference 13260-2011-I-0047). While this may have been sufficient as a coarse overview for terrestrial species, which highlighted aspects important to them (e.g., specifically identifying carcass burial, which is a key consideration for listed carnivores), a more precise proposed action is warranted for bull trout and its designated critical habitat.

For the purposes of this BO, we reorganize the proposed action into five Project elements to more precisely assess the effects of the action to bull trout and their critical habitat. We maintain that the three Project elements are valid, but some aspects of the proposed action are related to one or more discrete activities. As a result, a fourth Project element is appropriate because the operation of structures 2 and 5 influences or supports several LNFH activities. Finally, a fifth project element was added to capture the potential effects monitoring and evaluation (which have insignificant and discountable effects to terrestrial species). As a result of the reorganization of the discrete activities proposed by the LNFH (as described in the BA) into hierarchal functional groups important to bull trout and its designated critical habitat, we define the following Project elements (PE) and their subordinate aspects:

PE 1. Water Supply System

- Surface water intake diversion
- Groundwater well water withdrawals
- Snow/Nada Lakes storage and release
- LNFH Discharges

PE 2. Broodstock Collection and Rearing

- Fish ladder and holding ponds, sorting/selecting fish to be spawned, spawning and burial of salmon carcasses, incubation, and rearing activities
- Surplus/Excess Protocol
- Fish Health Management (examinations, chemotherapeutant use, fish feed, etc.)

PE 3. Pre-Smolt Release

- Release of 1.2 million pre-smolt Chinook

PE 4. Operation of Structures 2 and 5
- General O&M when structures are open
- O&M during conditions when structures are closed (see Table 1)

PE 5. Monitoring and Evaluation
- Activities that occur within LNFH facilities
- Activities that occur within waterways occupied by bull trout

The O&M activities of PE 1 involve all water withdrawn, stored, released, and discharged. Some aspects of LNFH discharges have already been analyzed through informal consultation insofar as EPA jurisdiction of the NPDES permit program allows (USFWS reference 13260-2011-I-0056). The O&M of PE 2 essentially groups all activities associated with the hatchery production of 1.2 million pre-smolt spring Chinook, and PE 3 encompasses the activities associated with their release. The O&M of PE 4 is related to PEs 1-3 and facilitates or supports many of their activities. PE 5 involves the monitoring and evaluation of LNFH fish production and the monitoring and evaluation of bull trout and other species. Monitoring and evaluation of bull trout and other listed species is covered under the MCFRO section 10(a)(1)(a) permit (TE-702631, MCFRO-13). Various conservation measures apply to the Project elements, including the protocol for handling and releasing bull trout captured as part of LNFH O&M; see the BA.

To describe and analyze Project effects in a logical way, we identified the following underlying premises:

1. Project elements trigger various impact mechanisms that directly kill (lethal effect), injure, or modify the behavior of bull trout, or result in changes in habitat condition that cause sub-lethal effects. Sub-lethal effects can vary from transient but significant disruptions of normal behaviors (e.g., feed, breed, etc. that temporarily reduce physiologic condition to physical injuries that reduce longevity and reproductive success.
2. All adverse effects can be integrated and expressed in the common currency of changes in the numbers, distribution and reproduction of bull trout.
3. The beneficial effects of the Project include the augmentation of flows in the Icicle from the release of water stored at Snow and Nada lakes. These augmentation flows are anticipated to reduce water temperatures and may extend the spatial and temporal habitat use of bull trout and improve the critical habitat function of PCE 5.
4. The bull trout impacted by the proposed action include individuals from the Icicle Creek local population (especially migratory individuals), other local populations from the Wenatchee core area, and perhaps local populations from other core areas. The lower Icicle provides important FMO habitat given the large number of individuals observed.

Based on these premises, our effect analysis consists of three major components:

1. Evaluate the potential for direct injury or mortality of individual bull trout,
2. Evaluate the potential for effects on habitat indicators to result in adverse effects to bull trout, and
3. Evaluate the potential for adverse effects to designated critical habitat through the use of the Matrix and the crosswalk.

We integrate these components to determine their combined influence on the numbers, distribution and reproduction of bull trout populations exposed to effects of the action. Evaluating effects at the individual level relative to components 1 and 2 requires several sub-steps:

a. Determine which Project elements and impact mechanisms are likely to result in adverse effects,
b. Identify the life stages most likely exposed to those effects,
c. Estimate the number of individuals in these life stages that will be exposed to Project effects based on the intersection between the timing of element effects and the seasonal timing of habitat use by different life stages, and
d. Estimate the relative severity of effects resulting from exposure.

Determining the Project elements likely to result in adverse effects can be accomplished by qualitatively evaluating the potential effects of each Project element on individual bull trout and habitat indicators (Table 12). Although Table 12 resembles that of the Matrix of Pathways and Indicators, we are not referring here to watershed-scale effects on indicators. Rather, we simply borrow the familiar MPI format to structure our qualitative ratings of the effects of Project elements at the action area scale. Identifying life stages likely to be exposed can usually be based on information about spatial and temporal patterns of bull trout habitat use. Estimating numbers of individuals exposed and the relative severity of effects requires many assumptions. The most basic assumption is that average conditions in the past can be used to predict conditions during Project implementation. Numerous additional assumptions about population size, age structure, migration timing, reproductive rate and other features contribute to high levels of uncertainty surrounding these estimates. The Service attempts to be as transparent as possible about these sources of uncertainty and our assumptions where uncertainty exists.

Based on the information in the BA and the qualitative assessment of the relative effects of Project elements on bull trout and habitat indicators (Table 12), we anticipate that adverse effects are likely to occur as a result of the activities of PE 1, 2, 4, and 5. The following sections describe the effects of the proposed action by Project element

B. Effects of the Water Supply System (PE 1)

As described above, PE 1, the water supply system, includes four subordinate aspects:

- O&M of surface water withdrawal facilities at the water diversion and intake structure in Icicle Creek gravity flow system that delivers water to the LNFH,
- Groundwater well withdrawals,
- Storage and release of water impounded at Snow and Nada Lakes,
- All LNFH water discharges.

<u>Direct Effects to Bull Trout</u>
Based on the description of the proposed action provided in the BA, and our subdivision of the proposed action into Project Elements and subordinate aspects, we believe PE1 has the potential to result in direct effects to bull trout. In particular, O&M of surface water withdrawal facilities

Table 12. Relative effects of Project elements on bull trout and habitat indicators.

Minus signs indicate level of negative impact. One minus sign indicates a negative impact that is insignificant or discountable. Two minus signs indicates a negative impact that has the potential to cause an adverse effect to bull trout that can be reliably avoided by proper implementation of conservation measures or mitigation. Three minus

Impact mechanisms (habitat indicators)	**Project Elements**				
	PE 1 Water Supply System	PE 2 Broodstock Collection and Rearing	PE 3 Pre-Smolt Release	PE 4 Operation of Structure 2 and 5	PE 5 Monitoring and Evaluation
Direct injury	---	---	-/+	---	---
Temperature	-/+			---	
Sediment					
Chemical contaminants and nutrients	--				
Physical barriers	--			---	
Substrate embeddedness	-			-	
Large woody debris	-			--	
Pool frequency and quality	-			--	
Large pools	-			--	
Off-channel habitat	-			--	
Refugia	-			--	
Width:depth ratio	-			--	
Streambank condition	-	-			
Floodplain connectivity		-		--	
Peak and base flow	-			---	
Drainage network		-			
Road density and location		-		-	
Riparian Conservation Areas	-	-		-	
Disturbance history				-	
Disturbance regime	-			-	

signs indicate a high likelihood of causing an adverse effect in all or a proportion of individuals exposed to this impact. A blank indicates an indicator is unlikely to be directly or indirectly affected by a project element because there are no impact mechanisms that link the project element to an indicator. Plus signs denote beneficial effects.

and water discharges may affect bull trout primarily due to impeded passage, entrainment, and exposure to increased concentrations of suspended sediment and contaminants.

O&M of Surface Water Withdrawal Facilities

Among the four subordinate aspects of PE 1, surface water withdrawal and conveyance has the greatest likelihood of resulting in direct injury to bull trout. Adult, sub-adult, and juvenile life stages of bull trout may be exposed to these effects. Juvenile and sub-adult life stages are likely to experience the most severe effects, including lethal effects. Potential mechanisms of direct effect include:

- Impeded upstream passage at the low-head diversion structure in Icicle Creek, resulting in increased physiologic costs,
- Impingement on components of diversion infrastructure, resulting in physical injury or death,
- Entrainment into the water delivery system, resulting in physiologic stress, risk of injury due to abrasion in the pipeline, stress and potential for injury associated with capture and salvage, and potential for stranding and mortality.

Potential direct effects to bull trout associated with exposure to elevated levels of suspended sediment will be discussed in the following sub-section.

Fish passage past the masonry diversion structure (rm 4.5) may occur over the structure or through a pool-and-weir fish ladder. A V-notch has been cut into a center flashboard on the weir dam boards to aid fish passage over the diversion structure at low flows. Bull trout passage past the diversion structure and through its fish ladder at low stream flows may be impeded over a range of flows. Attraction flow emanating from the V-notch may be greater than that from the fish ladder, although the fish ladder may be the more reliable and safe means of passage. Increased volume and reliability of water releases from Snow Lakes during lower flow periods may slightly improve passage at the diversion structure for both upstream and downstream bull trout migrants.

The degree to which the intake structure impedes passage of bull trout of different life stages during lower flow rates is unknown. A number of effects could occur: delay of upstream passage (poor attractant flow for the ladder, so use may be limited; no large pool is present below the v-notch, so attempts to leap the weir may not be well “aimed” or high enough), physical injury resulting from attempts to leap over the diversion or ascend the ladder when flows are inadequate, spawning in marginal or unsuitable habitat in lower Icicle Creek, or abandoning a spawning attempt in Icicle Creek. Use of the v-notch in the dam boards at the weir is dependent on the amount of streamflow; too high or too low of flow and water conditions are not conducive to upstream passage. These types of effects are likely to be confined to migratory adults attempting to move into Icicle Creek during late July and August, at the tail end of the run timing distribution. If we characterize this late migrating component of the population as corresponding to roughly the latest 5% of the run, this would represent about 1 bull trout annually experiencing adverse effects at current levels of abundance. We expect the severity of effects experienced by adult bull trout encountering the intake diversion structure at low flow to be sub-lethal physiologic costs (but are significant disruptions of normal behavior) and minor injuries associated with unsuccessful attempts to leap over the structure. As the Icicle Creek local population grows in response to improved migratory adult passage, numbers of adult migrants adversely affected by impeded migration will increase. Insufficient information is currently available to estimate future numbers of adult migrants that will experience adverse effects due to passage difficulties at the intake diversion.

Upstream passage opportunities for juvenile/subadult bull trout are not well understood. Most significant movements are likely downstream, keyed to high flow events (see Downs et al. 2006) but juvenile/subadult bull trout likely make small movements upstream to exploit prey and use various habitat. Not being as strong a swimmer as adults, juvenile/subadult bull trout are less likely to be able to leap the weir (at the v-notch) or ascend the fish ladder. This may also not be critical to their life history expression, since they primary concern is to survive and grow to sexual maturity (not migrate upstream). So while their movements may be altered, we do not expect the severity or significance to be substantial. Overall, we anticipate the potential effects of impaired upstream passage of juvenile/subadult bull trout to be insignificant.

Once or twice a year, between November 1st and June 1st, stream flow into the diversion structure's fish ladder is reduced and the boards within the ladder are removed to flush accumulated sediments. When this occurs, the fish ladder is inoperable for two to three days. The boards in the fish ladder are adjusted to optimize fish passage when it is necessary and safe. If this temporary closure occurs in winter or late fall, effects on bull trout are likely to be insignificant. A closure of this length during the upstream migration in the spring would represent an adverse effect to a proportion of the migratory population, but before the peak of migration.

The LNFH intake is not effectively screened at its initial point of diversion and bull trout may become entrained in the gravity flow delivery system. The gravity flow system delivers diverted water approximately 6,460 ft through a buried pipeline to the LNFH. Because the same intake is used by LNFH and the COIC, a total of up to 54 cfs may be diverted at the intake. About 1,260 feet down gradient from the intake, the COIC delivery system branches off, potentially taking 12.4 cfs of flow. The remaining flow, up to 42 cfs, continues the remaining 5,200 feet down gradient to the LNFH. Before water enters the LNFH rearing units, it is routed through a sand settling basin and then on to inside or outside screen chambers. Both screen chambers meet NOAA Fisheries 1994 standards for fish screening (NMFS 1994). However, they may not meet the more stringent criteria currently being developed by NOAA Fisheries. Fish bypass facilities at both screens do not work properly and are no longer used. Screens are therefore monitored twice daily (once at the start and once at the end of the working day, typically 7:30AM to 4:00 PM) so that observed fish can be netted and release according to Appendix D: Bull trout Protocols for Handling and Release of the BA (USFWS 2011).

All bull trout entrained into this water delivery system are likely to experience adverse effects. Bull trout that enter the system may experience abrasion injuries from striking trash racks, and it is difficult to capture fish in the vicinity of the fish screens. Near the intake itself, bull trout will first be exposed to an overflow water discharge channel which provides an opportunity to return to Icicle Creek. We believe that operational spill into this discharge channel is sufficient to keep the discharge channel flowing continuously to Icicle Creek, preventing entrained bull trout that enter the discharge channel from being stranded. Bull trout that enter the water delivery system are exposed to multiple risks of injury in the pipeline, with recent inspection showing deterioration of the interior walls of the pipeline. Once in the pipeline, entrained bull trout encounter the gate valve for the COIC diversion. If the COIC diversion is operating, some entrained bull trout could pass through the open gate valve and reach the COIC upwelling chamber and fish screen. Entrained bull trout that do not enter the COIC delivery system continue in a 31-inch diameter pipeline about a mile to the LNFH, causing prolonged exposure to abrasion risks. Upon reaching the LNFH, these fish may be captured and returned to Icicle Creek from either the sand settling basin or the screen chambers. These handling activities, even when accomplished carefully and efficiently, are likely to result in sub-lethal adverse effects (abrasions and stress) to all bull trout handled.

Records of bull trout retrieved from the water intake and delivery system for the last five years estimate that up to 9 bull trout can be entrained annually in LNFH facilities (Table 13). Most of the bull trout detected (n=8) were found in the sand settling basin and one was found dead against the trash rack (the source of mortality is unknown). Before 2006, the sand settling basin was drained and sediment removed once every year. Since the completion of the 2006 BO, the LNFH periodically checks (weekly to monthly, depending on the situation) for bull trout using a combination of drawdown and a fyke net. Past problems with bull trout potentially exiting over the overflow weir have been remedied; water levels are now monitored by low and high water level sensors. Based on bull trout detections, on average, 16% of entrained bull trout are killed, equating to roughly 1 mortality per year. Based on the sizes of entrained bull trout (mean = 261 mm, range 140 to 327 mm), they are typically in the juvenile and sub-adult life stages. Larger bull trout are probably more capable of avoiding entrainment, and may have less access to the intake. Most fish entrained overall are small (35-140 mm) and are rainbow and cutthroat trout.

Table 13. Bull trout entrained in the LNFH water delivery system from 2006 to 2010.

Year	Total bull Trout captured	Mortalities	Percent Mortality
2006	3	1	33%
2007	2	0	0
2008	2	0	0
2009	9	1	11%
2010	3	1	33%
Total	19	3	16%

The values in Table 13 represent minimum estimates of total bull trout entrainment and mortality. As numbers of large migratory bull trout spawning in Icicle Creek increase, as they are likely to do under the proposed action, the Icicle Creek local population is likely to grow and the numbers of juvenile and sub-adult emigrants likely to be entrained and killed annually will also increase. Insufficient information is currently available to estimate the likely rate of increase in future entrainment effects. For the purposes of this BO, we will assume that the maximum number of fish observed to be entrained in the past, occurs in future years and in a similar manner (i.e., 9 entrained, of which 1 mortality is expected).

Installation of a section of cyclone fence with 4-inch mesh on the outer grizzly rack at the intake from mid-July through September reduces the risk of entrainment of large migratory adult bull trout in the conveyance channel. Adult migratory bull trout are also likely to have the swimming capacity to avoid impingement on the fence. In 2010, the first year this activity was implemented, no impingement of bull trout was observed. Sub-adult and juvenile bull trout have a lower risk of impingement because their smaller body size reduces the potential for impingement on the 4-inch mesh of the cyclone fence, but they can be entrained through the fencing into the water delivery system because of their limited swimming power. The fencing also adds another layer of material that contributes to the risk of abrasion injury during entrainment.

Gaps in flashboards on the masonry diversion structure may function as a sieve at some flows. During periods of summer low flow, the diversion structure may be covered with tarps secured with sand bags to prevent leaking through flashboards on the masonry structure. This is done to maintain water surface elevations high enough to meet water supply needs. Tarps are removed in early fall when stream flow increases. Use of tarps to stop leakage through flashboards suggests gaps exist in the flashboards. When tarps are not in place, flow through these gaps may increase water velocity sufficiently to increase risk of impingement for juvenile life stages of bull trout with more limited swimming capacity. This form of impingement has the potential to result in severe injury or mortality for juvenile bull trout. Impingement risk is likely greatest at intermediate flow levels. At high flow, small bull trout are more likely to be swept over the flashboards.

Given that emigration of juvenile and sub-adult bull trout from upstream spawning and rearing areas is probably concentrated during periods of higher flow in spring and fall (Downs et al. 2006), overall exposure of bull trout in susceptible life stages to this flashboard sieving risk is probably low. Because areas in the vicinity of the gaps in the flashboards that have elevated water velocities are small, the proportion of juvenile bull trout potentially exposed to sieving risk at the diversion is further reduced. Consequently, we anticipate that the risk of juvenile bull trout impingement at the diversion structure is discountable.

Exposure to Suspended Sediment from Maintenance of the Intake and Sand Settling Basin
Removal of accumulated sediments from near the intake and from the sand settling basin may expose bull trout to elevated levels of suspended sediment. The 2006 BA prepared for consultation on the O&M at LNFH included data about suspended sediment monitoring in the vicinity of structures 2 and 5. Turbidity values from water samples collected about 300 feet downstream from the work activity were generally similar to sample values collected about 100 feet upstream of the work activity. Most downstream samples were less than 10 Nephelometric Turbidity Units (NTUs) higher than upstream samples; a few were about 20 NTUs higher. It appears that the higher readings were related to ambient conditions more than the work activities.

Comparing the highest turbidity values observed to information summarized by Waters (1995) indicates that the magnitude and duration of these increases in turbidity are too low to harm bull trout of any life stage likely to be exposed to these effects. The typical activities associated with operation and maintenance of the water supply system (sediment flushing or removal from the intake, fish ladder, and sand settling basin) likely cause brief pulses of turbidity similar to those observed during past monitoring activities. For these reasons, exposure to elevated suspended sediment resulting from O&M actions on the water supply system are likely to result in insignificant impacts to bull trout.

Exposure to Chemical Contaminants and Nutrients.
The Service recently completed informal consultation with the U.S. Environmental Protection Agency (EPA) regarding their issuance of a National Pollution Discharge and Elimination System permit to the LNFH (USFWS Reference number 13260-2011-I-0056). This consultation addressed all discharges from the LNFH and included a comprehensive analysis of potential effects to bull trout due to exposure to the wide variety of contaminants present in hatchery effluent. In that consultation, the Service concurred with the determination by the EPA that LNFH discharges were “not likely to adversely affect” the bull trout. The discharge permit issued by EPA to LNFH established discharge limits for settleable solids, total suspended solids, temperature, total residual chlorine, and total phosphorus. Based on information in the biological assessment for this permit, the Service does not expect discharges to approach lethal concentrations for any regulated parameters. We also expect that discharge levels will be sufficiently low that they will have insignificant effects on the behavior of bull trout exposed to LNFH effluents (i.e., avoidance will be minimized).

Summary of Direct Effects to Bull Trout from PE 1
Although multiple potential mechanisms of direct adverse effects are associated with PE 1, we believe adverse effects are only likely to occur to bull trout due to impeded upstream migration at the intake structure, and due to entrainment in the water delivery system. Our estimates of numbers of bull trout likely to experience these effects (summarized in Table 14) include many assumptions based on current conditions in Icicle Creek.

Table 14. Summary of direct adverse effect estimates for PE 1, stratified by impact mechanism, life stage, and severity of effect. Numbers are individual bull trout per year. See text for derivation of these estimates.

Impact Mechanisms	Life stage Affected	Severity of Estimated Effect	
		Lethal effects	Sub-lethal effects
Impeded passage	Adults	0	1
	Sub-adults and juveniles	0	0
Entrainment	Adults	0	0
	Sub-adults and juveniles	1	8
Total		1	9

<u>Effects to Habitat Indicators</u>

This sub-section provides details about the qualitative effects to bull trout habitat summarized in Table 12. The sequence of presentation here begins with indicators that we expect will experience the largest effects from PE 1, and proceeds through indicators that we expect to experience lower levels of effects (therefore the order does not follow the sequence in Table 12).

For the sake of presenting a systematic analysis of Project effects, we have subdivided the proposed action into 4 discrete project elements. In reality these project elements all interact. Specifically, the effects of PE 1 on some habitat indicators are strongly influenced by the operation of structure 2 (PE 4). Severity of effects on habitat indicators is generally increased by closure of structure 2, especially during low-flow periods in Icicle Creek. Our discussion of effects on each habitat indicator seeks to highlight situations in which the operational status of structure 2 has a large bearing on the severity of effects. For these indicators, we begin by discussing the likely effects with structure 2 open, followed by contrasting effects when it is closed.

Physical Barriers

The physical barrier of the intake diversion structure interrupts the continuum of natural processes that occur in streams. For example, continuity of transport of bedload and woody debris is interrupted, likely reducing the diversity and complexity of habitat below the diversion structure. The Service does not believe that levels of reduction in habitat diversity and complexity are sufficient to result in adverse effects to bull trout exposed to these degraded habitat conditions (e.g., see discussion of the Large Wood Debris indicator, below).

Removal of water from Icicle Creek at the intake has the potential to create barriers to passage in reaches below the diversion structure. Releases of cold water from Snow/Nada Lakes ameliorate the effects of this potential barrier during parts of the year when releases occur (July to early October). In typical years, during seasons when releases from Snow/Nada Lakes are not occurring, bull trout likely take advantage of high natural flows to move past LNFH infrastructure, and have sufficient opportunity to do so that they can avoid adverse effects. In dry years, however, low-flow impediments to passage may occur in the reaches below the intake before releases begin from Snow/Nada Lakes.

The severity of effects of water diversion on habitat access is dramatically affected by operation of structure 2. When structure 2 is closed, the majority of water that remains in Icicle Creek below the intake is diverted away from the historical channel and into the hatchery channel. Under these conditions, very low flows remaining in the historical channel are likely to result in structure 2 being a barrier to upstream passage for bull trout. Bull trout exposed to this barrier could also experience sub-lethal adverse effects due to prolonged exposure to elevated temperatures (see Effects of PE 4).

Chemical Contaminants and Nutrients

As described above, the Service expects discharges from the LNFH to have insignificant effects on bull trout and their habitat. We believe that the restrictive effluent limitations contained in the EPA permit will maintain water quality at levels that allow bull trout to use all habitat areas, including those near effluent discharges, without experiencing adverse effects. This finding assumes that LNFH discharges will comply with criteria specified in the EPA permit.

Bull trout are opportunistic predators that typically feed on the eggs and juveniles of anadromous salmon. They likely locate profitable feeding areas using chemical cues left in the water by their prey. Effluent from the hatchery likely contains relatively high concentrations of these cues, serving as a false feeding attractant to bull trout, except when Chinook pre-smolts are released. This "attractive nuisance" effect may keep bull trout from feeding as efficiently as they might if they were responding to feeding cues from naturally spawning salmonids. We are not aware of any means for estimating the scope and potential consequences of this potential effect.

Differences in water quality depending on whether the water source is upper Icicle Creek, Snow/Nada Lakes, or groundwater wells near the LNFH are likely negligible. Water released from Snow/Nada Lakes flows thru a tunnel between Snow Lakes and Nada Lake. Confinement in this tunnel may slightly reduce the trace nutrient content of this water compared to natural surface flow. Delivery of this water, however, during periods of typically low flow in Icicle Creek probably represents a slight nutrient bonus. Overall, we anticipate effects to the *chemical contaminants and nutrients* indicator to be minor.

Temperature
During periods when water from Snow/Nada Lakes is not being released, reductions in flow below the intake are likely to lead to slight increases in temperature. Water releases from Snow/Nada Lakes under the proposed action will occur during the period when high stream temperatures are most likely to occur (July to October), reducing the possibility of water withdrawals resulting in adverse effects due to elevated temperatures. We do not expect these temperature increases to be sufficient to impose injurious levels of physiologic costs to bull trout exposed to them, even if exposures are prolonged.

Temperature differentials associated with supplementing the surface water supply with pumped groundwater are difficult to estimate. While pumping groundwater from a shallow aquifer is unlikely to affect the temperature of remaining groundwater that emerges as surface flow in Icicle Creek, it is likely to reduce the volume of groundwater emergence, and this reduced volume is likely to contribute to elevated temperatures in the historic channel. The historical channel is likely hydrologically connected to the shallow aquifer being tapped by the array of wells used to supply water to the LNFH. Downstream of the LNFH, below the historical channel, groundwater pumping is expected to cool Icicle Creek about 2.4 °C (Hall and Kelly-Ringel 2011) due to the cool temperature of ground water added to the river.

By indirectly compensating for roughly all of its surface water consumption via water releases from the Snow Lakes during a critical time period, water temperatures will likely be slightly decreased below rm 5.5. Snow Lakes water is 2 or 3 °C colder than Icicle Creek during the time of year when Snow Lakes releases would occur. Previously the reach below the intake had extremely low flow and elevated water temperature during late summer. Some of the causes of elevated temperatures, both natural and anthropogenic other than those attributable to LNFH activities, will still exist, so elevated temperatures are still a concern. Due to the proposed action, the current negative conditions are expected to be ameliorated.

Peak and base flow
Under the proposed action, the LNFH will release approximately 50 cfs from the Snow Lakes reservoir system from early July through September 30 every year. Unusual events such as equipment malfunction or consecutive years of very limited snowpack could preclude release of 50 cfs through the entire period, but the Service expects these events to be rare. For this effects analysis, the Service assumes 50 cfs will be released throughout the scheduled period every year. Inability to do so would represent a trigger for reinitiating consultation. Typical flows from Snow Creek in the absence of LNFH releases are about 5 cfs.
The LNFH withdraws 42 cfs from Icicle Creek during a time of year when the total of all water rights on Icicle Creek exceeds total streamflow, sometimes by a factor of two or three. Icicle Creek can go dry, or nearly so, in a few areas near the diversions. Water is added to Icicle Creek from releases to Snow Creek at rm 5.5, removed at rm 4.5, and piped about 1.7 miles to the LNFH, where it is returned back to Icicle Creek at rm 2.8. Additional water may also be released from supplemental storage lakes operated by IPID; the likelihood, frequency, duration, and amount are unknown. As a result, several effects on bull trout habitat in the reach between rm 5.5 and 2.8 are likely to occur.

Generally, in mid-July, stream flow in Icicle Creek is dropping rapidly, and is still above base flow. At about this time, the Snow Lakes release will begin. As Icicle Creek base flow drops through the rest of the summer, Snow Lake's water will provide habitat benefits (flow and temperature) through September. By early October, Icicle Creek stream flow generally increases due to a combination of irrigation diversion shutdown upstream of LNFH, plus natural weather patterns (precipitation).

The LNFH diverts surface flow from Icicle Creek throughout the year. Thus, bull trout of all life stages using FMO habitat below the intake are exposed to reduced flow in Icicle Creek from rm 4.5 to rm 2.8 (location of the outfall) during all parts of the year when releases from Snow/Nada Lakes are not occurring (roughly from October 1 to early July). Assessing the impacts of reduced flow in this reach during this time period is hampered by limited information about the number and proportion of bull trout of different life stages present in late fall and winter, as well as limited information about channel morphology and the decrement in habitat amount and quality associated with reduced flow. Patterns of bull trout activity and habitat use in winter also are not well understood. Finally, the degree to which substituting pumped groundwater for surface diversion ameliorate the impacts of water withdrawals also complicates assessment of likely effects to bull trout.

Streamflow is considered a "master variable" (Poff et al. 1997) that is correlated with many indicators in the MPI and can limit the distribution and abundance of bull trout. Effects of reduced flow on bull trout likely vary greatly depending on timing (see Figure 2). Based on monthly streamflow statistics, October, January, February and March are the months when low flows may have the greatest effects on habitat amount and quality (USGS data for gauge 12458000). Average flows in Icicle Creek above the LNFH intake in October are about 230 cfs and in the remaining winter months are about 300 cfs (USGS data for gauge 12458000). During these periods, LNFH withdrawals represent about 14 to 18 percent of total stream flow. Withdrawals of this magnitude during warm times of the year would have the potential to result in adverse effects due to elevated temperatures and reduced habitat availability. During fall and winter, the primary mechanisms of effect of reduced stream flow on exposed bull trout are to reduce the amount of available habitat, and possibly to increase predation risk. Bull trout during this time of the year are likely to be relatively inactive, reducing the consequences of reduced habitat availability. The strong substrate orientation of bull trout may limit increased risk of predation associated with reduced water depth. Overall, we consider the potential for adverse effects to bull trout due to fall and winter water withdrawals to be discountable.

Habitat conditions in the historic channel are likely to be degraded by pumping of the shallow aquifer because this is the stream reach that is hydrologically connected to the well field and groundwater pumping reduces surface flow. Elevated water temperature and reduced water depth are expected from well use. These conditions are interrelated with operations at structure 2, because that structure regulates surface flow into the historic channel. The negative effects of groundwater pumping on temperature and volume of habitat for bull trout and their prey base are similar to, and compounded by, the effects of activities at structure 2 (see Effects of PE 4). Bull trout in the historic channel exposed to the combined negative effects of groundwater pumping and closure of structure 2, especially during periods of low instream flow and high temperatures, may experience sub-lethal adverse effects (i.e., degraded habitat conditions, especially temperature; see the effects of PE 4). It is possible that water released from Snow/Nada Lakes (in excess of the amount that LNFH diverts) will ameliorate somewhat the in-stream flow effects of groundwater pumping, but this has not been quantified.

Habitat for bull trout in Snow Creek, the outlet of water released from Snow and Nada Lakes, is limited by steep gradient and natural obstacles to the area near its confluence with Icicle Creek. Most of the year, Snow Lakes will be storing water, and thus Snow Creek will not augment Icicle Creek flow. The base flow of Snow Creek is less than 5 cfs, and consists mostly of snowmelt. In its natural state (without a dam and water delivery tunnel) peak outflow would normally occur in late spring when flow in Icicle Creek is high (at least several hundred cfs). Proposed operations will shift the hydrograph in this stream, delaying peak flows until releases begin, and extending base flows through the early summer period when unimpounded peak flows would normally occur. Because habitat for bull trout is so limited in Snow Creek, we expect negative effects of Snow Lakes operations on the bull trout to be insignificant.

Lowering of structure 2, by reducing the volume of flow into the historic channel, can have substantive effects on temperatures in the historic channel, especially if closure occurs during summer and fall when air temperatures are high. The Service believes that these effects to temperature may be sufficiently severe that bull trout exposed to them will experience sub-lethal adverse effects (see Effects of PE 4, below). Potential temperature effects associated with production of Chinook salmon will be discussed under Effects of PE 2, below.

Substrate Embeddedness

LNFH staff removes sediment from the head of the water intake conveyance channel (and intake building sump), fish ladder at the intake, and the sand settling basin. These activities are necessary to maintain an adequate surface water supply, and typically occur in later winter or early spring (but can occur anytime November 1-June 1). LNFH's gravity flow delivery system removes large quantities of sediment (sand settling basin) from Icicle Creek and therefore has a slight beneficial effect on substrate quality downstream of the LNFH. Removal of sediments from the sand settling basin are accomplished by dewatering the basin, salvaging any fish, and removing sediments with heavy equipment. Sediment removal at the intake is accomplished using a crane and truck to haul it to upland disposal sites, or by removing some flashboards in the canal and intake house (not the flashboards on the dam itself) and flushing the accumulated sediment downstream. The material that is mobilized during these activities is native material from Icicle Creek which settled in the margins near the intake after high flow events. Therefore, this activity does not introduce new sediment to the system. The associated turbidity increase is brief (usually a few hours spread out over a day or two) and probably has insignificant effects on the overall distribution of substrate particle sizes downstream of the intake. This level of sediment mobilization likely also has little effect on the capacity of downstream substrates to support production of macroinvertebrates, or to fill interstitial spaces in the substrate used for shelter by bull trout of all life stages. (See the *Exposure to Suspended Sediment from Maintenance of the Intake and Sand Settling Basin* section for more information.)

Effects to the *substrate embeddedness* indicator are considered minor. Although bull trout may be present year-round, their response to these insignificant effects is not expected to result in a significant disruption of normal behaviors. Overall, we anticipate the potential effects to be negligible.

Large Woody Debris

Maintenance of LNFH structures includes removing large wood and debris. These materials, however, are not removed from the Icicle Creek system. All natural material removed from upstream of structures are placed downstream within the ordinary high water mark, although the size and complexity of these materials are likely somewhat degraded by the removal and relocation process. Reductions in flow reduce the capacity of Icicle Creek to transport large wood, but most of this transport likely occurs during periods of high flow when the proportionate reduction represented by LNFH diversion is relatively small.

Surface water diversion and groundwater pumping, among other LNFH operations, likely influence the availability of groundwater to riparian trees. These effects are probably strongest just below the intake and in the historic channel. Changes in water availability may reduce growth rates of riparian trees and the overall spatial extent of riparian forest development. Under the proposed action, structure 2 would be closed only in certain circumstances, which results in more water in the historical channel and less water in the hatchery channel. Observations thus far indicate many cottonwood trees along the hatchery channel have died, presumably as a result of less available water. But overall these effects likely have relatively minor consequences on the supply of large woody debris in Icicle Creek. Effects to bull trout exposed to these reductions in large wood are likely to experience insignificant effects.

Pool Frequency and Quality and Large Pools
Diversion of water from Icicle Creek and release of sediment during structure maintenance have the potential to reduce the depth of pools below the intake. We believe that the magnitude of these effects will be slight when structure 2 remains open, and the number of pools in this reach is unlikely to be affected. Bull trout exposed to the expected minor reductions in pool depth will experience insignificant effects. Releases of water from Snow/Nada Lakes during the late summer and fall may contribute to minor improvements in pool quality, as long as structure 2 remains open.

When structure 2 is closed, however, effects to pool quality in the historic channel can be far more severe, particularly during low flows in Icicle Creek in late summer and early fall (see Effects of PE 4, below). Pool depths may be dramatically reduced in the historic channel and the number of large pools may be reduced. Bull trout exposed to these degraded pools may still be able to avoid adverse effects, but habitat quality and capacity will be reduced.

Off-channel Habitat
Release of water from Snow/Nada Lakes is likely to improve the quality of, and bull trout access to, off-channel habitat during the late summer and early fall. However, during low-flow periods when these releases are not occurring, diversion of surface water and pumping of groundwater will negatively affect off-channel habitat, especially along the historic channel. While the occurrence of these effects is highly likely, the scope and intensity of them is highly uncertain. Improved information about the effects of water diversion and groundwater pumping on habitat quality and access is needed. Our professional judgment, based on site visits while different operational scenarios were occurring, is that changes in off-channel habitat quality and access are not extensive and would not result in adverse effects to bull trout exposed to these differences in conditions.

If structure 2 is closed, however, then the severity of negative effects to this indicator will substantially increase (see Effects to PE 4). During low flows in late summer and early fall, closure of structure 2 could reduce flows in the historic channel sufficiently to limit access to edge and off-channel habitat features.

Refugia
Effects of PE 1 on this indicator are largely related to effects on habitat connectivity and habitat access. As described above, operation and maintenance of the water diversion and intake may create barriers to bull trout access that reduce connections between habitats suitable for spawning and rearing in upper Icicle Creek, and FMO habitat in the lower Icicle, Wenatchee, and Columbia rivers. Once again, operational status of structure 2 greatly influences the severity of PE 1 effects on this indicator. If structure 2 is open, limited numbers of late migrating bull trout may experience adverse effects as they attempt to pass the intake diversion. If structure 2 is closed in late summer and early fall, barriers to passage associated with low flows in the historic channel may further reduce access to upstream refugia for bull trout in other life stages.

Width:Depth Ratio
Little information about channel morphology of Icicle Creek below the LNFH intake was provided in the BA, making it difficult to assess likely effects of PE 1 on this indicator. Like the

Off-channel Habitat indicator above, we believe that PE 1 effects on this indicator will be limited when structure 2 is open. Closure of structure 2 and associated reductions in flow into the historic channel has the potential to result in larger changes in this indicator.

Because slightly more water will be released under the proposed action than will be diverted, somewhat more habitat area will be available to bull trout in the reach between the LNFH intake at rm 4.5 and the fish ladder at rm 2.8, where most LNFH water returns to Icicle Creek. The amount will vary depending on channel morphology, and will be most noticeable in reaches where there are shallow margins near a narrow thalweg. For example, in the relatively narrow reach adjacent to the RV park near rm 4.2, additional shallow margin habitat is likely to remain submerged due to the approximately 8 cfs added to this reach during the low flow period. This may benefit bull trout prey, such as young-of-year juvenile salmonids, which have been observed in these margins in the past (D. Morgan, pers. obs., August 2004). In contrast, where the width to depth ratio is very high, such as immediately upstream of structure 5, there will be little difference in habitat available.

Most channel-forming activity occurs during high stream flows. Water withdrawals for the LNFH during high flows are too small to have much influence on the outcome of channel-forming processes. Closure of structure 2 during high flows, however, may influence the morphology of the historic channel, which is deprived of high flows (see Effects of PE 4).

Streambank Condition

Manipulation of flow rates below the intake and pumping of shallow groundwater has the potential to influence the availability of water to riparian plants. This can affect the development of root strength that is critical to the formation of undercut banks, a key habitat feature for bull trout. As described above for the Large Woody Debris indicator, we believe that PE 1 effects on water availability may have minor effects on riparian plant growth. These effects to plants are likely to translate into minor effects on streambank stability.

Riparian Conservation Areas/Riparian Reserves

Effects to this indicator from PE 1 are similar to those described for Streambank Condition. The geographic scope of these effects is likely limited to the area from the intake (rm 4.5) to the outfall from the LNFH (rm 2.8). Effects of this scale have little influence on the functionality of riparian reserves at the watershed scale. Within the project area, riparian reserves are relatively intact and are probably effective at buffering Icicle Creek from impacts on upland areas.

Water releases from Snow/Nada Lakes likely increases the availability of water to riparian plants below Nada Lake. This may contribute to increased growth rates and greater spatial extent of riparian forests, with corresponding benefits to stream temperature, and large wood and nutrient inputs. Reductions of flow in the hatchery channel have resulted in loss of cottonwood trees along the bank, and this will likely continue under the proposed operational plan. Overall impacts to the *riparian conservation areas/riparian reserves* indicator are expected to be minor.

Disturbance Regime

The primary effect of PE 1 on this indicator is to slightly diminish the capacity of floods to reshape the Icicle Creek channel. Operations of Snow/Nada Lakes facilities may slightly increase the risk of wildfire in this watershed (e.g., related to helicopter use), but this is a minor effect.

We believe there are no mechanisms by which PE 1 can have effects on the following habitat indicators; *Floodplain Connectivity, Drainage Network, Road Density and Location, and Disturbance History*.

Summary of PE 1 Effects on Habitat Indicators
PE 1 has the most pronounced effects on *Physical Barriers, Temperature, and Peak and Base Flows,* with more limited effects to the remaining indicators. However, only the effects of the *physical barriers* habitat indicators are sufficiently large enough in magnitude to result in adverse effects to bull trout. Positive and negative effects to habitat indicators are likely to occur at the action area scale, but they will "maintain" their current function at the 5th-field scale. While effects to habitat indicators may alter the normal behavior of bull trout, we expect the outcome to be insignificant.

C. Effects of Broodstock Collection and Rearing (PE 2)

PE 2, broodstock collection and rearing, involves all aspects of collecting adult Spring Chinook salmon broodstock, spawning, and incubation activities. The period of BSC typically occurs from mid-May into early July. The PE and subordinate aspects are summarized below.

PE 2. Broodstock Collection and Rearing

- Fish ladder and holding ponds, sorting/selecting fish to be spawned, spawning and burial of salmon carcasses, incubation, and rearing activities
- Surplus/Excess Protocol
- Fish Health Management (examinations, chemotherapeutant use, fish feed, etc.)

<u>Direct Effects to Bull Trout</u>
The direct effects of PE 2 stems from bull trout being attracted to the flows from the hatchery, ascend the ladder into the adult holding ponds, and are trapped. Bull trout in the holding ponds would be captured by nets and then released back into Icicle Creek through the use of the release protocol (Appendix D of the BA).

A number of impacts are associated with confinement in the holding ponds before being captured, netted, and relocated. Bull trout can be harmed due to being held in the Chinook holding ponds with water treated with a variety of chemotherapeutants including Formalin, low levels of dissolved oxygen or build-up of toxins/waste products associated with high densities of fish in a confined space (i.e. mucus excretion, proteins, fish excrements, etc.), and stress from overcrowding. Effects associated with bull trout exposure to degraded water quality parameters, including chemotherapeutants, was previously analyzed in the EPA consultation on the issuance of their NPDES permit (USFWS reference 13260-2011-I-0056); therefore these effects are not considered in this BO. The likelihood of harm to bull trout from other parameters not assessed in the NPDES permit (e.g., overcrowding stress, exposure to mucus excretions, and proteins) are likely related to the length of time bull trout remain in the holding ponds. Information from the

BA suggests bull trout may spend several days in the holding ponds. During this time, a bill trout's ability to feed and continue their migration would be significantly impaired. While the frequency of bull trout ascending the ladder into the holding ponds is low, it does occur. In the last ten years, only 1 adult bull trout is known to have accessed the holding ponds. For the purposes of this BO, with an indefinite term of the proposed action, we assume up to 1 bull trout annually will ascend the ladder and be held in the holding ponds, leading to adverse effects associated with confinement.

Capturing and releasing bull trout can also have adverse effects. The netting or capturing, handling, and releasing of the bull trout can result in injury by increasing the potential for disease by removing the protective mucus coating on the skin, as well as increasing stress in affected individuals which can cause it to become susceptible to disease (and predators and competitors when released), and it can cause potential direct injury. According to Robert Stickney in the 1983 American Fisheries Society book titled *Fisheries Techniques*, in the chapter titled *Care and Handling of Live Fish*, death can result if fish are handled roughly or kept out of water for extended periods of time (Nielsen and Johnson 1983). The LNFH developed the Bull Trout Protocols for Handling and Release (see Appendix D in the BA) which stipulates ways to minimize harm associated with handling fish, which include timing handling (as applicable), using clean hands free of sunscreen and insect repellent, and stipulating types of containers for transferring the bull trout. In summary, we expect the potential injury of one adult bull trout annually in the holding ponds from capturing and handling.

All impacts to bull trout associated with PE 2 are assumed to be to adult bull trout. In the last ten year (the period for which comparable data are available), no subadult or juvenile bull trout have ever ascended the ladder and been held in the holding ponds. The ladder was built considering the swimming ability and other characteristics of adult spring Chinook. As a result, all impacts of PE 2 are specific to adult bull trout.

In the last 10 years, surplusing of excess Chinook has led to the death of 1 bull trout. Since then, the LNFH committed to educating and closely supervising LNFH staff and other volunteers conducting the surplusing of excess Chinook salmon, so we do not anticipate any future mortality of bull trout. Any bull trout encountered in surplus/excess activities will be captured, handled, and released according to the Bull Trout Protocols for Handling and Release (see Appendix D in the BA).

The potential effects of other aspects of PE 2, including the burial of salmon carcasses, incubation, and rearing activities, as well as all fish health management, are expected to be minor. Beyond water quality impacts (previous addressed in the NPDES permit), no impacts are anticipated. Similarly, maintenance activities, including the cleaning of all ponds and raceways, are also anticipated to result in minor effects. Water quality may be slightly degraded as sediments, laden with fish waste, residual feed, and other detritus are released in annual cleaning, but this is expected to be short-term and insignificant.

Summary of Direct Effects to Bull Trout from PE 2

Overall, we suggest that most aspects of PE 2 have little risk of direct effects to bull trout, but that 1 adult bull trout may ascend the ladder annually and be confined, captured, and released.

This is a direct injury to bull trout and a significant impairment of normal behaviors. However, we believe the Bull Trout Protocols for Handling and Release (see Appendix D in the BA) should alleviate impacts and the risk of mortality. Thus we conclude PE 2 will have sub-lethal effects to 1 adult bull trout annually.

Effects to Habitat Indicators

For the assessment of the impacts of PE 2 to habitat indicators, we used the information in the BA and developed Table 12 to illustrate the relative effects of Project elements. As a result, we anticipate PE 2 will impact the following Matrix indicators*: streambank condition, riparian conservation areas/riparian reserves, drainage network, floodplain connectivity,* and *road density and location.*

Streambank Condition, Riparian Conservation Areas, and Floodplain Connectivity

These indicators are grouped together since many of the same factors (e.g., location and O&M of LNFH broodstock collection, incubation, and rearing facilities) are similar in consideration of these indicators. Effects are anticipated and occur primarily from the maintenance of the features. Although maintenance of these features was not described in the BA, we assume they will be maintained in their current configuration into perpetuity. The large amount of riprap located along the left bank of Icicle Creek at rm 2.8 protects LNFH facilities from scour and damage. Long-term maintenance of these facilities may reduce the quality and degrade the function of *streambank condition, riparian conservation areas/riparian reserves,* and *floodplain connectivity* indicators. Since the baseline condition is already established, maintenance of these conditions results in a relatively minor impact. Overall, we anticipate effects to these indicators are insignificant.

Road Density and Location and *Drainage Network*

These indicators are grouped together since many of the same features (e.g., impervious surfaces and the confinement and routing of water) are similar in consideration of these indicators. Many LNFH facilities are made of cement or other material that create impermeable surfaces and routes water quickly (versus natural infiltration). Much of this is considered baseline, but we assume they will remain in their current configuration into perpetuity (i.e., it was not described in the BA). The size of this area in relationship to the floodplain and riparian area of Icicle Creek is quite small and effects are therefore expected to be insignificant. Because the roads are mostly paved, effects from sedimentation will be minimal. Overall, we anticipate effects to these indicators are insignificant.

Summary of Effects of PE 2 to Habitat Indicators

Positive and negative effects to habitat indicators are likely to occur at the action area scale, but they will "maintain" their current function at the 5^{th}-field scale. While effects may be measureable, they are unlikely to result in responses of bull trout that result in significant impairments of normal behavior. Overall, we expect no adverse effects to habitat indicators to result from PE 2.

D. Effects of Pre-Smolt Release (PE 3)

PE 3 consists of the annual release of about 1.2 million Chinook salmon pre-smolts into Icicle Creek. Releases typically occur in mid- to late-April. Manipulation of structure 2 to encourage downstream migration by these pre-smolts is discussed under Effects of PE 4. Release of these pre-smolts likely has both beneficial and negative effects on bull trout. For bull trout that are large enough to consume these pre-smolts, these annual releases likely represent a prey bonanza that contributes to a rapid accumulation of energy reserves. These reserves may promote increased growth and gamete production and increased survivorship. Pre-smolts move downstream relatively rapidly, however, limiting the time that this prey resource is available. For smaller bull trout, especially those that are about the same body size or smaller than the pre-smolts, release of the pre-smolts introduces a large number of fairly homogeneous competitors for food and space into Icicle Creek and downstream areas of the Wenatchee and Columbia Rivers. For these bull trout, rapid downstream movement by this swarm of competitors helps to minimize the duration of competitive interactions. Passage of the pre-smolts may deplete some prey resources, such as some macroinvertebrates, and rebuilding of this macroinvertebrate prey base may not occur for a prolonged period after the pre-smolts have emigrated. Small bull trout confronted with depleted prey resources may move away from familiar territories in search of food. These movements may expose juvenile bull trout to increased predation risk. The potential for bull trout in all life stages to contract diseases from hatchery pre-smolts is unknown.

The Service believes that all these effects on bull trout associated with pre-smolt release are likely to occur. While little information is available to allow us to evaluate the consequences of these effects to bull trout, we conclude that, based on our expectation that pre-smolts move downstream relatively rapidly, effects to bull trout exposed to pre-smolt releases are likely to be insignificant effects.

E. Effects of Operation of Structures 2 and 5 (PE 4)

As described in the BA, two instream structures (structures 2 and 5) in the historical channel of Icicle Creek are important for managing a variety of hatchery operations, and the LNFH has proposed a new operational approach for structures 2 (rm 3.8) and 5 (rm 2.8) beginning in 2011 to improve passage opportunities for bull trout. Essentially, structures 2 and 5 will always remain open except under the 5 discrete conditions (see Table 1): (1) 50 returning adult spring Chinook salmon pass upstream of structure 5 during broodstock collection (mid-May through early July), (2) stream flow through the hatchery channel is not sufficient to promote pre-smolt emigration during release (late April), (3) stream flow in the hatchery channel has not been sufficient enough to recharge the shallow aquifer and hatchery well production is affected (August through March), (4) high stream flows are endangering downstream infrastructure (spring runoff and rain on snow events), or (5) during maintenance of Structure 5.

<u>Direct Effects to Bull Trout</u>

To assess the potential impacts of PE 4 to bull trout, we need to first revisit the distribution and abundance of bull trout in the areas influenced by PE 4 (see the Environmental Baseline, section *E. Bull Trout Distribution and Abundance in the Action Area*). We previously described that a maximum of 125 bull trout have been observed in the LNFH spillway pool and 64 bull trout in the historical channel between rm 2.8-3.8 (see Table 3). The size of bull trout observed in surveys (from rms 0-5.6) in 2010 ranged from 130 to 650 mm, indicating that juvenile, subadult, and migratory bull trout are present.

Second, we need to describe the mechanisms of direct effects to bull trout that result from PE 4. The primary effect of PE 4 is that when structures 2 or 5 are closed, upstream or downstream passage is impeded or prevented; there is potentially some downstream passage when structure 2 is closed and water is spilling over the spillway dam. The secondary effect of PE 4 is that when structure 2 is closed, most of the water in Icicle Creek is directed into the hatchery channel, resulting in a variety of impacts associated with reduced streamflow in the historical channel.

Third, we need to describe the frequency and duration of the mechanisms of effects that result from PE 4. Table 1 summarized the five conditions in which structures 2 or 5 may be closed. The most important condition in which closure may occur in terms of the life history expression of bull trout (i.e., closure if >50 Chinook pass upstream of structure 5 during the BSC period) is also the condition with the greatest amount of uncertainty. An important consideration in evaluating any closure of structure 2 is the rate of closure. The LNFH slowly ramps the closure of structure 2 over a period of many hours or days for a variety of reasons. A slow ramping rate reduces the likelihood of stranding bull trout, and allows changes in habitat (less water in the historical channel corresponds to decreased habitat availability) to occur gradually.

Another consideration is the amount of flow in the historical channel versus the hatchery (outfall, ladder, and over the spillway) during this period, which was controlled at structure 2. Information from the LNFH (2-24-11 conference call) suggested about 1,000 cfs was discharged from the hatchery channel, 300 cfs from the historical channel, and about 50 cfs from the hatchery discharge during BSC. So despite a attractant flow in the historical channel and structure 5 being fully open, the vast majority of Chinook (about 11,000 fish returned to the LNFH, a record year) appeared to cue in on the hatchery instead of accessing the historical channel. By the end of July 2010, only 43 Chinook (live and carcasses) were discovered by LNFH staff to have passed upstream of structure 5. Although this is only a single year of observations, and flows were controlled at structure 2, this suggests over 99% of all returning Chinook are strongly attracted to the hatchery (perhaps because of lower temperatures and olfactory cues) and that the likelihood of exceeding the 50 Chinook “trigger” for closure is low. Under this scenario, upstream passage opportunities for bull trout past structure 5 are essentially unimpaired during their upstream migration to spawning habitats and probably represents the best-case scenario.

The worst-case scenario is that the >50 Chinook trigger is achieved early in the BSC period, structure 5 would be closed and would remain so until July 7 (the end of the BSC period), limiting upstream passage opportunities for bull trout. To close structure 5 (i.e., installing the picket gates and traps), structure 2 must be almost completely closed to manage the flow in the historical channel to protect these structures. Although we are uncertain of the response of Chinook to higher flows during the BSC period (i.e., the proposed action states structure 2 would not be closed for BSC as has been the case in the past), we generally expect more Chinook to access the historical channel at higher flows. In addition, as the total amount of flow in Icicle Creek increases during the early portion of the BCS period (as the typical hydrograph suggests), it seems reasonable to assume that the cues that attracted Chinook to the hatchery will become more "diluted" as increasing large volumes of streamflow from the historical channel are mixed with relatively fixed amounts of water discharged from the hatchery outfall and ladder. Water discharged over the spillway would likely resemble water discharged from the historical channel, and would not include the cues associated with the hatchery (i.e., colder water from groundwater wells, olfactory cues from hatchery production). This suggests, with an acknowledged high degree of uncertainty, that closure of structure 5 could occur fairly early in the BSC period. For the purposes of this BO, we estimate closure of structure 5 will occur on June 3 (see Figure 4 for reference and the illustration of the Icicle Creek Conceptual Passage Window) due to >50 Chinook passing upstream of structure 5. If it is necessary to block upstream passage for an extended period of time (for more than one week during the BSC period), LNFH will operate fish traps in structure 5 to capture bull trout and manually move them upstream of structure 2. Although the adaptive management group may be able to agree to open structure 5 before July 7, this is not guaranteed so we will assume once it is closed, structure 5 will remain closed through the remainder of the BSC period.

As the hydrograph increases, structure 2 may be closed during this same period due to another condition, high flows (i.e., when the water level in the historical channel is one foot from the bottom of the bridge deck at structure 5) from spring run-off. Although the exact timing of the closure of structure 2 due to high flows during the BSC period varies annually with the hydrograph, we can estimate this through review of USGS gauge station data. For the period of 1998-2009, peak flows in the Icicle (USGS gauge 12458000 above Snow Lakes) occur approximately late-May to early June, although there is considerable variability between years. As the hydrograph begins to peak, this likely triggers the closure of structure 2 due to high flows. For the purposes of this BO, we estimate the closure of structure 2 will occur on June 3 (see Figure 4 for reference and the illustration of the Icicle Creek Conceptual Passage Window) due to high flows. Re-opening of structure 2 occurs after the hydrograph peaks and begins to descend. Similarly, review of USGS gauge station data can inform the approximate date in which structure 2 is re-opened. For the period of 1998-2009, flows generally decline to a point where structure 2 can be re-opened by the end of second or third week of June, although there is considerable variability between years. For the purposes of this BO, we estimate that structure 2 may be re-opened by June 24.

Combining the anticipated closures of structures 2 and 5 during the BSC period, we summarize the chronology of passage impacts (worst-case scenario) as follows:

1. Before June 3, bull trout have passage opportunities past structures 2 and 5.
2. Beginning June 3, passage is blocked at structure 5 due to the >50 Chinook "trigger." Alternate passage would be provided by the installation of traps at structure 5.
3. Beginning June 3, passage is blocked at structure 2 to control high flows (spring run-off)
4. Beginning June 24, structure 2 will be re-opened, allowing for the upstream passage of bull trout that are above rm 2.8.
5. Beginning July 7, structure 5 will be re-opened and upstream passage opportunities between rm 2.8-3.8 would be restored.

A number of assumptions were made to derive this chronology, and we acknowledge we have simplified many ecological parameters. Sources of variability include the timing and number of the spring Chinook returning to the LNFH; annual variation in the discharge amount, timing, and duration of total streamflow in Icicle Creek; and the actual response of Chinook to increased flows in the historical channel and how that may influence whether the >50 Chinook trigger is achieved. Nonetheless, this represents our best estimate and helps illustrate the relative effect of the anticipated closures of structure 2 and 5 to bull trout. We estimate the impacts of the anticipated closures of structures 2 and 5, where volitional passage is not possible, are likely to occur over a period of June 3-July 7 (about 4 weeks). However, traps installed at structure 5 may allow manual passage (i.e., by trapping and hauling bull trout to a release point upstream of structure 2) between June 3-July 7.

Considering the other natural and human impediments to passage upstream of structure 2 and 5 (as previously described in the Environmental Baseline), our use of bull trout upstream passage timing at Tumwater Dam (as a surrogate for the timing of upstream bull trout migration in Icicle Creek), and the conceptual passage window for bull trout in Icicle Creek, we estimate that the total possible passage window (excluding all LNFH actions) to be about 7 weeks (see Figure 4). This defines a migration period specific to Icicle Creek which accounts for natural features impeding passage (e.g., the Boulder Falls at rm 5.6) and human activities (e.g., IPID actions, rm 5.7) over a range of high and low flows. This suggests two short windows for upstream bull trout passage: about one week before high flows and about 6 weeks prior to low flows.

Including the passage impacts of the anticipated closures of structures 2 and 5 (June 3-July 7, about 4 weeks), the possible passage window is reduced from 7 weeks to about 4 weeks. This accounts for the anticipated closure of structures 2 and 5 over the period June 3-July 7 under a worse-case scenario. Traps will be installed at structure 5 and provide manual passage opportunities through “trap and haul,” but to date they appear to be ineffective. Data provided by the LNFH show that while a number of other fish species were captured in previous efforts, no bull trout have ever been trapped.

Reducing the upstream passage opportunities for bull trout from 7 weeks to 4 weeks significantly impairs the expression of the migratory form, and a significant disruption of normal behavior. As described in the Environmental Baseline, as many as 125 bull trout have been observed in the hatchery pool at rm 2.8. Earlier estimates suggested only about 20 are thought to be bull trout from the Icicle local population, and the majority of these 125 individuals are believed to be from other local populations. A more precise estimate of the number of Icicle fish anticipated may be inferred from using the maximum number of fish known to spawn in the upper Icicle (n=16, based on 8 redds in 2008, which corresponds to 16 adults). Our assessment is the closure of structures 2 and 5 over the period June 3-July 7 (combining closures for high flows and >50 Chinook passing upstream of structure 5) affects 16 migratory bull trout by delaying or preventing their upstream migration to spawning habitats. It is important to note that when structure 2 is closed, it is almost never a complete closure (it is more accurate to say the radial gates are “lowered” to some degree). This suggests bull trout may be able to pass upstream of structure 2 under some flow conditions (i.e., not too high or too low) if they have already past upstream of structure 5. This suggests the nature of the effect is primarily a delay of the upstream migration of bull trout to their spawning habitats. This likely reduces the probability of successful spawning, affecting the numbers, distribution, and reproductive potential of the Icicle Creek local population. However, spawning has been documented in 2008-2010 in response to the modified operational conditions of PE 4. The proposed action should further improve passage opportunities, and consequently, we expect the numbers of adult bull trout to spawn successfully to continue to increase, and improve the reproduction, distribution, and abundance of bull trout in the Icicle Creek local population. While we expect this to occur, we cannot

Bull trout other than migratory adults are also impacted by all conditions that lead to the closures of structures 2 and 5 (see Table 1). Other adults (from other local populations or perhaps those from the Icicle local population that may not be spawning in a given year due to alternate-year spawning or a variety of other factors), subadults, and juveniles would also have their normal movement patterns and behavior altered. Most of these fish would likely be using the lower Icicle area as FMO habitat. As previously described, large numbers of bull trout (n=125) have been observed using the LNFH spillway pool, perhaps as thermal refugia, holding, and foraging habitats. Use of the historical channel is also relatively high (n=64) between rm 2.8-3.8. But “isolation” of bull trout above, below, or between closed structures for a relatively short period of time is not expected to result in adverse effects, except during August aquifer recharge (see “Effects to Habitat Indicators” below).

Downstream passage of bull trout in the historical is also affected when structures 2 and 5 are closed under all conditions (see Table 1), but the magnitude of this effect is smaller than the impacts to upstream migration in terms of implications to life history expression. Bull trout above structure 2 or 5 that would otherwise move downstream (but encounter a closed structure) are most likely emigrating subadult and juvenile fish (or were unable to seek refuge from high flows and were carried downstream), but may be adults as well. Most downstream moving bull trout are anticipated to be engaged primarily in FMO behaviors. While impairing their volitional movement, impacts may be insignificant so long as no direct injury, or modifications of normal behavior that are so severe or significant that they may lead to injury, occurs. One consideration, as we have experienced in many irrigation diversion consultations and other water management projects, is the potential for impingement of bull trout on structure 2 and 5 when they are closed. While we have no information documenting that this is occurring, we may also not have specifically investigated this possibility, nor is this an easy event to monitor. Structure 2 is rarely completely closed, so passage through the structure is possible under certain flow conditions (i.e., not too high or too low), at least for strong-swimming migratory bull trout (but juveniles and sub-adults may not be able to ascend structure 2 over a range of flows). The picket gates that “close” Structure 5 have gaps between the pickets, so smaller bull trout (juveniles and subadults) are likely to be able to pass through them but larger bull trout (adults) may not. Until we have more information, we suggest impingement of bull trout on structures 2 and 5 when they are closed is a possibility but at this point are not anticipating adverse effects.

The effects of closure of structure 2 to increase flows in the hatchery channel to facilitate aquifer recharge (and hatchery groundwater well use) are variable and depend on the timing. Normally, structure 2 is closed in October and/or March (one or more times, when streamflow in the Icicle is less that 300 cfs above rm 3.8) for aquifer recharge, but may occur as early as August. In August, habitat conditions in the historical channel are probably at their most degraded; streamflows are at or near base flows, temperatures are high, and habitat availability, access, and quality are reduced with decreased streamflow. September often brings cooler temperatures and precipitation, which begins to ameliorate the degraded conditions anticipated in August, and is generally considered adequate. October through March typically displays cool temperatures and rain and snow precipitation, so habitat conditions are adequate. All life history stages of bull trout are likely present and are anticipated to be exhibiting FMO behaviors in September through March, but the relatively short duration and low impact of these actions (even if they occur multiple times) are unlikely to produce direct adverse effects. Normal behavior of bull trout is likely altered by restricting their movement (through the closure of structure 2), but this impact is minor due to their relative flexibility in selecting the location, frequency of use, and duration of use of FMO habitats (i.e., bull trout have 1 mile of FMO habitat to use, and are not necessarily tied to any one location). In August, closure of structure 2 for aquifer recharge exposes all life history stages of bull trout in the historical channel to substantially reduced habitat quality and availability. While no direct adverse effects are anticipated (e.g., due to stranding), adverse effects are anticipated due to reduced habitat conditions; these impacts are discussed below by Matrix indicator.

Closure of structure 2 for other high flow events (e.g., rain-on-snow) occurs at a period of time (typically winter) that is less sensitive than bull trout upstream migration. All life history stages of bull trout are likely present and are anticipated to be exhibiting FMO behaviors. Under all high flow conditions, bull trout likely seek refuge from high flows in deep pools, off-channel habitats, and other complex features. The duration of closure depends on the timing and discharge of the high water event, but probably will not exceed two weeks. Since the ramping rates are slow, no direct adverse effects are anticipated due to stranding. Normal behavior of bull trout is likely altered, but this impact is minor due to their relative flexibility in selecting the location, frequency of use, and duration of use of FMO habitats. Habitat impacts by Matrix indicator are discussed below.

The other conditions for closure are better known in terms of frequency and duration. Closure of structure 2 (which reduces flows into the historical channel) provides safe working conditions to conduct maintenance of structure 5. This typically occurs once or twice a year in the fall or winter, and may last one week per event. The BA does state that the frequency of maintenance may increase as the extent of time structure 2 is opened increases. Ordinarily the maintenance of the structure is routine, including the removal of large woody debris with heavy equipment. Large woody debris is removed from upstream side of structure 5 and placed back into Icicle Creek on the downstream side. All life history stages of bull trout are likely present and are anticipated to be exhibiting FMO behaviors, but the relatively short duration and low impact of these activities are unlikely to produce direct adverse effects. Normal behavior of bull trout is likely altered, but this impact is minor due to the relative flexibility in selecting the location, frequency of use, and duration of use of FMO habitats. Bull trout that are exposed likely displace to nearby habitats. Personal experience in surveying and capturing bull trout suggests that even when you repeatedly pursue bull trout (snorkeling and with hand nets) they typically retreat only a short distance. This suggests the degree of exposure may be fairly constant, but our estimation of the magnitude of these effects in low.

Similarly, closure of structure 2 to increase flows in the hatchery channel and facilitate pre-smolt release is not expected to result in direct adverse effects to bull trout. This occurs every year about the third week in April and lasts for 7-10 days. Salmon smolts use physiological and environmental (spring runoff) cues to initiate their downstream migration. It is beneficial for hatchery pre-smolts to emigrate quickly to reduce potential interactions with non-hatchery fish and to take advantage of fish passage spills at mainstem Columbia River dams. Pre-smolt release occurs when all life history stages of bull trout are likely present and are anticipated to be engaged in FMO behaviors, but the relatively short duration and low impact of these activities are unlikely to produce direct adverse effects. Normal behavior of bull trout is likely altered, but this impact is minor due to the relative flexibility in selecting the location, frequency of use, and duration of use of FMO habitats. The effects of pre-smolt release are described in detail in section *D. Effects of Pre-Smolt Release (PE 3).*

Summary of Direct Effects to Bull Trout from PE 4
The preceding text estimates direct effects to bull trout include adverse effects that stem from impaired passage conditions, and are summarized in Table 15.

Table 15. Summary of direct effects to bull trout from PE 4. All direct effects are a result of impaired passage conditions.

Life History Stage	Lethal Effects	Sub-lethal Effects
Migratory bull trout	0	16
All other bull trout	0	0
Total	0	16

In Table 15, "migratory bull trout" are those that seek to spawn in upper Icicle Creek; "all other bull trout" include all other adult, subadult, and juvenile bull trout.

Effects to Habitat Indicators

To identify the impacts of PE 4 to habitat indicators, we used the information in the BA and developed Table 12 to illustrate the relative effects of Project elements. We anticipate PE 4 will impact the following Matrix indicators: *temperature, physical barriers, substrate embeddedness, large woody debris, pool frequency and quality, large pools, off-channel habitat, refugia, width:depth ratio, floodplain connectivity, peak and base flows, road density and location, riparian conservation area/riparian reserves, disturbance history,* and *disturbance regime.* Habitat effects of PE 4 are most pronounced between rm 2.8-3.8, but may have downstream effects (although they expected to be insignificant). The following describes the effects in detail, with the most impacted indicators described first.

Change in Peak and Base Flows
Effects to the *peak and base flows* indicator are related to the closure of structure 2. Peak flows are controlled through the closure of structure 2 during high-water events, which likely moderate key channel and habitat forming processes in the historical channel. Base flows in the historical channel are similarly manipulated, especially during aquifer recharge in August (i.e., when base flows are further reduced when the majority of water in Icicle Creek is diverted into the hatchery channel for 15 or more days). Streamflow is considered a "master variable" (Poff et al. 1997) that is correlated with many indicators in the MPI . The net effect is that the control of streamflow through the manipulation of structure 2 directly impacts a large number of other indicators: *temperature, substrate embeddedness, large woody debris, pool frequency and quality, large pools, off-channel habitat, refugia, width:depth ratio, floodplain connectivity, and*

riparian conservation areas/riparian reserves, and informs the potential effects to other indicators (*disturbance history,* and *disturbance regime*) related to watershed condition. For the sake of presenting a systematic analysis of Project effects, we have subdivided the effects of PE 4 into the discrete Matrix indicators, but in reality many of these indicators interact to some degree.

The result of effects to the *Peak and Base Flow* indicator is likely a variety of degraded habitat conditions in the historical channel; normal channel and habitat forming processes (i.e., that occur during peak flows) are unable to be fully expressed, and base flows are further reduced (and are likely most amplified in the *temperature* indicator) which limits habitat availability and quality. For these reasons, we anticipate adverse effects to the *peak and base flow* indicator due to impacts in the historical channel due to the periodic closures of structure 2. As described in the *physical barriers* indicator above, the timing and duration of the closures of structure 2 are substantial, although the adaptive management group may be able to substantially reduce the number of days.

Bull trout response to degraded habitat conditions likely varies with the timing and duration of closure of structure 2, but none is more important than aquifer recharge in August. During this period, streamflow in the historical channel is low and closure of structure 2 will further reduce flows. Reduction in flow impacts a number of other indicators; with decreased flow, we expect:

- temperatures to increase (causing physiological stress)
- width:depth ratio to increase (resulting in increased competition for space)
- pool quality to decrease (by decreasing pool depth)
- access to off-channel habitats to decrease (potentially limiting foraging opportunities)

We expect bull trout in the historical channel in August (estimated n=64) to be adversely affected in response to these degraded habitat conditions, but we do not anticipate direct mortality. Migratory bull trout attempting to spawn in upper Icicle Creek (estimated n=16) may also be present in the historical channel during August, but we believe that upstream passage above rm 5.7 is not possible most years due to low-flow conditions. For the purposes of this BO, any migratory bull trout that failed to make their upstream migration by August are considered a sub-set of the total of 64 bull trout expected to be present in the historical channel (i.e., the 16 migratory bull trout are not additive to the 64 bull trout; see the Environmental Baseline). Many of these effects are qualitative, since specific information on the degree of degradation is not available. But in all cases, it is reasonable to assume that these impacts will occur and that they result in a significant disruption of normal behavior. In response to degraded habitat conditions that result from August aquifer recharge, some bull trout may move downstream to seek reprieve (e.g., the hatchery spillway may provide refuge) but others may not. Some juvenile and subadult bull trout may stay in the historical channel, since they in all likelihood originate from the upper Icicle. Not being strong swimmers, they are less likely to be able to negotiate upstream passage above structure 2, the boulder falls, and the IPID diversion versus adult bull trout. They also likely lack the strong instincts of adults to move long distances and are more likely to stay in the historical channel until the next high flow event encourages downstream emigration (see Downs et al. 2006 for reference of emigration patterns). Bull trout response to degraded habitat conditions outside of August is likely measureable, but habitat is not so degraded during this period that significant impairments of normal behavior are anticipated.

Temperature
Effects to the *temperature* indicator occur when structure 2 is closed, thereby diverting the majority of the streamflow of Icicle Creek into the hatchery channel. Temperature conditions in the historical channel between rm 2.8-3.8 (the area influenced by the closure of structure 2) are anticipated to increase with decreased streamflow, especially in the summer months. Minimum flows in the historical channel are approximately 20 cfs, and would include the cold water supplemented by releases from Snow and Nada lakes. However, temperature data from 2005 through 2010 (Hall and Kelly-Ringel 2011), estimated a mean high 7DADmax in Icicle Creek of 16.7 °C in the headwaters and 19.1 °C at the mouth. These temperatures are above the 15 °C reported to limit bull trout distribution (Allan 1980, Brown 1992b, Fraley and Shepard 1989, Goetz 1991, BioAnalysts 2004).

The effects to the *temperature* indicator and bull trout in the historical channel in August are likely to be adverse. High stream temperatures can cause direct mortality, increased susceptibility to disease or other sublethal effects, displacement by avoidance (McCullough et al. 2001, Bonneau and Scarnechia 1996), or increased competition with species more tolerant of warm stream temperatures (Rieman and McIntyre 1993; Craig and Wissmar 1993 cited in USDI (1997); MBTSG 1998). While it appears that high (>15 °C) summer temperatures may occur naturally in Icicle Creek, closure of structure 2 in August for aquifer recharge (typically lasting for 15 or more days) likely exacerbates this condition.

Washington State Water Quality Criteria for lower Icicle Creek specify 16 °C as the expected 7DADMax for "core summer salmonid habitat" (WDOE 2008b). Past temperature monitoring (Hall and Kelly-Ringel 2011) suggests this criterion may be exceeded in the historic channel, even when aquifer recharge is not occurring. We believe that bull trout exposed to temperatures between 16 and 18 °C will experience sub-lethal adverse effects (Selong et al. 2001; USFWS 2008b). Selong et al. (2001) found bull trout exposed to 18 °C water over a 60 day period experienced 2% mortality; 60-day exposure to 20 °C water resulted in the first mortality in 5 days, and 21% mortality of age class 0 and 47% mortality of age class 1 bull trout.

Based on the temperature data summarized by Hall and Kelly-Ringel (2011), we anticipate August temperatures in the historical channel may be as high as 19 °C, but the cold water supplemented from Snow and Nada lakes would likely reduces this to 18 °C. This suggests bull trout in the historical channel when August aquifer recharge begins are already in water that is 18 °C, near where lethal limits begin, and that water temperature will increase through time so long as structure 2 is closed and streamflow is reduced in the historical channel. Structure 5 is open in August, so volitional movement downstream is possible. Non-spawning migratory adult bull trout are expected to seek refuge locally or move downstream to temperature refugia. Migratory bull trout moving upstream in toward the end of their migration period (but may have missed their upstream passage opportunity due to physical, temperature, and flow barriers) may remain in the historical channel following their instincts to spawn upstream. Juvenile and subadult bull trout are the life history stage most likely to remain in the historical channel, since they are most likely of upper Icicle origin (i.e., they are closely tied to their natal spawning and rearing areas; most significant movements are downstream). In any case, all bull trout remaining in historical channel are likely taking advantage of discrete, local features (e.g., deep pools, areas of upwelling, etc. which either supply or retain cold water) to moderate the impact of warm water conditions. In addition, the period of August aquifer recharge is much shorter than the 60 day experiment conducted by Selong et al. (2001), so severity of potential effects is expected to be less. Incorporating the above considerations, we suggest that the impacts to the *temperature* indicator, and effects to bull trout, will remain sub-lethal so long as temperatures in the historical channel do not exceed 19 °C during August aquifer recharge.

We believe that the closure of structure 2 in August for up to 15 days (or more) will adversely affect all bull trout in the historical channel (n=64) by significantly impairing normal behavior, sub-lethal physiological effects, and increased competition with other species. Migratory bull trout attempting to spawn in upper Icicle Creek (estimated n=16) may also be located in the historical channel during August, but we believe that upstream passage above rm 5.7 is not possible most years due to low-flow conditions. For the purposes of this BO, any migratory bull trout that failed to make their upstream migration by August are considered a sub-set of the total of 64 bull trout expected to be present in the historical channel (i.e., the 16 migratory bull trout are not additive to the 64 bull trout; see the Environmental Baseline). The severity of these adverse effects would be even greater if not for the conservation measure of releasing the cold Snow and Nada lakes water into Icicle Creek from July to October.

Physical Barriers

Effects to the *physical barriers* indicator occur whenever structures 2 and 5 are closed. As described above, structures 2 and 5 are closed only when five conditions are met (see Table 1). To assess the impacts to the *physical barriers* indicator, we evaluate man-made barriers and to what degree they allow for bull trout passage across a range of flows. The effect to the *physical barriers* indicator is the mechanism by which direct effects occur in this Matrix analysis, which is the same mechanism for effect in assessing direct effects to bull trout. These analyses are very similar and affect the same bull trout previously described in direct effects of PE 4. We briefly summarize effects here in keeping with the organizational approach of the Matrix.

According to the BA and previous sections in this BO, closures are anticipated to occur for a number of reasons every year. Under the worst-case scenario, structures 2 and/or 5 would be closed every year for pre-smolt release (10 days typically beginning the third week of April), during the BSC period when high flows and >50 Chinook passing upstream of structure 5 are anticipated to occur (June 3-July 7, or 35 days), during aquifer recharge (facilitating the use of groundwater wells) one or more times in August-March (15 or more days per event; assume two events or about 30 days), other high flow events in the winter (e.g., rain-on-snow, about 14 days), and maintenance of structure 5 (assume two events, about 14 days). This suggests that the *physical barrier* indicator may be adversely affected about 103 days a year across a range of flows under a worst-case scenario.

Although we expect the total days of closure to be less than 103 days due to the history thus far of the adaptive management group (which has been steadily improving passage opportunities during BSC), we cannot precisely estimate this nor be certain a reduction in the number of days of closure will occur given the specific circumstances of any given year. We are also optimistic that the >50 Chinook trigger will not be achieved most years, and if the maintenance of structure 5 and aquifer recharge only occur once a year instead of twice a year, then the number of days of total closure might be reduced to about 60 days. But again, we cannot be reasonably certain this will occur for the purposes of this BO.

Peak and Base Flow
The following sections describe the effects to other indicators that largely stem from impacts to the *peak and base flow* indicator (resulting from the closure of structure 2). While these effects are measureable, we do not anticipate adverse effects to these indicators. The following effects are not large enough in duration, frequency, or magnitude, as compared to the Environmental Baseline, to suggest adverse effects will occur. While the response of bull trout to changed habitat indicators may include the alteration of normal behaviors, including the modified use of habitat, we do not anticipate adverse effects to individual bull trout beyond that described in the effects to the *peak and base flow, temperature*, and *physical barriers* indicators.

Substrate Embeddedness
Effects to the *substrate embeddedness* indicator result from a manipulation of a natural sediment regime through the closure of structure 2. This has likely manifested itself in the alteration of sediment transport and deposition processes, and has resulted in at least the partial filling of pools and increased embeddedness of the interstitial spaces of substrate. This in turn can reduce the availability of habitat for macroinvertebrate prey, and reduces cover for small, substrate-oriented bull trout. Many important sediment processes occur at peak, high, and moderate flows, including transport and "flushing" of accumulated sediments in depositional reaches. However, these LNFH effects are expected to be minor, due in part to the fact that Icicle Creek is naturally a high-sediment watershed (see the Environmental Baseline for reference) and the degree of impact to the *substrate embeddedness* indicator that is directly attributable to LNFH is likely small. We expect that LNFH influences on the sediment regime are small since the closure of structure 2 has the effect of reducing the magnitude of peak flows, but still allows sediment processes to occur in the historical channel at high (but not peak) and moderate flows.

Large Woody Debris
Effects to the *large woody debris* indicator are anticipated to occur because large wood dynamics may be altered by structures 2 and 5. This essentially interrupts the normal processes of large wood in fluvial processes. Large woody debris is important in providing cover and habitat complexity, but also in habitat-forming processes such as pool creation. Structure 2 does not pass most larger-sized large woody debris (LWD) because water cannot spill over the crest. Water is forced through small openings that are generally submerged and through which only smaller-sized debris can pass. Given how the gradient changes downstream of rm 3.8, as Icicle Creek emerges from the canyon upstream, this area probably used to accumulate LWD that was flushed from the upper basin. The resulting lack of LWD in the historic channel inhibits pool development, limits hiding cover, and restricts habitat complexity downstream. Most LWD from upper Icicle Creek is "blown out" of the system during high flows via the hatchery channel (since structure 2 is closed in high flow events) and over the spillway, and does not remain in the reach that flows past the LNFH in the hatchery or the historic channels. Under the proposed action, these conditions will not change. Structure 5 tends to accumulate large concentrations of the smaller sizes of debris passed LWD. Maintenance activities generally consist of removing LWD from the upstream side of structure 5 with heavy equipment (located on top of structure 5) and placing it back into Icicle Creek on the downstream side. This suggests LWD processes still

function in the historical channel, but may lack the larger-sized LWD, and may be temporarily interrupted by accumulation at structure 5. Overall, we consider LNFH impacts to the *large woody debris* indicator minor in effects to LWD process, but note an important reduction in larger-sized LWD.

Pool Frequency and Quality and *Large Pools*
Effects to these two indicators are combined under a single heading since *pool frequency and quality* and *large pools* are fairly similar. As described above, an altered flow regime has resulted from the operation of structure 2, which has impacted sediment transport and depositional processes, as well as habitat-forming processes during peak flows. *Pool frequency and quality* has been impacted through at least the partial filling of pools, with the overall condition of this indicator being assessed as "functioning at unacceptable risk" (see the Environmental Baseline). Pools in the historical channel, especially large pools, are important for bull trout for many reasons including thermal refugia. Large, deep pools may by one of the more important features in the historical channel in terms of seeking refuge when water temperatures are >15 °C. In addition to pools filling with sediment, the closure of structure 2 during base flows (i.e., August aquifer recharge) reduces the amount of streamflow in the historic channel and essentially reduces the depth of all pools between rm 2.8-3.8. LNFH impacts to these indicators are measureable, and may affect the normal behaviors patterns of bull trout. But the overall effects to these indicators are expected to be minor, due in part to the fact that Icicle Creek is naturally a high-sediment watershed (see the Environmental Baseline for reference) and the degree of impact to the *substrate embeddedness* indicator that is directly attributable to LNFH is likely small. Effects associated with the reduction of the depth of pools (e.g., temperature) are described above in the effects to the *temperature* indicator.

Off-Channel Habitat
Effects to the *off-channel habitat* indicator are anticipated to occur when both high and low flows are controlled at structure 2. When high flows (spring run-off and rain-on-snow events) require the closure of structure 2, natural channel-forming processes and river access of its floodplain are altered. Off-channel habitats may be created or accessed, but they likely occur in different locations or to a different extent since flows are controlled. During the summer, when aquifer recharge occurs, already low flows would be further reduced and likely decreases bull trout access to off-channel habitats. This may occur in August, during a period when stream temperatures likely exceed >15 °C, so impacts to bull trout may be relatively minor. Although nighttime foraging (when daily temperatures are at their lowest) by bull trout may occur in off-channel habitats, we expect the majority of bull trout to seek the coolest habitats (e.g., pools, areas of upwelling). Overall, we expect effects to the *off-channel habitat* indicator, and bull trout response, to be minor.

Refugia
Effects to the *refugia* indicator are anticipated to minor. Evaluation of this indicator in terms of Matrix criteria involves consideration of many habitat characteristics to assess to what degree "habitats capable of supporting strong and significant populations are protected and are well distributed and connected for all life stages and forms of the species." The overall condition of this indicator is "functioning at risk" (see the Environmental Baseline section for reference) and the primary use of the historical channel by bull trout is primarily for FMO behaviors. Operation

of structures 2 and 5 and the anticipated effects to *refugia* are difficult to detect in such a multi-facetted indicator. We expect habitat conditions for bull trout to be generally degraded in the historical channel, especially during August aquifer recharge, but we also suggest that the spatial and temporal habitat use by bull trout has improved with the supplementation of cold Snow and Nada lakes water. Other areas in the action area above rm 5.7 are not affected by LNFH and are important considerations in the function of the *refugia* indicator. Overall, we expect the effects of PE 4 to the *refugia* indicator to be comparatively small at the action area scale.

Width:Depth Ratio
Effects to the *width:depth ratio* indicator are anticipated to occur primarily when structure 2 is closed for August aquifer recharge. Streamflow conditions are low during this period, and closure of structure 2 further reduces flow. Reduced flow can alter the width:depth ratio of a stream. The historical channel resembles a Rosgen C-type channel, characterized by moderate to high sinuosity, low gradient, and slight entrenchment. We expect reduced flows from aquifer recharge to increase the width:depth ratio, indicating degraded habitat conditions (e.g., warmer temperatures, less habitat access to off-channel habitat, etc.). The specific effects due to increased temperature were described above; direct effects to the *width:depth ratio* indicator are comparatively small at the action area scale.

Floodplain Connectivity
Similar to the *off-channel habitat* indicator, effects to the *floodplain connectivity* indicator are anticipated to occur when both high and low flows are controlled at structure 2. When high flows (spring run-off and rain-on-snow events) require the closure of structure 2, natural channel-forming processes and river access of its floodplain are altered. Many structures and features in the watershed (e.g., roads, weirs, surface water diversions, etc.) confine floodplain connectivity, including structures 2 and 5. Effects may include reduced linkage of wetlands and other hyporheic flows, reduced frequency of overbank flows, and reduced access of Icicle Creek to its channel migration zone. This indicator is related to the *peak and base flow* indicator, since the majority of channel migration occurs at peak flows. But while floodplain connectivity is degraded, and this is maintained by the O&M of structures 2 and 5, impacts in the historical channel due to PE 4 are considered relatively minor. The area of influence of structures 2 and 5 (i.e., the historical channel from rm 2.8-3.8) is small compared to the entire action area and this area still resembles a Rosgen C-type channel, and fluvial processes can still occur at high (but not peak) and moderate flows. While the full expression of this channel type is likely suppressed, it continues to function reasonable well. Overall, we expect the effects of PE 4 to the *floodplain connectivity* indicator to be relatively small.

Road Density and Location
Effects to the *road density and location* indicator are anticipated to be minor. Although not specifically described in the BA, there are roads associated with access to structures 2 and 5. Their use and maintenance likely have some impact to the *road density and location* indicator, but some of these impacts may have already been described by other indicators (e.g., *substrate embeddedness, floodplain connectivity*, etc.). Roads can contribute fine sediment (either directly to streams or through drainage networks of ditches and cross drains) and their location can reduce floodplain function. However, personal observations of access roads to structure 2 suggest impacts are minor. The access road between the hatchery and historical channels may

contribute some sediment into Icicle Creek, be this may not be detectable in this high-sediment watershed. The largest potential impact of LNFH roads may be confinement of the floodplain, which was previously described in the *floodplain connectivity* indicator. Overall, we consider the impacts of PE 4 to the *road density and location* indicator to be minor.

Riparian Conservation Areas/Riparian Reserves
Effects to the *riparian conservation areas/riparian reserves* indicator are anticipated to be minor. Like the *refugia* indicator, the *riparian reserve* indicator considers the condition of many habitat characteristics and processes. The Matrix criterion for this indicator assesses shade, large woody debris recruitment, habitat protection and connectivity, buffers from land management, and similarity of riparian vegetation to the potential natural community/composition. The physical structures of PE 4 and their O&M occur within riparian reserves, but most impacts are related to in-water effects. The CWFO is only aware of one fuel reduction project on LNFH land (USFWS reference 1-9-2003-I-W0222) that may have had direct impacts to riparian vegetation structure and composition, but the outcome of that consultation was "no effect" to aquatic species and their habitats. We suggest that while effects of the O&M of structures 2 and 5 do occur within the riparian reserve of Icicle Creek, in-water impacts are better analyzed in the other indicators above. Overall, we consider impacts to the *riparian conservation areas/riparian reserve* indicator to be minor.

Disturbance History
Effects to the *disturbance history* indicator are anticipated to be minor. O&M of structures 2 and 5 represent an annual moderation of peak flows (i.e., spring run-off and rain-on-snow events) and a further reduction of low flows when aquifer recharge occurs in August. The criterion for the *disturbance history* indicator characterizes the degree of human perturbation in the action area, as compared to the Environmental Baseline. While we acknowledge annual effects to the *disturbance history* indicator due to PE 4, another indicator that considers multiple habitat conditions and processes, the highest magnitude of impacts that result may be better analyzed in the *temperature* and *peak and base flow* indicators above. Overall, we expect impacts to the *disturbance history* indicator to be annual, but have a low magnitude of effect.

Disturbance Regime
Effects to the *disturbance regime* indicator are anticipated to minor. As described above, the major habitat impacts of PE 4 stem from controlling streamflow (i.e., moderate peak flows and decreased low flows during August aquifer recharge) in the historical channel. This leads to decreased expression of the key habitat-forming processes at high flows, impaired passage opportunities for bull trout, and degraded habitat quality and availability at low flows. These impacts are described in detail above in the *peak and base flow, physical barriers,* and *temperature* indicators. The natural disturbance regime continues to function, but with less amplitude. In addition, impacts to flow conditions have been moderated by water supplementation for Snow/Nada lakes releases in July to October. Bull trout have responded positively to improved passage opportunities (i.e., spawning in the upper Icicle in 2008-2010) and suggests good resiliency to degraded habitat conditions. For these reasons, we consider the impacts to the *disturbance regime* indicator minor at the scale of the action area.

Summary of Effects to Habitat Indicators from PE 4

The preceding sections describe the effects to individual habitat indicators affected by the O&M of structures 2 and 5. Positive and negative effects to habitat indicators are likely to occur at the action area scale, but they will “maintain” their current function at the 5th-field scale. Table 16 summarizes the anticipated adverse impacts.

Table 16. Summary of Effects to Habitat Indicators from PE 4

Life History Stage	**Peak and Base Flow**		**Temperature**		**Physical Barriers**	
	Lethal effects	Sub-lethal effects	Lethal effects	Sub-lethal effects	Lethal effects	Sub-lethal effects
Migratory bull trout	0	0	0	0	0	16
All other bull trout	0	64	0	64	0	0
Total	**0**	**64**	**0**	**64**	**0**	**16**

In Table 16, “migratory bull trout” are those that seek to spawn in upper Icicle Creek; “all other bull trout” include all other adult, subadult, and juvenile bull trout. “Adverse effects” occur when a significant disruption of normal behavior occurs. The 64 bull trout affected by the *peak and base flow* and *temperature* indicators are the same individuals; this simply reflects more than one avenue of adverse effects (i.e., these numbers are not additive).

In the assessment of effects to habitat indicators related to PE 4, aquifer recharge was described to have a duration of “15 days or more.” This sort of open-ended statement greatly confounds our effects analysis. For the purposes of this BO, we assumed that this means 15 days. Effects beyond 15 days were not considered in our analysis.

F. Effects of Monitoring and Evaluation (PE 5)

The MCFRO provides monitoring, evaluation, and coordination services concerning LNFH production. Monitoring and evaluation includes the evaluation of hatchery returns, straying rates, biological characteristics of the hatchery stock, fish marking, tag recovery, and other aspects of the hatchery program. They also maintain the database that stores this information. MCFRO cooperates with the hatchery, fish health and technology centers, and co-managers to evaluate fish culture practices, assess impacts to native species, and coordinate hatchery programs both locally and regionally.

Monitoring and evaluation activities can be described such that they fall into two discrete categories: (1) activities that occur within LNFH facilities (e.g., mass marking, tagging, etc. of hatchery stock) and (2) activities that occur within waterways occupied by bull trout (e.g., snorkeling, in-stream temperature and other monitoring). Monitoring and evaluation activities that occur within LNFH facilities have no effect to bull trout or bull trout critical habitat since bull trout are not present in the infrastructure related to production (i.e., incubation and rearing areas) and release. The only bull trout that are present within LNFH facilities are those individuals entrained in the water intake system (PE 1). Those effects were previously described in section *B. Effects of the Water Supply System (PE 1).*

Monitoring and evaluation activities that occur within waterways occupied by bull trout are covered under a separate section 10(a)(1)(A) scientific permit (USFWS TE-702631, MCFRO-13). Because incidental take of those activities has already been issued and measures to minimize that take have already been developed, no further analysis is required in this BO.

G. Tribal Chinook Salmon Fishery

Treaties and other agreements allow a tribal Chinook salmon fishery at the LNFH spillway pool. Adult salmon returns to the LNFH generally exceed the number of broodstock needed (approximately 900 adults) under the current production regime (i.e., approximately 1.2 million pre-smolts are released each year). The tribal fishery lasts for six or eight weeks every year, with peak activity occurring about the first half of the season (mid-May through early-July). Sometimes there are several anglers actively fishing all day. In some years, such as 2007, based on a smaller projected run size, the fishery may only be two or three days per week. This activity lasts for six or eight weeks every year, with peak activity occurring about the first half of the season (mid-May through early-July). Based on creel survey data provided by the Yakama Nation and Colville Confederated Tribes, the Service is unaware of any bull trout being caught in the spillway pool, but steelhead have been caught (David Morgan, USFWS, pers. comm. with Craig, J., USFWS, 2006).

Incidental take of bull trout due to the Tribal fishery at the LNFH is exempted under an ESA section 4(d) special rule pertaining to State and Native American Tribal angling, in accordance with their applicable laws and regulations; this special rule was included in the June 10, 1998, final rule listing the coterminous U.S. population of the bull trout (64 FR 58910). As a result, the potential impacts of the Tribal Fishery are not analyzed in this BO.

H. Interrelated and Interdependent Actions

"Interrelated and Interdependent Actions" are defined in the Service's consultation handbook (USFWS and NMFS 1998). In brief, they are actions that would not occur "but for" the proposed action. Effects of the O&M of the LNFH must consider impacts of other activities that are interrelated to, or interdependent with, the proposed action. Supplemental information regarding interrelated and interdependent actions was supplied by the LNFH on May 5, 2011.

LNFH shares a point of diversion with COIC in Icicle Creek at rm 4.5. LNFH maintains and operates the intake diversion structure as part of a 1939 contract between the United States and COIC. LNFH funds the Washington Department of Fish and Wildlife to maintain COIC's diversions, screens, and fish bypass. COIC has a 1905 water right for 12.4 cfs during the irrigation season (May 1st through October 1st) and LNFH holds a 1942 water right to divert 42 cfs year around.

A 33 inch diameter buried pipeline delivers surface water approximately 1,260 ft down gradient from the beginning of LNFH's intake piping system to COIC's delivery system. A gate valve controls flow into COIC's pipe which connects to LNFH's main pipe at a 45^0 angle. COIC's pipe delivers water to a concrete, rectangular upwelling chamber where an updated drum screen prevents entrained fish from continuing through COIC's water delivery system. In the past, fish that had entered the upwelling chamber could exit through a bypass flume (rm 4.2), which involved an initial waterfall drop of up to 3 ft, to Icicle Creek. Currently (as of the 2011 irrigation season), the entrance to the bypass flume is blocked by dam boards and any fish that enter the upwelling chamber are netted out and returned to Icicle Creek. Dam boards may be replaced with a16 inch perforated mesh screen when overflow is necessary. Hatchery personnel check the upwelling chamber twice a day, once at the beginning and once at the end of each work day. A maximum of 42 cfs of surface water that does not enter COIC's water delivery system is transported through a 31 inch diameter buried pipeline approximately 5,200 ft to the hatchery.

Very little information is known on how many fish entrained in LNFH's water delivery system enter COIC's system. However, the number of fish is expected to be low due to the orientation of the pipes and the division of flow. LNFH is only aware of two instances in which fish have been observed in the upwelling chamber. One fish in the past 20 years was observed by the hatchery's maintenance supervisor. One fish in the past 25 years was seen by Cot Rice, past president of COIC. In the near future, LNFH will reevaluate the bypass flume, which is no longer being used, to assess how effects to bull trout may be minimized.

Assessing the potential impacts to bull trout is difficult with such limited information. From capture log information (2006-2010) 1,481 fish have been captured (dead or alive) on or within LNFH structures/facilities and only 19 have been bull trout. Of the 111 fish captured in the sand settling basin in 2009 (the year in which the most bull trout were entrained), only 8 have been bull trout, with rainbow and cutthroat being the major species encountered. This suggests bull trout represent about 7 percent of all fish entrained into the LNFH water supply system. Data for COIC's upwelling chamber are more limited, with only 2 fish observed in the last 20-25 years; one of these fish was identified as a rainbow, the identity of the other fish is unknown.

Overall, bull trout appear to be a small proportion of fish entrained into the LNFH water supply system. An even smaller proportion of total fish entrained appear to enter the COIC upwelling chamber (i.e., 2 total fish in the last 20-25 years). As a result, while we acknowledge the possibility that bull trout may be entrained and enter the COIC system, this is extremely unlikely to occur. The effects of the interrelated and interdependent actions to bull trout are discountable. If bull trout are discovered in COIC's upwelling chamber, reinitiation of consultation is required.

I. Summary of Direct Effects to Bull Trout

As described above, PEs 1, 2, 4, and 5 are all anticipated to result in adverse effects to bull trout. The adverse effects of PE 5 are covered by a separate section 10(a)(1)(A) scientific permit (USFWS TE-702631, MCFRO-13). Because incidental take of those activities has already been issued and measures to minimize that take have already been developed, no further analysis is required in this BO. Likewise, take of bull trout due to the Tribal fishery at the LNFH is exempted under an ESA section 4(d) special rule pertaining to State and Native American Tribal angling and will also not be further analyzed in this BO. The summary of direct adverse effects to bull trout from all remaining LNFH activities is displayed in Table 17.

Table 17. Summary of all direct adverse effects to bull trout due to the O&M of the LNFH.

Life History Stage	**PE 1: Water Supply**		**PE 2: BCS and Rearing**		**PE 4: Structures 2 and 5**	
	Lethal Effects	Sub-lethal Effects	Lethal Effects	Sub-lethal Effects	Lethal Effects	Sub-lethal Effects
Migratory bull trout	0	1	0	1	0	16
All other bull trout	1	8	0	0	0	0
Total	**1**	**9**	**0**	**1**	**0**	**16**

In Table 17, "migratory bull trout" are those that seek to spawn in upper Icicle Creek; "all other bull trout" include all other adult, subadult, and juvenile bull trout. "Adverse effects" occur when a significant disruption of normal behavior occurs.

J. Summary of Effects to Habitat Indicators

As described above in the preceding text, and summarized by Table 12, a number of Matrix habitat indicators are impacted to varying degrees by the proposed action. Only a few are affected by PE 4 (O&M of structures 2 and 5) to the extent that they result in significant adverse effects to bull trout (Table 16). These adverse effects are related to the August aquifer recharge, the need for which is dictated by the annual hydrograph. Although aquifer recharge in August has been done infrequently in the past, for the purposes of this BO (with an indefinite term of the proposed action), we must assume it may occur annually.

K. Summary of Effects to Critical Habitat

The summary of effects to habitat indicators in the previous sections can be used to inform the effects to the PCEs of critical habitat for the bull trout. To assess these effects, we use the crosswalk (Appendix B) to show the relationship between habitat indicators and the PCEs of critical habitat for the bull trout. Because PE 4 includes adverse effects to the *peak and base flows*, *temperature*, and *physical barriers* indicators, we expect adverse effects to the PCEs that show a strong relationship to these indicators (see the crosswalk, Appendix B). As a result, we expect adverse effects to occur to PCEs 1, 2, 5, 7, and 8. These adverse effects stem from aquifer recharge in August (degrading habitat conditions in the historical channel from rm 2.8-3.8) and the closures of structures 2 and 5 for broodstock collection, high flows, and pre-smolt release. Although aquifer recharge in August has been done infrequently based on past operations, for the purposes of this BO (with an indefinite term of the proposed action), we must assume it may occur annually. Table 18 displays the anticipated effects of PE 4 to the PCEs of bull trout critical habitat.

We also expect effects of the proposed action to PCE 2 (migration corridors) to be positive. The proposed action will increase passage opportunities for migratory bull trout to pass above the LNFH and access their spawning habitats in upper Icicle Creek. We anticipate that this will increase the abundance and distribution of the Icicle Creek local population through time, and improve the overall status of the Wenatchee core area metapopulation. This is consistent with the conservation role of critical habitat to support viable core area populations.

L. Effects of the Action on the Survival and Recovery of the Bull Trout

As discussed previously in this document, the draft bull trout recovery plan (USFWS 2002a) identifies the following survival and recovery needs for the bull trout within what is now recognized as the Columbia River interim recovery unit: maintain or expand the current distribution of the bull trout within core areas; maintain stable or increasing trends in bull trout abundance; maintain/restore suitable habitat conditions for all bull trout life history stages and strategies; and conserve genetic diversity and provide opportunities for genetic exchange. It has also been recently recognized that bull trout populations need refugia from catastrophic fires across the range of each interim recovery unit. Collectively, these criteria constitute the intended survival and recovery functions of this interim recovery unit. For the reasons described under the “Analytical Framework for the Jeopardy Determination” section, an emphasis is being placed on characterizing the effects of the action relative to the intended survival and recovery functions of the Columbia River interim recovery unit for purposes of the jeopardy analysis.

Table 18. Summary of adverse effects to the PCE of bull trout critical habitat.

Pathways (bold) and Indicators	PCE 1 - Springs, Seeps, Groundwater	PCE 2- Migratory Corridors*	PCE 5 - Temperature	PCE - 7 Hydrograph	PCE 8 - Water Quality/ Quantity
Water Quality					
Temperature	---/+	---	---/+		---/+
Sediment					
Chemical Contamination/Nutrients					
Habitat Access					
Physical Barriers		---/+			
Habitat Elements					
Substrate Embeddedness	-	-			
Large Woody Debris					
Pool Frequency and Quality					
Large Pools			--		
Off-Channel Habitat	--		--		
Refugia	--	--	--	--	--
Channel Conditions and Dynamics					
Wetted With/Max. Depth Ratio		--	--		--
Streambank Condition					
Floodplain Connectivity	--		--	--	--
Flow/Hydrology					
Changes in Peak/Base Flows	---	---	---	---	---
Drainage Network Increase					
Watershed Conditions					
Road Density and Location	-		-	-	-
Disturbance History	-		-	-	
Riparian Conservation Areas	-		-	-	-
Disturbance Regime					-

Minus signs indicate level of negative impact. One minus sign indicates a negative impact that is insignificant or discountable. Two minus signs indicates a negative impact that has the potential to cause an adverse effect that can be reliably avoided by proper implementation of conservation measures or mitigation. Three minus signs indicate a high likelihood of causing an adverse effect. A blank indicates an indicator is unlikely to be directly or indirectly affected by a project element because there are no impact mechanisms that link the project element to an indicator.

The effects of the action in terms of the “jeopardy” and “destruction or adverse modification” analyses are discussed below. This section considers all of the preceding effects, collectively. Comparison of the effects of the proposed action (in terms of the jeopardy analysis) with respect to the survival and recovery needs of the bull trout, are as follows.

1. Maintain or expand the current distribution of the bull trout within core areas: The proposed action should improve the current distribution of the bull trout in the core area. Passage opportunities under the proposed action should be at least as good as the operations in 2008-2010, so we expect migratory bull trout to spawn in upper Icicle Creek in all future years. We anticipate increased spawning will occur, resulting in increased abundance through time; we anticipate that additional tributaries (e.g., Leland, Jack and Chain Creeks) may eventually be used, increasing the distribution within Icicle Creek, expanding the overall distribution within the core area.

2. Maintain stable or increasing trends in bull trout abundance: The population trend of the migratory population of bull trout in Icicle Creek has likely been negative from hatchery construction in about 1940 until 2000 (when passage opportunities were few to none), and the population trend may have moderated or decreased its rate of decline in 2001-2007 (with improved, but still limited, passage opportunities). Further improvements in passage 2008-2010 (evidenced by three consecutive years of spawning by migratory fish) may have resulted in a positive trend in population abundance (see Figure 3). The proposed action should provide passage conditions at least as good as those in 2008-2010, and likely better, so we expect migratory bull trout to spawn in all future years. This suggests the past decline in bull trout abundance has recently moderated and is now on the path toward an increasing trend in abundance.

3. Maintain/restore suitable habitat conditions for all bull trout life history stages and strategies: Habitat in the action area is generally in poor condition below rm 5.7 as compared to generally good conditions above rm 5.7. Recent improvements in LNFH operations related to flow have not only benefited passage opportunities, but have improved the condition of some Matrix habitat indicators adversely affecting bull trout. In particular, supplemental water releases from Snow and Nada lakes likely increases the spatial and temporal habitat use and overall distribution and abundance of bull trout. This improves habitat conditions for all life stages of bull trout by decreasing temperatures and increasing streamflow in the historical channel in the summer, which is a limiting factor.

4. Conserve genetic diversity and provide opportunities for genetic exchange: With improved opportunities for passage, and anticipated increases in distribution and abundance of bull trout in the upper Icicle that should result, we expect increased opportunities for genetic exchange. When considering overall population dynamics, demographic performance is more difficult to restore than genetic performance (gene exchange). Few successful reproductive events are generally required to establish gene flow, but positive demographic performance can require multiple years of successful reproduction to demonstrate population improvement (e.g., in establishing trends in abundance). Thus, we anticipate that genetic exchange will occur with the amount of successful reproduction anticipated (i.e., successful reproduction in all subsequent years, at a level at least equal to the period 2008-2010).

Demonstrating the conservation of genetic diversity is more difficult to establish. Conserving genetic diversity involves the consideration of many factors, including population size. The population size of migratory bull trout in the Icicle local population is currently small, but is anticipated to increase over time. However, as long as population abundance trends are positive, we assume the genetic diversity will be conserved.

At the same time, several negative effects to bull trout are expected to occur as a result of the proposed action. Negative effects include adverse affects to bull trout migration at multiple locations; entrainment into the water intake system; confinement, capture, and relocation associated with BSC; and exposure to degraded habitat conditions in the historical channel. However, these negative effects are not outweighed by the improvements made primarily in passage opportunities, which has resulted in secondary habitat improvements, as well as other conservation measures. In particular, supplemental water releases from Snow and Nada lakes likely increases the spatial and temporal habitat use and overall distribution and abundance of bull trout. On balance, we acknowledge the adverse effects of the proposed action, but suggest the conservation of the species is overall being advanced, with expectations of increased abundance and distribution of bull trout over time. We suggest the proposed action does not appreciably reduce the likelihood of survival and recovery of the bull trout at the metapopulation scale (the Wenatchee core area), so evaluation of impacts at the larger Columbia River interim recovery unit scales are likely not detectable.

All effects previously considered are discussed on an annual basis. A proposed action with an indefinite term presents several challenges and poses many questions. One, should we assume short-term expectations (i.e., improved passage opportunities will lead to an increased frequency of spawning, and therefore increased distribution and abundance) will continue in the long-term? Second, with most expectations of the impacts of climate change suggesting warmer and wetter annual weather patterns, to what degree do we estimate responses of bull trout population dynamics and local population persistence? Third, how do we incorporate the array of direct and indirect effects from future actions we have no ability to predict? Ultimately, we must rely on monitoring efforts to test our reasoned assumptions and regulatory reinitiation triggers to address these changed conditions, since the above questions are far beyond our predictive capabilities.

M. Effects of the Action on the Role of Bull Trout Critical Habitat

Similar to the preceding section, a parallel analysis is also conducted for bull trout critical habitat, emphasizing the effects of the action relative to the intended role of critical habitat for the purposes of our destruction or adverse modification analysis. The conservation role of bull trout critical habitat is to support viable core area populations (75 FR 63898). Activities that cause adverse effects to critical habitat are evaluated 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; USFWS 2004d, Vol. 1. pp. 140-193, Vol. 2. pp. 69-114). The action area is located in Icicle Creek, a portion of the Wenatchee CHSU within the Upper Columbia River Basin CHU (Unit 10), and includes both SR and FMO habitats.

Comparison of the effects of the proposed action (in terms of the destruction or adverse modification analysis) in respect to the conservation role of critical habitat for the bull trout, are as follows. The questions posed are:

> *1. To what degree does the CHU serve the intended conservation role for the species?* As described in section "VI. Environmental Baseline of Critical Habitat," the Upper Columbia River Basin critical habitat unit (Unit 10) and three CHSUs are functioning reasonably well, although there is variation within and between PCE functionality in all subunits. Within the action area, 5 of 9 PCEs are "functioning at unacceptable risk." This suggests little resiliency to endure additional adverse effects at the local scale in terms of determining whether the conservation role of the entire CHU is being fulfilled. However, the scale of the action area relative to the CHU is small, and large or significant impacts would need to be present to suggest the conservation role of the CHU is not being met. We suggest that the conservation role of the CHU is being met based on the overall status of the metapopulation in the Wenatchee core area (i.e., critical habitat is designated to support viable core area populations). The Wenatchee core area is considered stable with high interannual variation; the Chiwawa River population represents a stronghold for the bull trout, and for that reason is likely to significantly influence the population trend for the entire core area. As long as future actions, including this proposed action, suggest progress toward metapopulation stability (or improvement), we suggest the intended conservation role of critical habitat is being met.
>
> *2. To what degree does the function of the PCEs relate to the ability of the area to support the species?* The proposed action negatively affects 5 PCEs of designated critical (see section *J. Summary of Effects to Critical Habitat*). However, most of these effects are related to a single, short-term (15 days) action of aquifer recharge in August, impacting the historical channel between rms 2.8-3.8. Positive aspects of the proposed action (i.e., improved passage opportunities, PCE 2, which facilitates spawning and increased abundance and distribution of bull trout) are more potent and long-term than the short-term impacts. Overall, we suggest that PCE function within the action area is improving overall, and supports the life history requirements of bull trout.

At the same time, several negative effects to bull trout critical habitat are expected to occur as a result of the proposed action. Negative effects include adverse effects to PCEs 1, 2, 5, 7, and 8. These adverse effects stem from aquifer recharge in August (degrading habitat conditions in the historical channel from rm 2.8-3.8) and the closures of structures 2 and 5 for broodstock collection, high flows, and pre-smolt release. Table 18 displays the anticipated effects of PE 4 to the PCEs of bull trout critical habitat. Although we acknowledge adverse effects to the PCEs of critical habitat, we suggest the proposed action does not significantly impair the ability of the Wenatchee CHSU to support a viable core area population, nor are functions of these affected PCEs significantly impaired in their ability to support the species. If the effects of the proposed action are not significant at the action area scale, then evaluation of impacts at the larger CHSU or CHU scales are likely not detectable.

All effects previously considered are discussed on an annual basis. A proposed action with an indefinite term presents several challenges and poses many questions. One, should we assume short-term expectations (i.e., improved passage opportunities will lead to an increased frequency of spawning, and therefore increased distribution and abundance) will continue in the long-term? Second, with most expectations of the impacts of climate change suggesting warmer and wetter annual weather patterns, to what degree do we estimate changes in the habitat conditions of the PCE of critical habitat? Third, how do we incorporate the array of direct and indirect effects from future actions we have no ability to predict? Ultimately, we must rely on monitoring efforts to test our reasoned assumptions and regulatory reinitiation triggers to address these changed conditions, since the above questions are far beyond our predictive capabilities.

VIII. Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Diversions

Upstream from the LNFH intake there is a non-Federal water diversion at rm 5.7 which is likely to continue to adversely affect in-stream flow and fish passage, particularly during low flows. The irrigation districts have a water right to nearly 118 cfs of Icicle Creek water between approximately mid-March and mid-October, but usually diversion does not begin quite that early. Data collected in the early 1990s indicate that IPID diverted a maximum of about 100 cfs (Montgomery Water Group, Inc. 2004b). The municipal water intake at the same location (opposite bank along the same dam) takes 3 cfs year-round. The IPID supplements in-stream flow above the point of diversion using alpine lakes fitted with small dams, but the amount of water stored (about 10,000 ac/ft) and released (about 5,000 ac/ft per season) is much less than the amount diverted. The amount of water diverted often exceeds the total flow of Icicle Creek as measured by a USGS gauge just upstream of this location, which in late September of 2005 streamflow was as low as 60cfs. This water is carried by a long open canal to areas downstream in the lower Wenatchee River Valley as far east as Monitor; this water is returned to the Wenatchee River at several locations along the way. The diversion dam at rm 5.7 does not pass fish during low flow. It is unknown whether this diversion, which operates from April to October, is adequately screened to prevent fish from entering the diversion canal. Given that ¾" gravel was observed impinged on the screen itself (D. Morgan, USFWS, pers. comm.. with Kolk, S., BOR, 2006), it is likely that bull trout are at high risk of impingement if they are entrained. This diversion also has a fish return that shunts fish out of the canal, over a rock ledge, and drops them about 15 feet directly onto a boulder that is not submerged for most of the irrigation season. Any bull trout that pass through this return when flows are low are likely to be injured or killed. In 2006, the BOR began a process to update and replace the screen, and possibly to address fish passage and other concerns. But it was recently deemed a lower priority by the likely lead entity and project sponsor, and it appears that it will not be completed soon (D. Morgan, USFWS, pers. comm.. with Kolk, S., BOR, 2006).

Residential Development and Recreation
As the human population in Washington State continues to grow, residential growth and demand for dispersed and developed recreation is likely to occur, including areas within the lower Icicle Creek watershed. This trend is likely to result in increasing habitat degradation from riparian road construction, levee building, bank armoring, and campsite development on private lands in the lower watershed. Despite some local permitting requirements and regulations, our observations are that these activities tend to remove riparian vegetation, disconnect rivers from their floodplains, interrupt groundwater-surface water interactions, reduce stream shade (and increase stream temperature), reduce off-channel rearing habitat, and reduce the opportunity for large woody debris recruitment.

Each subsequent action by itself may have only a small incremental effect, but taken together they may substantively degrade the watershed's environmental baseline and undermine the improvements in habitat conditions necessary for listed species to survive and recover. Watershed assessments and other education programs may reduce these adverse effects by continuing to raise public awareness about the potentially detrimental effects of residential development and recreation on salmonid habitats and by presenting ways in which a growing human population and healthy fish populations can co-exist.

The above effects may further degrade in-stream conditions for migratory bull trout ascending Icicle Creek below the LNFH. Similarly, the PCEs of critical habitat can also be degraded through development and the on-going operations of non-Federal irrigation diversions. As discussed above, most of the upper Icicle Creek watershed is on Federal lands designated as Wilderness, which provides substantial protection to bull trout habitat in that portion of the watershed.

VIX. Conclusion

After reviewing the current status of the bull trout and its designated critical habitat range-wide, the environmental baseline for the bull trout and its designated critical habitat in the action area, the effects of the proposed action, the effects of interrelated and interdependent actions, and cumulative effects, it is the Service's biological opinion that the Project, as proposed, is not likely to jeopardize the continued existence of the coterminous U.S. population of the bull trout, and is not likely to destroy or adversely modify designated critical habitat for the bull trout. The basis for these conclusions is discussed below.

<u>No Jeopardy Determination</u>

The range-wide status of the bull trout is variable among and within the five interim recovery units that comprise the threatened coterminous U.S. population. Each of these units is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions. The Columbia River interim recovery unit (where the action area is located) is especially important to the survival and recovery of the bull trout because it contains 90 of the 114 (79%) core areas range-wide, and 500 of the 594 (84%) local populations within the coterminous U.S. range of the bull trout.

The bull trout is threatened within all of the interim recovery units by the combined effects of habitat degradation, fragmentation and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, incidental angler harvest, entrainment into diversion channels, and introduced non-native species.

Based on recovery planning to date, conservation of the bull trout at the coterminous U.S. scale is dependent upon maintaining and enhancing the condition of local populations and core areas within the five interim recovery units. Therefore, proposed Federal actions that are compatible with achieving those objectives are not likely to jeopardize the continued existence of the bull trout range-wide.

The status of the bull trout in Icicle Creek is considered poor, but the overall condition of the bull trout in the Wenatchee core area is relatively good. Evaluation of all available information indicates that Icicle Creek supports the smallest local population in the Wenatchee core area. The overall bull trout population trend in Icicle Creek has likely been negative between 1940 and 2000, moderated somewhat between 2001 and 2007, and may have increased slightly between 2008 and 2010, but the population remains very small. The small size of this population makes it the most vulnerable local population in the Wenatchee core area to extirpation. Maintenance and expansion of the Icicle Creek local population of the bull trout is largely dependent on restoring the migratory life history form, which is likely to enhance the viability of this local population by reducing competition, demographic, distributional, and genetic risks.

The proposed Project is likely to cause impaired upstream passage of migratory bull trout, entrainment of bull trout into the water supply system (and the capture, handling, and release of affected bull trout), confinement of bull trout in the Chinook holding ponds (and the capture, handling, and release of affected bull trout), and exposure of bull trout to degraded habitat conditions in the historical channel during August aquifer recharge. As many as 91 bull trout may be adversely affected annually by the Project, but these effects are likely to cause the death of only 1 bull trout annually. Despite these adverse effects, improvement in upstream passage opportunities for migratory bull trout is expected to occur under the proposed Project with increased spawning by migratory bull trout in upper Icicle Creek. This increased spawning by migratory fish is expected to increase the abundance and distribution of the bull trout within

Icicle Creek during the term of the Project, and improve the overall status of the Wenatchee core area metapopulation of the bull trout.

No significant interrelated or interdependent actions or cumulative effects are anticipated to occur during the term of the proposed Project.

Considering the effects of the proposed Project, together with cumulative effects, the status of the bull trout in Icicle Creek and the Wenatchee core area are likely to be maintained and enhanced with implementation of the Project. No detectable adverse effects are likely to be caused by the proposed Project at the interim recovery unit scale. Therefore, the proposed action is not likely to jeopardize the continued existence of the bull trout at the range-wide scale.

No Adverse Modification

The range-wide status of designated critical habitat for the bull trout is variable among and within CHUs, which were designated in five states in a combination of reservoirs/lakes and streams/shoreline. Designated bull trout critical habitat is of two primary use types: (1) spawning and rearing; and (2) foraging, migration, and overwintering. The conservation role of bull trout critical habitat is to support viable core area populations. The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. Thirty-two CHUs and 78 associated subunits are designated as critical habitat under the 2010, final rule.

The status of habitat conditions and the PCEs of designated critical habitat in the action area are marginal. Five of 9 PCEs are “functioning at an unacceptable risk” (USFWS 1999). The degradation of PCEs is caused by the over-allocation of Icicle Creek stream flow, excessive embeddedness of the lower reaches (impacting hyporheic flows), and multiple Clean Water Act section 303(d) listed impairments (temperature, dissolved oxygen, instream flow, pH, PCBs, fecal coliform, and ammonia-N). Substantial past impacts to the bull trout migratory corridor (from both human activities and natural conditions) in lower Icicle Creek have created a very narrow window of opportunity (about 7 weeks) for upstream passage of migratory bull trout. Supplemental flow released by the LNFH from Snow and Nada Lakes increases total stream flow and reduces stream temperatures on an annual basis. Overall, the condition of the Icicle Creek watershed is “bimodal.” The lower portion (below rm 5.7) has been substantially degraded and generally is considered to be in poor condition. The upper portion (above rm 5.7) of the watershed is generally considered to be in good condition.

The proposed Project is likely to affect the PCEs of designated critical habitat for the bull trout by degrading habitat conditions in the historical channel from rm 2.8 to rm 3.8 as a result of aquifer recharge in August, and the closures of structures 2 and 5 for broodstock collection, high flows, and pre-smolt release. Under the proposed Project, the manipulation of flows at structure 2 is likely to adversely impact peak and base flows (PCE 7) in lower Icicle Creek, which negatively impacts temperature (PCE 5), and a variety of habitat parameters (PCEs 1, 2, and 8) indirectly. But at the same time, supplemental flow released by the LNFH from Snow and Nada Lakes under the proposed Project is likely to ameliorate streamflow reductions (PCE 7) and degraded habitat conditions (PCEs 1, 2, and 8), and reduce stream temperature (PCE 5). In aggregate, the anticipated effects of the proposed Project are likely to improve upstream passage opportunities (PCE 2) for migratory bull trout with increased spawning by migratory bull trout expected in upper Icicle Creek.

No significant interrelated or interdependent actions or cumulative effects are anticipated to occur during the term of the proposed Project.

This aggregate effect is consistent with the conservation role of critical habitat range-wide to support viable core area populations. On that basis, implementation of the proposed Project is not likely to destroy or adversely modify bull trout critical habitat at the range-wide scale.

Conclusion

Therefore, it is the Service's biological opinion that the Project, as proposed, is not likely to jeopardize the continued existence of the coterminous U.S. population of bull trout and will not destroy or adversely modify designated critical habitat for the bull trout at the range-wide scale.

Incidental take of bull trout is likely to occur as a result of implementation of the proposed action described above. The Incidental Take Statement accompanying this biological opinion includes mandatory Reasonable and Prudent Measures and Terms and Conditions intended to minimize this incidental take.

INCIDENTAL TAKE STATEMENT

I. Introduction

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harm is further defined by Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions or omissions that create the likelihood of injury to listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns which include but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the LNFH so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The LNFH has a continuing duty to regulate the activity covered by this incidental take statement. If the LNFH fails to assume and implement the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) will lapse. In order to monitor the impact of incidental take, the LNFH must report the progress of the action and its impact on the species to the Service as specified in this Incidental Take Statement [(50 CFR §402.14(i)(3)].

II. Anticipated Amount or Extent of Take of the Bull Trout

Incidental take of the bull trout is likely to occur as a result of implementing Project Elements (PE) 1, 2, and 4, as described in detail in the “Effects of the Action” section above. The form of take caused by these effects is described below:

- PE 1 (Water Supply System): harm from entrainment into the intake at rm 4.5, and the capture, handling, and release of affected bull trout;
- PE 2 (Broodstock Collection and Rearing): harm from confinement in the holding ponds at rm 2.7, and the capture, handling, and release of affected bull trout;
- PE 4 (Operation of Structures 2 and 5): harassment from impairing upstream passage in the historical channel at rm 2.8-3.8; and
- PE 4 (Operation of Structures 2 and 5): harassment from degrading habitat quality in the historical channel at rm 2.8-3.8 during August aquifer recharge.

The annual amount of incidental take expected to occur due to the direct effects of the proposed Project, stratified by PE, severity of effect, and bull trout life history stage, is summarized in Table ITS-1:

Table ITS-1: Summary of anticipated incidental take of the bull trout by Project Element, severity of effect, and bull trout life history stage.

Life History Stage	**PE 1: Water Supply**		**PE 2: BCS and Rearing**		**PE 4: Structures 2 and 5**
	Harm (Lethal)	Harm (Sub-lethal)	Harm (Lethal)	Harm (Sub-lethal)	Harassment
Migratory bull trout	0	1	0	1	16
All other bull trout	1	8	0	0	0
Total	**1**	**9**	**0**	**1**	**16**

In Table ITS-1, "migratory bull trout" are those that seek to spawn in upper Icicle Creek; "all other bull trout" include all other adult, subadult, and juvenile bull trout.

Additional incidental take of the bull trout is expected due to degraded habitat quality in the historical channel at rm 2.8-3.8 caused by August aquifer recharge (PE 4). The annual amount of incidental take expected to occur to bull trout as a result of the effects of PE 4 to habitat indicators during August aquifer recharge, stratified by severity of effect and life history stage, is summarized in Table ITS-2:

Table ITS-2: Summary of incidental take to bull trout from the indirect effects of habitat degradation from PE 4, severity of effect, and life history stage.

Life History Stage	**Peak and Base Flow**	**Temperature**	**Physical Barriers**
	Harassment (Sub-lethal)	Harassment (Sub-lethal)	Harassment (Sub-lethal)
Migratory bull trout	0	0	16
All other bull trout	64	64	0
Total	**64**	**64**	**16**

In Table ITS-2, "migratory bull trout" are those that seek to spawn in upper Icicle Creek; "all other bull trout" include all other adult, subadult, and juvenile bull trout.

Please note that the 16 migratory bull trout listed in Table ITS-1 and in the right column of Table ITS-2 are the same individuals (i.e., these numbers are not additive, but indicate bull trout are taken by more than one PE). Similarly, the 64 bull trout affected in Table ITS-2 by the *peak and* *base flow* and *temperature* indicators are the same individuals (i.e., these numbers are not additive, but indicate bull trout are taken by more than one mechanism of effect).

The amount of incidental take of the bull trout resulting from the Project will be difficult to detect due to: (1) the bull trout's primarily nocturnal activity patterns, tendency to hide in or near the substrate, and the small body size, cryptic coloration, and behavior of juvenile and sub-adult bull trout; (2) the low likelihood of finding an injured or dead individual in the relatively complex habitats in the action area; and (3) high rate of removal of injured or dead individuals by predators or scavengers. Given these difficulties, any detection of incidental take of the bull trout can provide valuable information that the Service can utilize to develop better methods for avoiding and minimizing incidental take of the bull trout, and to refine estimates of incidental take for future projects of a similar nature in similar situations.

Pursuant to the terms and conditions (listed below) of this incidental take statement, monitoring the amount or extent of incidental take of the bull trout caused by PE 1 and PE 2 shall consist of counting the number of individual bull trout captured in the sand settling basin and holding ponds each calendar year.

Monitoring the amount or extent of incidental take of the bull trout caused by PE 4 by counting individual fish is not practical because it would result in more harassment to bull trout than the Project alone, and logistical considerations suggest this is not feasible. For those reasons, a surrogate will be used to establish a clear numerical limit of take that if exceeded would trigger reinitiation of formal consultation on the Project.

Our surrogate for detecting and monitoring the number of bull trout taken is the number of days where incidental take is anticipated for each discreet action in PE 4. In the accompanying Biological Opinion, our best estimate of the number of bull trout likely to be adversely affected through impairment of upstream passage opportunities (direct effects of PE 4, see Table ITS-1) is 16 migratory bull trout. This is a result of impaired passage conditions due to the closure of structures 2 and 5 over a 4-week period. The incidental take that was evaluated comprised a 28-day period where passage was impaired for the estimated 16 migratory adult bull trout. Thus, we provide the LNFH 28 days of passage impairment (i.e., the total number of days where closure of either structures 2 and 5 occurs) during the BSC period (May 15-July 7) as our surrogate for establishing limits on the take of an estimated 16 adult bull trout per year.

The same approach is being applied to the monitoring of take impacts caused by aquifer recharge in August (also PE 4). The take limit and monitoring parameter is expressed in terms of days of bull trout exposure to degraded habitat conditions during August in the historical channel (rm 2.8 to rm 3.8). Our best estimate is that as many as 64 bull trout of all life history stages may be incidentally taken due to degraded habitat conditions over a 15-day period in August due to aquifer recharge. If those degraded habitat conditions exceed 15 days during August of each year of Project implementation, reinition of formal consultation is required.

The Service believes that as long as each Project element is implemented as described in the Biological Assessment, the LNFH will not exceed the level of incidental take exempted here.

However, if implementation methods are changed in ways that are likely to result in different net effects, resulting incidental take could exceed the level exempted here, and reinitiation of consultation is required. Numerical take estimates will be tested through required monitoring described below.

III. Effect of the Take

In the accompanying Biological Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the bull trout.

IV. Reasonable and Prudent Measures

The Service believes that the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize and monitor the impacts of take of the bull trout likely to be caused by the proposed Project.

RPM 1. Minimize and monitor the impacts of incidental take of the bull trout caused by impaired upstream passage conditions for migratory bull trout at structures 2 and 5 (see PE 4).
RPM 2. Minimize and monitor the impacts of incidental take of all life history stages of the bull trout caused by August aquifer recharge (see PE 4).
RPM 3. Minimize and monitor the impacts of incidental take of the bull trout caused by entrainment of bull trout into the LNFH water supply system (see PE 1).
RPM 4. Minimize and monitor the impacts of incidental take of the bull trout caused by confining bull trout in the Chinook holding ponds (see PE 2).

V. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the LNFH must comply with the following terms and conditions (T&Cs), which implement the reasonable and prudent measures described above, and are designed to minimize impacts to bull trout. These terms and conditions are mandatory.

To implement RPM 1:

T&C 1. In years where the >50 Chinook salmon trigger is met (and structure 5 is closed during the BSC period, which will also require structure 2 to be closed to manage flows), structures 2 and 5 shall be re-opened by June 24. This action will minimize the period of impairment of upstream passage of migratory bull trout and provide for a total of 6 of 7 predicted weeks of passage opportunities for migratory bull trout.

To implement RPM 2:

T&C 2. The analysis in the Biological Opinion assumed up to 64 bull trout would be exposed to adverse effects as a result of aquifer recharge in August. To validate this assumption and ensure that the extent of effects of the Project is within the scope of what was analyzed, the LNFH shall conduct surveys as follows:

- Conduct 3 daytime snorkel surveys (as broadly spaced in time as possible) between rm 2.8-3.8 at least 2 weeks prior to the August aquifer recharge.
- If the mean number of bull trout observed is <64, then the effects are within those analyzed and August aquifer recharge may proceed.
- If the mean number of bull trout observed is >64, then the effects are not within those analyzed and reinitiation of consultation is required prior to the August aquifer recharge. Alternately, if the mean number of bull trout observed is >64, and aquifer recharge is delayed until September, then reinitiation of consultation is not required.

T&C 3. The analysis in the Biological Opinion assumed lethal effects to bull trout would not likely be caused by the August aquifer recharge. To validate this assumption and ensure that the effects of the Project are within the scope of what was analyzed, the LNFH shall conduct temperature monitoring as follows:

- Temperature monitoring shall be conducted at least two weeks prior to the August aquifer recharge, and should incorporate the techniques of Isaak and Horan (2011) and Dunham et al. (2005). Measure the 7-day average daily maximum (7-DADMax) temperature in the historical channel with structure 2 open. If the 7-DADMax is less than 19 °C, the temperature criterion for proceeding with aquifer recharge is met and August aquifer recharge may proceed.
- If the 7-DADMax is greater than 19 °C in the historical channel with structure 2 open, defer aquifer recharge for one week, and continue temperature monitoring. If the 7-DADMax remains above 19 °C after one week, reinitiate consultation. Alternately, if aquifer recharge is delayed until September, then reinitiation of consultation.
- Monitor water temperatures during August aquifer recharge, if it occurs. If the 7-DADMax is greater than 19 °C during August aquifer recharge, cease operations immediately and re-open structure 2.
- If on-going temperature monitoring efforts can achieve this same objective of determining water temperatures in the historical channel in August, then the additional temperature monitoring prescribed above need not occur.

To implement RPM 3:

T&C 4. Monitor, capture, and release all bull trout in the sand settling basin as follows (based on the expected likelihood of bull trout presence recorded in the LNFH 2006-2010 capture log):

- In July through October, weekly monitoring for bull trout presence in the sand settling basin shall occur. Monitoring may consist of visual observation (to determine if fish are present and capture and release is required) as long as the entire sand settling basin can be viewed. If any bull trout are detected, they shall be promptly captured and released.
- In January through June and November through December, the interval for monitoring, capturing, and releasing all bull trout shall be monthly. If any bull trout are detected in this period, then the interval shall be changed to weekly and reinitiation of consultation shall occur.
- Any bull trout captured in the sand settling basin shall be released downstream of rm 4.5.

T&C 5. Schedule the annual maintenance at the intake (ladder, water conveyance channel, and building sump) to avoid the upstream migration period of bull trout. The BA specifies that once or twice a year, maintenance could occur between November 1 and June 1 for 2-3 days.

To implement RPM 4:

T&C 6. During BSC, when water temperatures are <15 °C in the Chinook salmon holding ponds, the interval for monitoring, capturing, and releasing all bull trout shall be weekly. During BSC, when water temperatures are >15 °C in the Chinook salmon holding ponds, the interval of monitoring, capturing, and releasing all bull trout shall be twice weekly. This T&C is designed to minimize physiological stress and allow for the bull trout to return to normal behavior patterns (e.g., the ability to feed, breed, etc.), with consideration of environmental (e.g., temperature, water quality, overcrowding, etc.) stressors.

T&C 7. Between May and August, release all bull trout captured in the Chinook holding ponds above rm 5.7. Based on past records, very few bull trout ascend the hatchery ladder and enter the Chinook salmon holding ponds. If the affected individuals are of Icicle Creek local population origin, then this T&C facilitates their upstream migration. If these affected individuals are not of Icicle Creek local population origin, then they will likely either (1) not spawn and move downstream under their own volition, or (2) they may spawn in upper Icicle Creek (which would be consistent with the expected infrequent demographic and genetic contributions from bull trout from other local populations).

T&Cs common to all RPMs:

T&C 8. Continue the adaptive management group process, during the BSC period, to develop and implement strategies to minimize upstream passage impairment at structure 2 and 5 and other adverse effects to bull trout caused by the Project. These strategies shall be consistent with the conservation needs of the bull trout and the conservation role of critical habitat for the bull trout.

T&C 9. Keep written records of all adjustments to structures 2 and 5. Include key information such as staff gauge readings at structure 2, dates of operational changes and maintenance, estimated degree of opening at structure 2, and other data. These data may better inform our understanding of the relationship between operational changes and effects of the Project on bull trout.

T&C 10. Record all incidents of bull trout being observed, captured, handled, and released at LNFH facilities and structures. These data will enhance our understanding of bull trout distribution and abundance in the Project area and better inform the assessment of LNFH effects to bull trout.

VI. Reporting Requirements

The LNFH shall prepare an annual report describing the progress of the Project, including implementation of the incidental take statement RPMs and T&Cs, and its impacts on the bull trout (50 CFR § 402.14(I)(3)). The report, which shall be submitted to the Central Washington Field Office on or before February 1 of each year, shall list and describe:

1. Documented take of the bull trout resulting from Project activities including the number and life stages of affected individuals detected, if any.
2. Implementation of all T&Cs, as applicable. In particular, document key outcomes of the adaptive management group in terms of strategies and implementation of measures that minimize upstream passage impairment impacts at structures 2 and 5 or that minimized other Project-related adverse effects to the bull trout.
3. Implementation of any conservation recommendations provided in this Biological Opinion.

Upon locating a dead, injured, or sick specimen of an endangered or threatened species, initial notification must be made to the nearest Service Law Enforcement Office (Richland, Washington; Special Agent Corky Roberts, telephone 509.546.8344). Care should be taken in handling sick or injured specimens to ensure effective treatment and care or the handling of dead specimens to preserve biological material in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered species or preservation of biological materials from a dead animal, the finder has the responsibility to carry out instructions provided by Law Enforcement to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

No more than 91 bull trout are likely to be incidentally taken annually as a result of the proposed Project. The RPMs, with their implementing T&Cs, are designed to minimize the impacts of that incidental take on the bull trout. If, during the course of the action, this level of incidental take is exceeded based on the monitoring requirement set forth in the above T&Cs, such incidental take represents new information requiring reinitiating of consultation and review of the RPMs provided herein. Under such circumstances, the LNFH must immediately cease operations causing the excessive take, and contact the CWFO immediately.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Furthermore the Service' conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends that the LNFH:

CR 1. Aggressively pursue funding for the analysis and redesign of LNFH infrastructure. The amount and extent of effects to bull trout is related to the overall design of the LNFH. Long-term solution for the hatchery's water supply system is needed, and should meet state and federal screening criteria. Similarly, we strongly encourage the LNFH consider BCS alternatives that do not impair or prevent the upstream migration of migratory bull trout. All alternatives should seek to minimize impacts to the hydrograph.

CR 2. Continue to monitor bull trout through a variety of means, including annual summer snorkel surveys, redd surveys, and other efforts. These data were invaluable in our analysis in the biological opinion, providing (1) estimates of the number of individuals exposed to the effects of the proposed action and (2) information to suggest the distribution and abundance of the Icicle local population is improving.

CR 3. Coordinate and cooperate with other agencies and entities to collect information on the abundance, genetics, life history, and temporal and spatial distribution of bull trout throughout the Icicle Creek watershed. The methods and techniques should be applicable to account for various life stages and distributions and could include radio telemetry, snorkeling, walking, angling, tagging, marking, and genetic analysis.

CR 4. Continue to provide BPA and YN an alternative (such as an unused pond at LNFH) so Coho smolt acclimation is not necessary in the side channel, which will eliminate the associated barrier and improve passage for wild fish.

CR 5. If LWD is lodged on the upstream side of dam 2, place it downstream of dam 2 in the historic channel provided it is safe for personnel to do so.

CR 6. Continue to use low Phosphorus food. Obtain food from certified sustainable fisheries.

CR 7. Install a video camera in the fish ladder at the intake structure (rm 4.5). This may improve our understanding of the use of the ladder by bull trout.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests written notification of the implementation of any conservation recommendations.

RE-INITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR §402.16, reinitiating of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

In the accompanying biological opinion, we made a number of assumptions and simplified several complex processes in order to account for uncertainties and ecological variation. Monitoring and evaluating these specific reinitiation triggers will help verify our assumptions, provide new information, and allow more precise quantification of impacts to the bull trout and its designated critical habitat. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

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Appendix A. Projects subject to prior section 7 consultation that may have had effects on bull trout in the Icicle Creek watershed.*

Project Name	**FWS Reference**
Eightmile Salvage	1-3-1995-I-824
Minor activities covered under the Wenatchee National Forest programmatic	1-3-1997-I-600
Icicle Campground Vegetation Management	1-3-1998-I-256/IC-257
Forestwide Noxious Weed Project (Wenatchee National Forest)	1-3-99-I-548
Ongoing Activities in the Wenatchee River Subbasin	1-3-99-I-0383, 0387, and 0624
Mid-Columbia Coho Reintroduction	1-9-2001-F-E0231
Icicle Creek Dredging	1-9-2001-F-E0456
Icicle Creek Restoration	9-2002-F-E0081
Eightmile and Mountaineer Bridge Replacements	1-9-2002-I-0852
Leavenworth National Fish Hatchery Fuels Reduction project	1-9-2003-I-W0222
Icicle Complex Fire Emergency Consultation	1-09-2004-F-W0470
2001 Icicle Complex Fire Salvage, Chatter Creek Trail and Trailhead Relocation, and Doctor Bob Bridge Replacement Projects	1-9-2004-F-W0021
Outfitter Guide Use Allocation Project (Wenatchee River Ranger District, Chelan County)	1-09-2005-I-W0038
Forestwide Programmatic for Selected Forest Management Activities, located on the Okanogan and Wenatchee National Forests (Chelan, Kittitas, Okanogan, and Yakima Counties, WA	1-09-2005-I-W0172
Leavenworth National Fish Hatchery Interim Operations	05-0153
District-wide 5-year plan for timber stand improvement (Wenatchee River Ranger District, Chelan County)	1-09-2005-I-W0302

Section 10(a)(1)(B) Incidental Take Permit (PRT-TE-X121202-0), State of Washington	1-3-06-FWI-0301
Operations and Maintenance of Leavenworth National Fish Hatchery through 2011	13260-2006-F-0189
USDA Forest Service (Pacific Northwest Region), Aquatic Habitat Restoration Activities in Oregon and Washington That Affect ESA-listed Fish, Wildlife, and Plant Species and their Critical Habitats	13420-2007-F-0055
Environmental Protection Agency's proposed approval of the 2006 revised water quality standards for the State of Washington	13410-2007-F-0298
Operations and Maintenance of Leavenworth National Fish Hatchery through 2011 (Remanded BO)	13260-2008-F-0040
Forestwide Programmatic for Selected Forest Management Activities, located on the Okanogan and Wenatchee National Forests (Chelan, Kittitas, Okanogan, and Yakima Counties, WA	13260-2008-I-0076
Corp of Engineer's Fish Passage and Habitat Enhancement Restoration Project (Programmatic Consultation)	13410-2008-F-0209
Icicle Road Relocation Project	13260-2010-I-0056
NPDES Permit WA0001902, Leavenworth National Fish Hatchery Project	13620-2011-I-0056
Non-Commercial Tree Thinning and Fuels Reduction Project	13620-2011-I-0066

* This list does not include projects that were determined to have "no effect" on bull trout or its designated critical habitat or projects that were covered under programmatic consultations.

Appendix B. Crosswalk between the Bull Trout Matrix and Bull Trout Critical Habitat Primary Constituent Elements

Prepared by: Jeff Krupka, Karl Halupka, and Judy De La Vergne, CWFO, March 31, 2011

The purpose of this document is to provide a consistent means for analyzing baseline conditions and project effects to both the bull trout and designated critical habitat for the bull trout using the Matrix of Pathways and Indicators.

The Matrix of Pathway Indicators (Matrix) for bull trout is used to evaluate and document baseline conditions and to aid in making effect determinations for proposed projects (USFWS 1999). The Matrix analysis incorporates 4 population indicators and 19 physical habitat indicators. Analysis of these indicators provides a systematic approach for evaluating the existing baseline condition and potential impacts in terms of metrics meaningful to bull trout.

Designated critical habitat for the bull trout (75 FR 63898) is comprised of nine primary constituent elements (PCEs). These physical, chemical, and biological features correspond to many of the Matrix habitat parameters. Table 1 shows the relationship between the PCEs for bull trout critical habitat and the Matrix habitat indicators. The *refugia* indicator is relevant to all PCEs because in order for the refugia indicator to be rated "functioning appropriately" most if not all of the PCEs must be present. Only one indicator from the population pathways, *persistence and genetic integrity*, applies to evaluation of the condition of PCEs, but this indicator is not depicted in the Crosswalk to simplify Table 1. The following information provides the rationale for how the nine PCEs for bull trout critical habitat can be addressed by using the Matrix indicators (named using italics font).

1. **Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.**

   The analysis of *floodplain connectivity* considers the hydrologic linkage of off-channel areas with the main channel and overbank-flow maintenance of wetland function and riparian vegetation and succession. Floodplain and riparian areas provide hydrologic connectivity for springs, seeps, groundwater upwelling and wetlands and contribute to the maintenance of the water table. The *sediment* and *substrate embeddedness* indicators describe the level of fine sediment in the gravel which affects hyporheic flow. Fine sediment fills interstitial spaces making the movement of water through the substrate less efficient. The *chemical contamination/nutrients* and *temperature* indicators evaluate the water quality of groundwater. The *off-channel habitat* indicator suggests how much off-channel habitat is available, and generally off-channels are connected to adjacent channels via subsurface water. The *change in peak/base flows* indicator considers whether or not peak flow, base flow, and flow timing are comparable to an undisturbed watershed of similar size, geology, and geography. Peak flows, base flows, and flow timing are directly related to subsurface water connectivity and the degree to which soil compaction has decreased infiltration and increased surface runoff. The *drainage network increase* and *road density and location* indicators assess the influence of the road and trail networks on subsurface water connectivity. If there is an increase in drainage network and roads are located in riparian areas, it is likely that subsurface water is being intercepted before it reaches a stream. If groundwater is being intercepted then it is likely that water quality is being degraded through increased temperatures, fine sediment, and possibly chemical contamination. *Streambank condition* addresses groundwater influence through an assessment of stability. The *disturbance history* indicator evaluates disturbance across the watershed and provides a picture of how management may be affecting hydrology. The *riparian conservation areas* indicator determines whether riparian areas are intact and providing connectivity. If riparian areas are intact it is much more likely that springs, seeps, and groundwater sources are able to positively affect water quality and quantity.

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.**

The *physical barriers* indicator provides the most direct assessment of this PCE. Analysis of this indicator includes consideration of whether man-made barriers within the watershed allow upstream and downstream passage of all life stages at all flows. However, some indicators further evaluate physical impediments and others evaluate the biological or water quality impediments that may be present. The *temperature*, *sediment*, *substrate embeddedness,* and *chemical contamination/nutrients* indicators assess whether other barriers may be created, at least seasonally, by conditions such as high temperatures, high concentrations of sediment, or contaminants. The *average wetted width/maximum depth ratio* indicator can help identify situations in which water depth for adult passage may be a problem. A very high average wetted width/maximum depth value may indicate a situation where low flows, when adults migrate, are so spread out that water depth is insufficient to pass adults. The *change in peak/base flows* indicator can help determine if change in base flows have been sufficient to prevent adult passage during the spawning migration. The *persistence and genetic integrity* indicator addresses biological impediments by evaluating negative interactions (e.g., predation, hybridization, and competition) with other species.

3. **An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.**

None of the indicators directly address this PCE, but a number of them address it indirectly. The *sediment* and *substrate embeddedness* indicators document the extent to which substrate interstitial spaces are filled with fine sediment. Interstitial spaces provide important habitat for aquatic macroinvertebrates, sculpin, and other substrate-oriented prey which are important food sources for bull trout. The *chemical contamination/nutrients* indicator evaluates the level to which a stream is contaminated by chemicals or has a high level of nutrients. Chemicals and nutrients greatly affect the type and diversity of aquatic invertebrate communities present in a water body. The *large woody debris* and *pool frequency and quality* indicators assess habitat complexity. High stream habitat complexity is associated with diverse and abundant macroinvertebrate and fish prey. The *off-channel habitat* and *floodplain connectivity* indicators document the presence of off-channels which are generally more productive than main channels. Off channel areas are important sources of forage, particularly for juveniles. The *streambank condition* and *riparian conservation areas* indicators both shed light on the very basis of the food base of a stream. Vegetation along streambanks and in riparian areas provide important habitat for terrestrial macroinvertebrates that can fall into the water as well as sources of nutrient inputs that support aquatic invertebrate production.

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.**

   Several indicators address this PCE directly. The *sediment* and *substrate embeddedness* indicators provide insight into how complex substrates are within a stream by documenting percent fines and embeddedness. As percent fines and embeddedness increase, substrate complexity decreases. The *large woody debris* indicator provides an excellent picture of habitat complexity. The indicator rates the stream based on the amount of in-channel large woody debris. Habitat complexity increases as large wood increases. The *pool frequency and quality* and *large pools* indicators address habitat complexity by rating the stream based on the frequency of pools and their quality. Habitat complexity increases as the number of pools and their quality increase. The *off-channel habitat* indicator directly addresses complexity associated with side channels. The indicator is rated based on the amount of off-channel habitat, cover associated with off-channels, and flow energy levels. *Average wetted width/maximum depth ratio* is an indicator of channel shape and pool quality. Low ratios suggest deeper, higher quality pools. The *streambank condition* and *riparian conservation areas* indicators both shed light on the complexity of river and stream shorelines. Vegetation along streambanks and in riparian areas provides important habitat complexity and channel roughness. The *streambank condition* indicator also provides information about the capacity of an area to produce undercut banks, which can be a very important habitat feature for bull trout. The *floodplain connectivity* indicator addresses complexity added by side channels and the ability of floodwaters to spread across the floodplain to dissipate energy and provide access to high-flow refugia for fish. The *road density and location* indicator addresses complexity by identifying if roads are located in valley bottoms. Roads located in valley bottoms reduce complexity by eliminating vegetation and replacing complex habitats with riprap or fill, and often confine the floodplain. The *disturbance regime* indicator documents the frequency, duration, and size of environmental disturbance within the watershed. If scour events, debris torrents, or catastrophic fires are frequent, long in duration, and large, then habitat complexity will be greatly reduced.

5. **Water temperatures ranging from 2 to 15 °C (36 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.**

The *temperature* indicator addresses this PCE directly. The indicator rates streams according to how well temperatures meet bull trout requirements. Other matrix indicators address temperature indirectly. The *off-channel habitat* and *floodplain connectivity* indicators address how well stream channels are hydrologically connected to off-channel areas. Floodplains and off-channels are important to maintaining the water table and providing connectivity to the channel for springs, seeps, and groundwater sources which contribute cool water to channels. The *average wetted width/maximum depth ratio* indicator also corresponds to temperature. Low width to depth ratios indicate that channels are narrow and deep with little surface area to absorb heat. The *streambank condition* indicator documents bank stability. If the streambanks are stabilized by vegetation rather than substrate then it is likely that the vegetation provides shade which helps prevent increases in temperature. The *change in peak/base flows* indicator evaluates flows and flow timing characteristics relative to what would be expected in an undisturbed watershed. If base flow has been reduced, it is likely that water temperature during base flow has increased since the amount of water to heat has decreased. The *road density and location* and *drainage network increase* indicators documents where roads are located. If roads are located adjacent to a stream then shade is reduced and temperature is likely increased. Roads also intercept groundwater and can reduce this cooling influence, as well as discharge typically warmer stormwater. The *disturbance history* indicator describes how much of the watershed has been altered by vegetation management and therefore indicates how much shade has been removed. The *riparian conservation areas* indicator addresses stream shade which keeps stream temperatures cool. The presence of *large pools* may provide thermal refugia when temperatures are high.

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 *sediment* and *substrate embeddedness* indicators directly address this PCE. These indicators evaluate the percent fines within spawning areas and the percent embeddedness within rearing areas. The *streambank condition* and *riparian conservation areas* indicators indirectly address this PCE by documenting the presence or lack of potential fine sediment sources. If streambanks are stable and riparian conservation areas are intact then there is a low risk of introducing fine sediment from bank erosion. Also, the *floodplain connectivity* indicator indirectly addresses this PCE. If the stream channel is connected to its floodplain, then there is less risk of bank erosion during high flows because stream energy is reduced as water spreads across the floodplain. The *increase in drainage network* and *road density and location* indicators assess the effects of roads on the channel network and hydrology. If the drainage network has significantly increased as a result of human-caused disturbance or road density is high within a watershed and roads are located adjacent to streams, then it is likely that in-channel fine sediment levels will be elevated above natural levels. The *disturbance regime* indicator documents the nature of environmental disturbance within the watershed. If the disturbance regime includes frequent and unpredictable scour events, debris torrents, and catastrophic fire, then it is likely that fine sediment levels will be elevated above background levels. A consideration for all indicators directly or indirectly influencing this PCE is that it is desirable to achieve an appropriate balance of stable areas to provide undercut banks and eroding areas that are sources for recruiting new spawning gravels. Too little sediment in a stream can also be detrimental.

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.**

   The *change in peak/base flows* indicator addresses this PCE directly by documenting the condition of the watershed hydrograph relative to an undisturbed watershed of similar size, geology, and geography. There are several indicators that address this PCE indirectly. The *streambank condition* indicator documents bank stability. If the streambanks are stabilized by vegetation rather than substrate then it is likely that the streambank can store water during moist periods and releases that water during dry periods which contributes to water quality and quantity. The *floodplain connectivity* indicator is relevant to water storage within the floodplain which directly affects base flow. Floodplains are important to maintaining the water table and providing connectivity to the channel for springs, seeps, and groundwater sources which contribute to water quality and quantity. The *increase in drainage network* and *road density and location* indicators assess the influence of the road and trail networks on hydrology. If there is an increase in drainage network and roads are located in riparian areas, it is likely is being intercepted and quickly routed to a stream which can increase peak flow. The *disturbance history* indicator evaluates disturbance across the watershed and provides a picture of how management may be affecting hydrology; for example, it may suggest the degree to which soil compaction has decreased infiltration and increased surface runoff. The *riparian conservation areas* indicator determines whether riparian areas are intact, functioning, and providing connectivity. If riparian areas are intact it is much more likely that springs, seeps, and groundwater sources are able to positively affect water quality and quantity.

8. **Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.**

   This PCE is closely related to PCE 7, with PCE 8 adding a water quality component (i.e., there is a high level of overlap in indicators that apply to both PCEs 7 and 8). The *temperature* and *chemical contamination/nutrients* indicators directly address water quality by comparing water temperatures to bull trout water temperature requirements, and documenting 303(d) designated stream reaches. Several other indicators indirectly address this PCE by evaluating the risk of fine sediment being introduced that would result in decreased water quality through increased turbidity. The *streambank condition* and *riparian conservation areas* indicators indirectly address this PCE by documenting the presence or lack of potential fine sediment sources. If streambanks are stable and riparian conservation areas are intact then there is a low risk of introducing fine sediment from bank erosion. Also, the *floodplain connectivity* indicator indirectly addresses this PCE. If the stream channel is connected to its floodplain, then there is less risk of bank erosion during high flows because stream energy is reduced as water spreads across the floodplain. *Average wetted width/maximum depth ratio* is an indication of water volume, which indirectly indicates water temperature, (i.e., low ratios indicate deeper water, which in turn indicates possible high-flow refugia). This indicator in conjunction with *change in peak/base flows* is an indicator of potential water quality and quantity deficiencies, particularly during low flow periods. The *increase in drainage network* and *road density and location* indicators assess the effects of roads on the channel network and hydrology. If the drainage network has significantly increased as a result of human-caused disturbance or road density is high within a watershed and roads are located adjacent to streams, then it is likely that suspended fine sediment levels will be elevated above natural levels. If roads are located adjacent to a stream then shade is reduced and temperature is likely increased. Roads also intercept groundwater and can reduce this cooling influence, as well as discharge typically warmer stormwater. The *disturbance regime* indicator documents the nature of environmental disturbance within the watershed. If the disturbance regime includes frequent and unpredictable scour events, debris torrents, and catastrophic fire, then it is likely that turbidity levels will be elevated above background levels.

9. **Sufficiently low levels of occurrence of nonnative 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.**

The only indicator that directly addresses this PCE is the *persistence and genetic integrity* indicator. This indicator addresses the likelihood of predation, hybridization, or displacement of bull trout by competitive species. The *temperature* indicator can provide indirect insights about whether conditions are conducive to supporting “warm water” species.

Table 1. Relationship of the Matrix Indicators to the Primary Constituent Elements of Bull Trout Critical Habitat

Pathways (bold) and Indicators	PCE 1 - Springs, Seeps, Groundwater	PCE 2- Migratory Corridors*	PCE 3 - Abundant Food Base	PCE 4 - Complex Habitats	PCE 5 - Temperature	PCE 6 - Substrate	PCE - 7 Hydrograph	PCE 8 - Water Quality/ Quantity	PCE 9 - Nonnative Species*
Water Quality									
Temperature	X	X			X			X	X
Sediment	X	X	X	X		X			
Chemical Contamination/Nutrients	X	X	X					X	
Habitat Access									
Physical Barriers		X							
Habitat Elements									
Substrate Embeddedness	X	X	X	X		X			
Large Woody Debris			X	X					
Pool Frequency and Quality			X	X					
Large Pools				X	X				
Off-Channel Habitat	X		X	X	X				
Refugia	X	X	X	X	X	X	X	X	X
Channel Conditions and Dynamics									
Wetted With/Max. Depth Ratio		X		X	X			X	
Streambank Condition	X		X	X	X	X	X	X	
Floodplain Connectivity	X		X	X	X	X	X	X	
Flow/Hydrology									
Changes in Peak/Base Flows	X	X			X		X	X	
Drainage Network Increase	X				X	X	X	X	
Watershed Conditions									
Road Density and Location	X			X	X	X	X	X	
Disturbance History	X				X		X		
Riparian Conservation Areas	X		X	X	X	X	X	X	
Disturbance Regime				X		X		X	

* = PCE is also related to the population pathway, *persistence and genetic integrity* indicator

Appendix G

Crosswalk between the Bull Trout Matrix and Bull Trout Critical Habitat Primary Constituent Elements

Crosswalk between the Bull Trout Matrix and Bull Trout Critical Habitat Primary Constituent Elements

Prepared by:
Jeff Krupka, Karl Halupka, and Judy De La Vergne, CWFO,
March 31, 2011

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1. **Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.**

   The analysis of *floodplain connectivity* considers the hydrologic linkage of off-channel areas with the main channel and overbank-flow maintenance of wetland function and riparian vegetation and succession. Floodplain and riparian areas provide hydrologic connectivity for springs, seeps, groundwater upwelling and wetlands and contribute to the maintenance of the water table. The *sediment* and *substrate embeddedness* indicators describe the level of fine sediment in the gravel which affects hyporheic flow. Fine sediment fills interstitial spaces making the movement of water through the substrate less efficient. The *chemical contamination/nutrients* and *temperature* indicators evaluate the water quality of groundwater. The *off-channel habitat* indicator suggests how much off-channel habitat is available, and generally off-channels are connected to adjacent channels via subsurface water. The *change in peak/base flows* indicator considers whether or not peak flow, base flow, and flow timing are comparable to an undisturbed watershed of similar size, geology, and geography. Peak flows, base flows, and flow timing are directly related to subsurface water connectivity and the degree to which soil compaction has decreased infiltration and increased surface runoff. The *drainage network increase* and *road density and location* indicators assess the influence of the road and trail networks on subsurface water connectivity. If there is an increase in drainage network and roads are located in riparian areas, it is likely that subsurface water is being intercepted before it reaches a stream. If groundwater is being intercepted then it is likely that water quality is being degraded through increased temperatures, fine sediment, and possibly chemical contamination. *Streambank condition* addresses groundwater influence through an assessment of stability. The *disturbance history* indicator evaluates disturbance across the watershed and provides a picture of how management may be affecting hydrology. The *riparian conservation areas* indicator determines whether riparian areas are intact and providing connectivity. If riparian areas are intact it is much more likely that springs, seeps, and groundwater sources are able to positively affect water quality and quantity.

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.**

The *physical barriers* indicator provides the most direct assessment of this PCE. Analysis of this indicator includes consideration of whether man-made barriers within the watershed allow upstream and downstream passage of all life stages at all flows. However, some indicators further evaluate physical impediments and others evaluate the biological or water quality impediments that may be present. The *temperature*, *sediment, substrate embeddedness,* and *chemical contamination/nutrients* indicators assess whether other barriers may be created, at least seasonally, by conditions such as high temperatures, high concentrations of sediment, or contaminants. The *average wetted width/maximum depth ratio* indicator can help identify situations in which water depth for adult passage may be a problem. A very high average wetted width/maximum depth value may indicate a situation where low flows, when adults migrate, are so spread out that water depth is insufficient to pass adults. The *change in peak/base flows* indicator can help determine if change in base flows have been sufficient to prevent adult passage during the spawning migration. The *persistence and genetic integrity* indicator addresses biological impediments by evaluating negative interactions (e.g., predation, hybridization, and competition) with other species.

3. **An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.**

None of the indicators directly address this PCE, but a number of them address it indirectly. The *sediment* and *substrate embeddedness* indicators document the extent to which substrate interstitial spaces are filled with fine sediment. Interstitial spaces provide important habitat for aquatic macroinvertebrates, sculpin, and other substrate-oriented prey which are important food sources for bull trout. The *chemical contamination/nutrients* indicator evaluates the level to which a stream is contaminated by chemicals or has a high level of nutrients. Chemicals and nutrients greatly affect the type and diversity of aquatic invertebrate communities present in a water body. The *large woody debris* and *pool frequency and quality* indicators assess habitat complexity. High stream habitat complexity is associated with diverse and abundant macroinvertebrate and fish prey. The *off-channel habitat* and *floodplain connectivity* indicators document the presence of off-channels which are generally more productive than main channels. Off channel areas are important sources of forage, particularly for juveniles. The *streambank condition* and *riparian conservation areas* indicators both shed light on the very basis of the food base of a stream. Vegetation along streambanks and in riparian areas provide important habitat for terrestrial macroinvertebrates that can fall into the water as well as sources of nutrient inputs that support aquatic invertebrate production.

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.**

Several indicators address this PCE directly. The *sediment* and *substrate embeddedness* indicators provide insight into how complex substrates are within a stream by documenting percent fines and embeddedness. As percent fines and embeddedness increase, substrate complexity decreases. The *large woody debris* indicator provides an excellent picture of habitat complexity. The indicator rates the stream based on the amount of in-channel large woody debris. Habitat complexity increases as large wood increases. The *pool frequency and quality* and *large pools* indicators address habitat complexity by rating the stream based on the frequency of pools and their quality. Habitat complexity increases as the number of pools and their quality increase. The *off-channel habitat* indicator directly addresses complexity associated with side channels. The indicator is rated based on the amount of off-channel habitat, cover associated with off-channels, and flow energy levels. *Average wetted width/maximum depth ratio* is an indicator of channel shape and pool quality. Low ratios suggest deeper, higher quality pools. The *streambank condition* and *riparian conservation areas* indicators both shed light on the complexity of river and stream shorelines. Vegetation along streambanks and in riparian areas provides important habitat complexity and channel roughness. The *streambank condition* indicator also provides information about the capacity of an area to produce undercut banks, which can be a very important habitat feature for bull trout. The *floodplain connectivity* indicator addresses complexity added by side channels and the ability of floodwaters to spread across the floodplain to dissipate energy and provide access to high-flow refugia for fish. The *road density and location* indicator addresses complexity by identifying if roads are located in valley bottoms. Roads located in valley bottoms reduce complexity by eliminating vegetation and replacing complex habitats with riprap or fill, and often confine the floodplain. The *disturbance regime* indicator documents the frequency, duration, and size of environmental disturbance within the watershed. If scour events, debris torrents, or catastrophic fires are frequent, long in duration, and large, then habitat complexity will be greatly reduced.

5. **Water temperatures ranging from 2 to 15 °C (36 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.**

   The *temperature* indicator addresses this PCE directly. The indicator rates streams according to how well temperatures meet bull trout requirements. Other matrix indicators address temperature indirectly. The *off-channel habitat* and *floodplain connectivity* indicators address how well stream channels are hydrologically connected to off-channel areas. Floodplains and off-channels are important to maintaining the water table and providing connectivity to the channel for springs, seeps, and groundwater sources which contribute cool water to channels. The *average wetted width/maximum depth ratio* indicator also corresponds to temperature. Low width to depth ratios indicate that channels are narrow and deep with little surface area to absorb heat. The *streambank condition* indicator documents bank stability. If the streambanks are stabilized by vegetation rather than substrate then it is likely that the vegetation provides shade which helps prevent increases in temperature. The *change in peak/base flows* indicator evaluates flows and flow timing characteristics relative to what would be expected in an undisturbed watershed. If base flow has been reduced, it is likely that water temperature during base flow has increased since the amount of water to heat has decreased. The *road density and location* and *drainage network increase* indicators documents where roads are located. If roads are located adjacent to a stream then shade is reduced and temperature is likely increased. Roads also intercept groundwater and can reduce this cooling influence, as well as discharge typically warmer stormwater. The *disturbance history* indicator describes how much of the watershed has been altered by vegetation management and therefore indicates how much shade has been removed. The *riparian conservation areas* indicator addresses stream shade which keeps stream temperatures cool. The presence of *large pools* may provide thermal refugia when temperatures are high.

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.**

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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.**

   The *change in peak/base flows* indicator addresses this PCE directly by documenting the condition of the watershed hydrograph relative to an undisturbed watershed of similar size, geology, and geography. There are several indicators that address this PCE indirectly. The *streambank condition* indicator documents bank stability. If the streambanks are stabilized by vegetation rather than substrate then it is likely that the streambank can store water during moist periods and releases that water during dry periods which contributes to water quality and quantity. The *floodplain connectivity* indicator is relevant to water storage within the floodplain which directly affects base flow. Floodplains are important to maintaining the water table and providing connectivity to the channel for springs, seeps, and groundwater sources which contribute to water quality and quantity. The *increase in drainage network* and *road density and location* indicators assess the influence of the road and trail networks on hydrology. If there is an increase in drainage network and roads are located in riparian areas, it is likely is being intercepted and quickly routed to a stream which can increase peak flow. The *disturbance history* indicator evaluates disturbance across the watershed and provides a picture of how management may be affecting hydrology; for example, it may suggest the degree to which soil compaction has decreased infiltration and increased surface runoff. The *riparian conservation areas* indicator determines whether riparian areas are intact, functioning, and providing connectivity. If riparian areas are intact it is much more likely that springs, seeps, and groundwater sources are able to positively affect water quality and quantity.

8. **Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.**

This PCE is closely related to PCE 7, with PCE 8 adding a water quality component (i.e., there is a high level of overlap in indicators that apply to both PCEs 7 and 8). The *temperature* and *chemical contamination/nutrients* indicators directly address water quality by comparing water temperatures to bull trout water temperature requirements, and documenting 303(d) designated stream reaches. Several other indicators indirectly address this PCE by evaluating the risk of fine sediment being introduced that would result in decreased water quality through increased turbidity. The *streambank condition* and *riparian conservation areas* indicators indirectly address this PCE by documenting the presence or lack of potential fine sediment sources. If streambanks are stable and riparian conservation areas are intact then there is a low risk of introducing fine sediment from bank erosion. Also, the *floodplain connectivity* indicator indirectly addresses this PCE. If the stream channel is connected to its floodplain, then there is less risk of bank erosion during high flows because stream energy is reduced as water spreads across the floodplain. *Average wetted width/maximum depth ratio* is an indication of water volume, which indirectly indicates water temperature, (i.e., low ratios indicate deeper water, which in turn indicates possible high-flow refugia). This indicator in conjunction with *change in peak/base flows* is an indicator of potential water quality and quantity deficiencies, particularly during low flow periods. The *increase in drainage network* and *road density and location* indicators assess the effects of roads on the channel network and hydrology. If the drainage network has significantly increased as a result of human-caused disturbance or road density is high within a watershed and roads are located adjacent to streams, then it is likely that suspended fine sediment levels will be elevated above natural levels. If roads are located adjacent to a stream then shade is reduced and temperature is likely increased. Roads also intercept groundwater and can reduce this cooling influence, as well as discharge typically warmer stormwater. The *disturbance regime* indicator documents the nature of environmental disturbance within the watershed. If the disturbance regime includes frequent and unpredictable scour events, debris torrents, and catastrophic fire, then it is likely that turbidity levels will be elevated above background levels.

9. Sufficiently low levels of occurrence of nonnative 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.

The only indicator that directly addresses this PCE is the *persistence and genetic integrity* indicator. This indicator addresses the likelihood of predation, hybridization, or displacement of bull trout by competitive species. The *temperature* indicator can provide indirect insights about whether conditions are conducive to supporting “warm water” species.

Table 1. Relationship of the Matrix Indicators to the Primary Constituent Elements of Bull Trout Critical Habitat

Pathways (bold) and Indicators	**PCE 1 - Springs, Seeps, Groundwater**	**PCE 2- Migratory Corridors***	**PCE 3 - Abundant Food Base**	**PCE 4 - Complex Habitats**	**PCE 5 - Temperature**	**PCE 6 - Substrate**	**PCE - 7 Hydrograph**	**PCE 8 - Water Quality/ Quantity**	**PCE 9 - Nonnative Species***
Water Quality									
Temperature	X	X			X			X	X
Sediment	X	X	X	X		X			
Chemical Contamination/Nutrients	X	X	X					X	
Habitat Access									
Physical Barriers		X							
Habitat Elements									
Substrate Embeddedness	X	X	X	X		X			
Large Woody Debris			X	X					
Pool Frequency and Quality			X	X					
Large Pools				X	X				
Off-Channel Habitat	X		X	X	X				
Refugia	X	X	X	X	X	X	X	X	X
Channel Conditions and Dynamics									
Wetted With/Max. Depth Ratio		X		X	X			X	
Streambank Condition	X		X	X	X	X	X	X	
Floodplain Connectivity	X		X	X	X	X	X	X	
Flow/Hydrology									
Changes in Peak/Base Flows	X	X			X		X	X	
Drainage Network Increase	X				X	X	X	X	
Watershed Conditions									
Road Density and Location	X			X	X	X	X	X	
Disturbance History	X				X		X		
Riparian Conservation Areas	X		X	X	X	X	X	X	
Disturbance Regime				X		X		X	

* = PCE is also related to the population pathway, *persistence and genetic integrity* indicator