Fisheries Biological Assessment For the Upper Wenatchee Pilot Restoration Project

Wenatchee River Ranger District, Okanogan-Wenatchee National Forest

WATERSHED ANALYSES: Mainstem Wenatchee River (1999), Little Wenatchee-White River (1998), Chiwawa River (1997)

PROJECT LOCATION BY HUC WATERSHEDS:

HUC 4: Wenatchee River

HUC 10: Wenatchee River
HUC 12: Beaver Creek-Wenatchee River

HUC 10: Little Wenatchee-White River
HUC 12: Lake Wenatchee

HUC 10: Chiwawa River
HUC 12s: Lower Chiwawa River, Big Meadow Creek

EFFECTS DETERMINATION FOR NON-ARBO II ACTIONS ANALYZED IN THIS BA:

May Affect, Likely to Adversely Affect:
Upper Columbia River steelhead
Upper Columbia River steelhead Critical Habitat
Columbia River Bull Trout & Critical Habitat

May Affect, Not Likely to Adversely Affect:
Upper Columbia River Spring-Run Chinook & Critical Habitat

Not Adversely Affected**:** Essential Fish Habitat

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Introduction

The purpose of this Biological Assessment (BA) is to present an analysis of effects for the proposed Upper Wenatchee Pilot project on federally listed aquatic endangered, threatened, candidate, proposed species, and US Forest Service, Region 6 sensitive species and their habitat. The analysis is conducted to determine whether formal consultation or conference is required with the United States Department of Interior (USDI) Fish and Wildlife Service, pursuant to the Endangered Species Act. The BA/BE is prepared in compliance with the requirements of Forest Service Manual 2670 and provides for compliance with Code of Federal Regulations (CFR) 50-402.12. The BA also meets information requirements for essential fish habitat (EFH) consultation for Pacific salmon under the Magnuson-Stevens Fishery Conservation and Management Act and its implementing regulations (50 CFR Part 600).

Design and implementation of all aquatic restoration actions would be consistent with aquatic restoration activity categories and design criteria in the Aquatic Restoration Biological Opinion (ARBO II, NMFS 2013); these projects would have a low level of project design and implementation detail and would be consulted on under the Aquatic Restoration Biological Opinion (ARBO) II programmatic biological assessment (BA). The list of aquatic restoration actions presented in Appendix 1 will not be reanalyzed in this BA and have been included in this analysis in order to share information about the aquatic restoration projects we are anticipating implementing in the future within the action area. Aquatic restoration actions will be beneficial in the long-term for fish and their habitats.

The Upper Wenatchee Pilot project occurs on land administered by the US Forest Service (USFS), Okanogan-Wenatchee National Forest (Oka-Wen NF) and Wenatchee River Ranger District, Figure 1. This BA evaluates the preferred alternative, Alternative 1, which proposes vegetation treatments, National Forest System (NFS) road treatments and in-stream and riparian habitat treatments.

This analysis includes the following listed fish species and the associated Designated Critical Habitat: Upper Columbia River steelhead Distinct Population Segment (DPS) (threatened), the Upper Columbia River Spring-run Chinook Evolutionarily Significant Unit (ESU; endangered), and Columbia River Bull Trout (threatened).

Project Location

The southern extent of the Upper Wenatchee Pilot Project (UWPP, or Project) area is located approximately 6 miles north of the town of Leavenworth in Chelan County, Washington (Figure 3) and extends another 18 miles north. The Project area crosses large environmental gradients, extending from the lower elevation dry ponderosa pine forests to high elevation sub-alpine fir and whitebark pine dominated forests.

The UWPP planning area includes three Hydrologic Unit Code (HUC) 10 watersheds (Chiwawa River, Wenatchee River, and the White River-Little Wenatchee) and four HUC 12 subwatersheds (Beaver Creek-Wenatchee River, Lake Wenatchee, Lower Chiwawa River, and Big Meadow Creek; Figure 1).

Wenatchee River Watershed:

The Beaver Creek-Wenatchee River subwatershed is the largest and lowest in the planning area. It covers approximately 28,540 acres and includes the mainstem Wenatchee River upstream of U.S. Highway 2, Beaver Creek, and Fish Lake. Lake Wenatchee and the Chiwawa River are major tributaries to this subwatershed. Nason Creek is also a direct tributary to the Beaver Creek-Wenatchee River subwatershed but is not included in the UWPP project area.

White River-Little Wenatchee Watershed:

The Lake Wenatchee subwatershed covers approximately 10,990 acres and includes Lake Wenatchee and the short, steep drainages flowing directly into the lake. The White River and the Little Wenatchee River are both significant tributaries to the lake but are delineated as separate subwatersheds and not included in the UWPP planning area. Lake Wenatchee is a natural lake formed by a glacial moraine at the downstream terminus of the lake (Inter-Fluve, 2012) and the mainstem Wenatchee River begins at its outlet.

Chiwawa River Watershed:

The Lower Chiwawa River subwatershed is the second largest in the planning area, covering approximately 25,090 acres. It includes the lower reaches of the mainstem Chiwawa River from its confluence with the mainstem Wenatchee River, upstream to the confluence with Chikamin Creek. Farther upstream, outside of the planning area, the headwaters originate in the Cascade and Entiat mountains. Numerous tributaries drain into the Lower Chiwawa River subwatershed, most notably Big Meadow Creek.

The Big Meadow Creek subwatershed is a headwater system that covers approximately 10,130 acres and drains into the Chiwawa River. It is characterized by a large, low gradient meadow and floodplain valley that receives flow from short, steep tributaries originating on the slopes immediately surrounding the valley. Downstream of the meadow, the creek runs through a narrowly confined reach before joining the Lower Chiwawa River subwatershed.

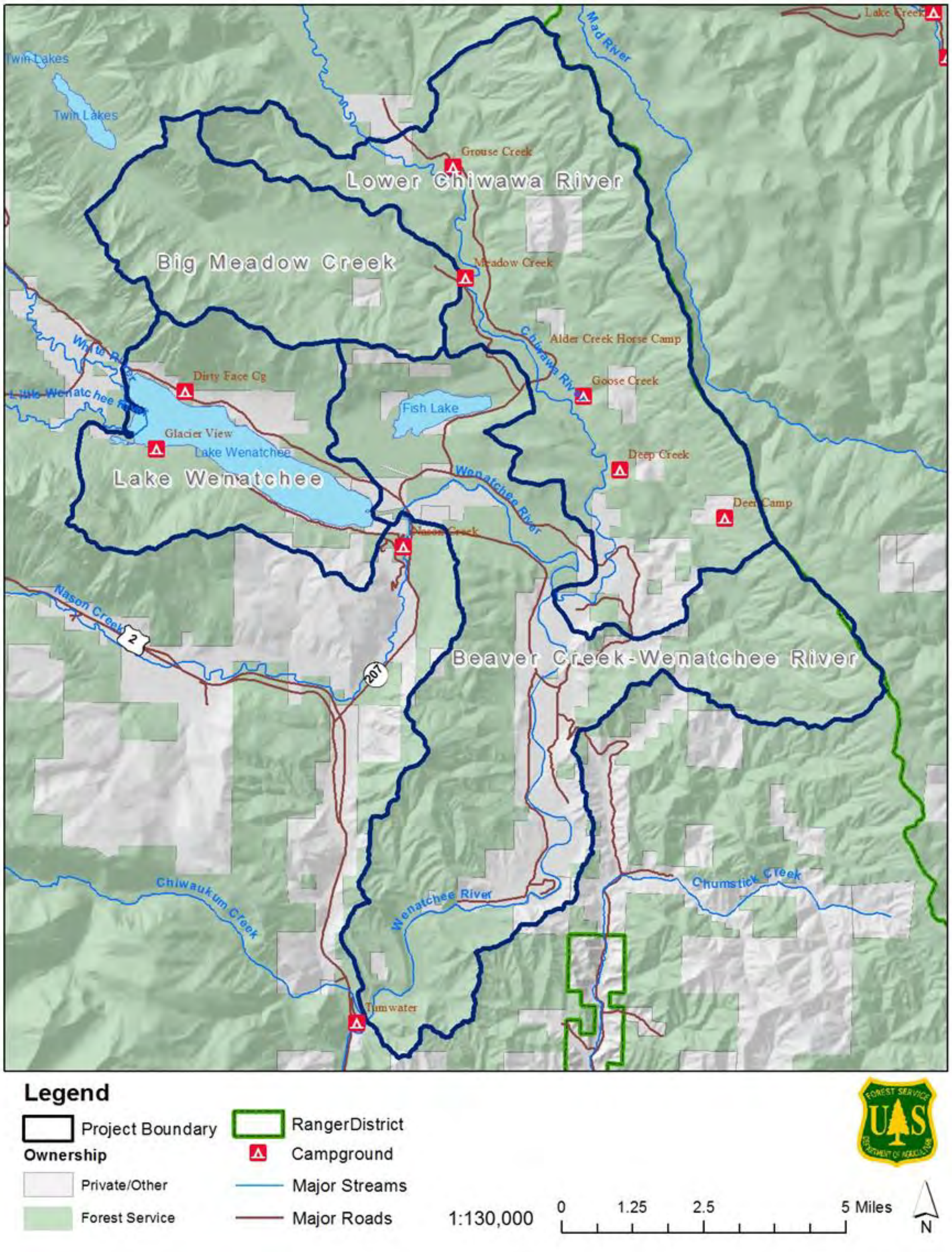

Figure 1. Upper Wenatchee Pilot Project HUC 12 subwatersheds and land ownership.

Purpose and Need

As a collaborative pilot project, the purposes for the Project have been defined as a set of goals developed by the collaborative work groups created to assist and support the Forest Service in developing the proposed action for the Project. The Wenatchee River Ranger District, Okanogan-Wenatchee National Forest, has developed proposals for the Project, to support the purpose of the project and that are consistent with the Wenatchee National Forest Plan, as amended.

The primary **purpose** of this project is to create a more resilient terrestrial and aquatic landscape to:

1. Address conditions that have departed from the historical range of variability to reduce the risk of wildfire and other disturbances to protect lives, communities, and ecological values.

2. Promote better outcomes for a broad spectrum of ecological, social, and community resources and values in a manner that recognizes and responds to the important role of natural fire and helps mitigate risk in the wildland-urban interface (WUI) while providing for sustainable user access.

3. Protect and restore watershed conditions that maintain uplands, late-successional habitat and large and old trees, riparian and instream habitat, and water quality and quantity for the benefit of communities and native fish and wildlife.

4. Design and implement treatments to support the recovery of threatened, endangered, and sensitive species.

The Forest Restoration Strategy (USDA Forest Service, 2012a), as detailed specifically in the Upper Wenatchee Landscape Evaluation (USDA Forest Service, 2017a), provides the basis for most of the needs being addressed through this EA. Guidance is also provided in the Forest Plan, as amended, and the Restoration Strategy (including large and old tree policy, as well as guidance provided in LSR Assessments and Watershed Assessments). The following sections detail the specific **needs** identified for terrestrial and aquatic resources within the planning area. Needs are described as the specific existing conditions that have departed from historical and/or desired conditions. Desired future conditions intended to be created by the proposed action are defined under each need.

Terrestrial Needs and Desired Future Conditions

As documented in the Upper Wenatchee Landscape Evaluation (USDA Forest Service, 2017a), the Upper Wenatchee landscape is a product of its history. The legacy of logging in the early to mid-twentieth century, followed by a sudden drop in logging activity and increased fire suppression, has led to major changes on the landscape, including a lack of large old trees and areas of poor forest health and high risk of uncharacteristic wildfire (within dry forests of the lower reaches) and insect and disease infestations. The past practices and increased fire suppression have altered the size, composition, and connectivity of forest stands. Many stands have grown into dense, multi-layered forest canopies where there is a lack of large and old trees, areas of poor forest health, high risk of wildfire, and high risk of insect and disease infestations. Thus, there is a need to:

Create and maintain successional pathways that provide the amount and spatial arrangement of forest conditions that increase resilience to natural disturbance and sustainability. Past logging and fire suppression have resulted in an overabundance of what is called “young forest multi-story” forest structural class. These stands have also grown into dense, multi-layered forest canopies, creating conditions that are at high risk of insect and disease outbreaks and uncharacteristically severe fires. The abundance of young multi-layered forest represents a significant departure from historical reference conditions and places the area at high risk for fire and insect/disease outbreaks. This threat of high-intensity wildfire puts ecological values, human lives, and communities at risk. Based on these existing conditions, desired future conditions include the following:

- At the landscape level, shift the current overabundance of young multilayered stands to include more open-forest conditions by removing smaller trees (ladder fuels) while retaining large-diameter trees.
- Create a landscape with intact ecological processes, patterns, and functions and forest vegetation that is resilient to climate change.
- Shift across the landscape key components of the species composition, structure, and pattern of forest vegetation closer to the historical and estimated future range of variability.
- Maintain early-successional habitat throughout the landscape at the appropriate proportions, patch size, and distribution.
- Create forest stand structure, species, and genetic composition appropriate for the specific site and landscape conditions. Multilayered forest stands should be located where they are sustainable and historically occurred.
- Reduce fuel loadings where needed to allow fire to function as a natural process on the landscape at intensities within the historical range of variability.

Improve habitat conditions within LSRs while reducing risk of stand-replacing fires. The planning area has large amounts of land designated as LSRs under the NWFP. A major purpose of LSRs is to support the recovery of NSO and associated late-successional species. Many of the LSRs in the planning area, however, include large amounts of the dense, at-risk forest types described above. In addition to being at risk of stand-replacing crown fire, the uncharacteristically dense forests within LSRs may also inhibit habitat use by forest birds that forage under the canopy, including NSO and northern goshawks (Accipiter gentilis). Designated LSRs also contain younger forests that have not yet reached late-successional conditions and associated ecological functions and values intended to be provided by LSRs. Based on these existing conditions, desired future conditions include the following:

- Shift late-successional habitat species composition and structure to improve LSR functions and values within the planning area.
- Align fire regimes within late-successional habitat closer to historical conditions, including more frequent, low-intensity fires and less frequent stand-replacing events.
- Create conditions within late successional and old-growth forests that support plant and animal life associated with late-successional and old-growth–related species, including the NSO.

- Support NSO recovery, as described in the 2011 Revised Northern Spotted Owl Recovery Plan (USFWS, 2011).

Maintain, enhance, or accelerate the development of large and old trees and increase proportion of old forest structure. Past logging and fires and salvage have greatly reduced the amount of late-successional forests containing large old trees and snags. These structures provide important ecosystem values, including biological diversity. These important values and associated functions are generally lacking at the landscape level in the Project area. The vulnerability to infestations of insects is higher compared to historical conditions. Native root diseases are also common in young multilayered stands dominated by Douglas-fir (Pseudotsuga menziesii). Based on these existing conditions, desired future conditions include the following:

- Increase the presence of large old trees and snags across the landscape to levels within the historical and estimated future range of variability.
- Encourage the development of large old trees and snags where needed to support viable populations of snag-dependent species.
- Maintain and protect large and old trees across the planning area.
- Reduce tree densities and shift forest stand structure, species composition, and landscape pattern to reduce insects and disease risks and damage to endemic levels.

Conserve the existing spotted owl and old forest habitat, and identify and implement vegetation treatments to develop additional habitat in the most sustainable landscape location. The Project area provides extensive suitable NSO habitat. At the same time, many of the stands that provide NSO habitat are young multilayered forest and are also at high risk for fire and insect/disease outbreaks. Based on these existing conditions, desired future conditions include the following:

- Support NSO recovery, as described in the 2011 Northern Spotted Owl Recovery Plan (USFWS, 2011).
- Prioritize retention of habitat within the highest priority NSO activity centers.
- Retain or restore higher-priority NSO habitats, defined as older, multilayered structurally complex forests characterized as having large-diameter trees, high amounts of canopy cover, and decadence components such as broken-topped live trees, mistletoe, cavities, large snags, and fallen trees.
- Maintain connectivity of NSO dispersal habitat across the landscape.
- Implement shaded fuel breaks to protect NSO habitat.

Support biodiversity by restoring, enhancing, and/or maintaining unique habitats including aspen, white bark pine, meadows, and huckleberry fields. The Project includes several types communities other than conifer forests, including aspen, whitebark pine stands, meadows, huckleberry fields, and other special plant communities and habitats. These habitats support biodiversity but have been reduced across the landscape over time due to fire suppression, which has allowed conifer species to encroach upon these areas. Based on these existing conditions, desired future conditions include the following:

- Reduce conifer encroachment into special habitats.
- Increase special habitats, including aspen, white bark pine, meadows, and huckleberry fields and associated plant and wildlife species and communities where needed and appropriate.
- Enhance huckleberry production by strategically placing openings across the area where this shrub is present.

Reduce impacts from fire and return fire as a natural element of the landscape. The landscape has departed from historical conditions. While fire metrics such as risk, rate of spread, and crown-fire potential mostly fall within reference conditions, the arrangement of fuels across the landscape has departed from historical condition. The density of high-risk fire areas is spread out evenly throughout the landscape in small but dense patches. Over 30 percent of each subwatershed is classified as having a high risk of crown fire, which is on the high end of the historical range of variability. Based on these existing conditions, desired future conditions include the following:

- Reduce fuel levels to allow fire to function as a natural process on the landscape at intensities within the historical range of variability.
- Shift stand structures and composition to allow more frequent, low-intensity fires and lower probability of major stand-replacing events, particularly within dry forest zones.
- Retain the largest and most fire-tolerant tree species and increase patch sizes.
- Develop shaded fuel breaks along ridgelines, system roads, and pre-existing firelines.

Reduce risk of fire on National Forest System lands in the WUI. Wildland fire that threatens developed lands is a major concern throughout the United States (U.S.), particularly in the western U.S. The WUI is a place where humans and their development meet or intermix with wildland fuel. The Project planning area includes areas of high and increasing densities of homes and recreational properties. The Washington Department of Natural Resources (WDNR), local communities, and collaboratives, including the North Central Washington Forest Health Collaborative, have all identified the need to reduce the risks to property and human lives posed by fire. Based on these existing conditions, desired future conditions include the following:

- Creating landscape-level conditions where the potential for fire spread and intensity is within the historical range of variability.
- Reducing the threat from wildland fire spreading to local communities as well as the threats of fire spreading from local communities to Forest Service lands.
- Coordinating and aligning fire and fuels management efforts on National Forest System lands within the WUI with efforts on adjacent lands being conducted by the WDNR, Chelan County, local Firewise Communities, and others.
- Develop fuel breaks around non-federal lands.

Aquatic and Riparian Needs and Objectives

Aquatic and riparian desired conditions and management objectives are established in the Forest Plan, as amended by the ACS. Restoration opportunities that may move watershed conditions towards improved watershed conditions and aquatic objectives that may contribute towards recovery of listed fish species and critical habitat have been identified in six related studies including the Upper Wenatchee Pilot Project Aquatic Habitat Assessment and Restoration Report, Appendix C (Cramer Fish Sciences, 2019), Upper Wenatchee River Stream Corridor Assessment and Habitat Restoration Strategy (Inter-Fluve, 2012), A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region (UCRTT, 2017), Fish Passage Project Prioritization in the Upper Columbia (UCSRB, 2018), USFS road and stream survey data, and the Upper Wenatchee Pilot Project Travel Analysis Report (USDA Forest Service, 2019a). The landscape evaluation was used to identify restoration opportunities that could move watershed conditions towards aquatic objectives and contribute towards recovery of listed fish species and critical habitat. It identified numerous catchments where the road system is affecting stream habitat. Thus, there is a need to:

Improve habitat connectivity for Chinook salmon, bull trout, and steelhead by removing barriers to fish passage. Road-related barriers (primarily culverts) currently block potential habitat for focus fish species. Habitat connectivity for Chinook salmon, bull trout, and steelhead is good in the Chiwawa and Wenatchee rivers but limited by roads and culverts in most tributaries. The mainstem rivers are key migration corridors for all three species, and key areas for juvenile steelhead rearing. Tributaries to these main channels, however, include good potential habitat not currently accessible. Based on these existing conditions, desired future conditions include the following:

- Remove fish passage barriers created by roads and culverts so that suitable intrinsic habitat is available to salmon, trout, and steelhead.
- Support recovery of Columbia River Chinook salmon, steelhead, and bull trout.

Improve aquatic habitat, including instream, riparian, banks, and floodplains. As documented in the Upper Wenatchee Landscape Evaluation (USDA Forest Service 2017a), the Project area has a long history of land use that has altered aquatic habitats. Both the Wenatchee and the Lower Chiwawa rivers have seen road development and riparian vegetation removal associated with urban development on private land, as well as the annual log drives that were known to have occurred in the early 1900s. These log drives are known to greatly reduce woody debris within streams as well as physically changing stream channels and banks, and the effects of such impacts remain in places today. In addition, relatively heavy timber harvest initiated in the late 1950s and early 1960s and continuing into the late 1980s resulted in extensive logging, which included building roads and harvesting trees within riparian zones. This has reduced stream channel stability and overall aquatic habitat values in many places. Based on these existing conditions, project objectives include the following:

- Remove or realign existing roads where needed to reconnect floodplains
- Restore abandoned roadbeds to more natural conditions within floodplains and riparian areas

- Increase large woody material in streams where currently lacking and where conditions support such structure
- Improve instream and riparian habitat where needed to support native fish and wildlife species and protect water quality
- Reduce the presence of roads and informal dispersed campsites within floodplains or riparian zones
- Ensure that floodplain, wetland, and riparian conditions are consistent with the Aquatic Conservation Strategy defined in the Northwest Forest Plan
- Reduce effects of roads on water quality and riparian function, including reducing road related sediment generation and delivery to streams.
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Reduce road-related impacts to terrestrial and aquatic habitats. The Landscape Evaluation identified numerous catchments within the planning area where the road system is affecting stream habitat within the subwatersheds. Three of the four subwatersheds within the project area are not functioning properly due to high total open road densities (>2.4 miles/miles2), riparian open road densities, and the percent of drainage increase from roads (see table below). Only the Lake Wenatchee subwatershed is functioning at risk for these metrics.

Subwatershed	Total Open Road Density (miles/miles^2)	Riparian Open Road Density (miles/miles^2)	Road Crossings by Stream Mile	Drainage Increase % from Roads
Lower Chiwawa River	2.8	2.6	0.9	21%
Lake Wenatchee	1.3	0.8	0.6	8%
Big Meadow Creek	2.6	2.1	0.3	17%
Beaver Creek-Wenatchee River	2.5	2.5	1.0	22%

In addition, the aging road network in the project area includes unmaintained and degraded roads, including undersized culverts that present risks for road failure and sediment delivery to streams. The Project area is an important and heavily used camping, snowmobile, motorcycle, ATV, and mountain bike use area. However, several campsites and motorcycle and mountain bike trails may be contributing sediment to aquatic systems. Based on these existing conditions, the project objectives are:

- Remove roads where needed to reduce sediment deposition, correct altered hydrology, reduce road density, or improve riparian habitat functioning while still providing the essential function of safe, sustainable, and efficient access for administration, public use, and protection of National Forest System lands

Based on these existing conditions, the project objective is:

- Remove roads where needed to reduce sediment deposition, correct altered hydrology, reduce road density, or improve riparian habitat functioning while still providing the essential function of safe, sustainable, and efficient access for administration, public use, and protection of National Forest System lands.

Species Considered

Listed fish species in the project area include Upper Columbia River steelhead Distinct Population Segment (DPS) (threatened), the Upper Columbia River Spring-run Chinook Evolutionarily Significant Unit (ESU; endangered), and Columbia River Bull Trout (threatened). Spring Chinook, steelhead, and bull trout have designated critical habitat within the proposed project area. Magnuson-Stevens Fishery Conservation and Management Act (MSA) species include Chinook and coho salmon.

Summary of Determinations:

The UWPP includes commercial and non-commercial vegetation treatments, prescribed fire, road treatments and a suite of aquatic/watershed restoration treatments. After review and agreement with the Okanogan-Wenatchee Level 1 Team, we approached consultation by splitting treatments into ARBO II bin activities and non-ARBO II bin activities, for fisheries. This BA will focus on the effects from proposed actions that are not consistent with the ARBO II for fisheries, which include all vegetation treatments and all changes to the transportation system. For wildlife species, the ARBO II consistent activities are considered in this BA.

Our effect determinations for non-ARBO II project activities are may affect, not likely to adversely affect bull trout and spring Chinook, and their designated CH. The project is likely to adversely affect steelhead and steelhead designated CH. Effect determinations for wildlife species, for all project activities are may affect, not likely to adversely affect" for wolf, grizzly bear, lynx, spotted owl and Critical Habitat for lynx, and no effect for wolverine (if listed).

Management Direction

Principal regulatory direction applicable to the management of fisheries resources on the Okanogan-Wenatchee National Forest include:

- National Forest Management Act of 1976 (NFMA)
- Endangered Species Act of 1973 (ESA)
- Clean Water Act of 1972
- Wenatchee National Forest, Forest Plan (USDA 1990), as amended
- Northwest Forest Plan (USDA and USDI 1994)

The National Forest Management Act (NFMA) (1976) requires that the Forest Service manage for a diversity of fish habitat to support viable fish populations (36 CFR 219.19). Regulations further state the effects on these species and the reason for their choice as management indicator Species be documented (36 CFR 219.19 (a) (1)).

Regulations of NFMA (219.12g) state, "Fish and wildlife habitats will be managed... to maintain and improve habitat of management indicator species." Executive Orders 11988 and 11990 (May 24, 1977) contain as part of their objectives minimizing the destruction, loss, and degradation of wetlands, and to give preferential consideration to riparian dependent resources when conflicts among land use activities occur.

A range of standards are included in the Wenatchee National Forest Plan (USDA 1990) are applicable to the management of riparian and aquatic resources. Forest Plan standards and guidelines require maintenance or enhancement of riparian and aquatic habitat parameters that affect fish and other aquatic life. These parameters include fine sediment, pool habitat, large woody debris, riparian vegetation, and provision of fish passage at road crossings. The Northwest Forest Plan (USDA and USDI 1994) (NWFP henceforth) amended the Forest Plan and provides additional direction for the project area. See the Northwest Forest Plan pages C-31 to C-35 for applicable Standard and Guidelines.

Current forest management guidelines provide considerably more protection for aquatic and riparian resources than was granted in the past. For example, under the Northwest Forest Plan direction, all management activities occurring within Riparian Reserves must maintain functional ecological conditions or lead to improved conditions to be consistent with the management guidance.

The Northwest Forest Plan provides management direction from the Mission Restoration project area. Riparian management in NWFP areas follows four components of the Aquatic Conservation Strategy (ACS). The four components include Riparian Reserves (RRs), Key Watersheds, Watershed Analyses, and Watershed Restoration. These components are combined to restore and maintain ecological health of watershed and aquatic ecosystems contained within public lands. Activities associated with the proposed Mission project are designed to be consistent with the ACS at site, sub-watershed (project), and watershed scales. RR widths are the default widths outlined in the ACS.

The Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act require that consultation be completed with respect to effects of proposed activities on Endangered, Threatened, Sensitive, and Management Indicator Species, Critical Habitat, and Essential Fish Habitat. The species and habitat of concern in the Mission Restoration Project are described later in this section. Consultation on effects to ESA listed species will be completed with the required regulatory agencies (U.S. Fish and Wildlife Service [USFWS] and National Marine Fisheries Service [NMFS]) prior to issuance of the Environmental Assessment and Decision Notice for this project.

Proposed Action

There are two primary components of the action alternatives that are described in detail below:

1) Terrestrial Vegetation Treatments – These include a combination of commercial and non-commercial thinning, commercial harvests, fuels reduction, and prescribed fire to restore forest health and wildlife habitats, and to reduce risk of uncharacteristic fires; and

2) Watershed and Aquatic Restoration Actions - These include a combination of treatments aimed at reducing impacts to listed fish habitats, restoring habitat connectivity, and restoring watershed functions. Projects will include removal or upgrading fish passage barriers, increasing habitat complexity by adding large wood structures and restoring off-channel habitat, and restoring beaver habitat. Stream restoration projects are still in development and will be consulted on as they are designed.

Terrestrial Vegetation Treatments

This project is designed to create and maintain successional pathways that provide the amount and spatial arrangement of forest conditions that improve resilience to natural disturbances and sustainability into the future. To reduce the risk of large-scale habitat loss from severe wildfires and insect outbreaks and to restore the structure and composition of the landscape that is consistent with reference and predicted future reference conditions, the project would implement the following actions (non-commercial and commercial): tree thinning and prescribed fire. To achieve this, the following objectives are identified along with vegetation restoration and maintenance treatments proposed. Within the Late Successional Reserve Land Allocation, treatments would maintain late-successional forest ecosystems and protect from loss due to large-scale fire, insect, and disease epidemics and major human impact (Page B-1 paragraph 3 NWFP S&Gs).

The following broad treatment objectives were identified for terrestrial treatments:

1. Restore Large Tree Structure—Restoration of very large (>25-inch-diameter at breast height [DBH]) and old trees applies to all vegetation types and treatments across the planning area. Very large trees (>25-inch DBH) would be maintained and protected, except for those trees that are suffering from root disease. Stands would be thinned to increase diameter growth rates to develop this tree structure more quickly in areas where they do not currently exist. Old trees that meet the definition described in Van Pelt (2008) would be retained except where these trees could perpetuate root disease spread.
2. Restore Landscape Spatial Patterning—After treatments, the amounts and distribution of forest covers and structures would more closely resemble reference conditions across the landscape. The landscape resilience would be increased from the existing conditions, and natural disturbance processes would perpetuate a healthy landscape into the future.
3. Restore Within Stand Diversity and Spatial Patterning—After treatments, the within stand conditions would more closely resemble historical patterns. Individual trees and variable sized clumps of trees would be distributed across the stand with interspersed openings. Historical stand reconstruction would guide these patterns.
4. Reduce Fire and Insect Risk—After treatments, the resulting stand conditions would be less prone to lethal fire effects and widespread insect-caused mortality.
5. To further meet the Project purpose and need of recovering the NSO, the prescriptions described here would be modified within priority NSO habitat, as outlined below for each owl habitat condition (Table 5).

Vegetation treatments can be broken into three general categories: commercial harvest, non-commercial thinning/fuels reduction, and prescribed fire. Within these three categories, more specific objectives were developed to achieve desired conditions based on the forest stand condition. Forest stand conditions include the following: 1) Plantations, 2) Plantations of Off-Site Ponderosa, 3) Early Seral Stem Exclusion Closed Canopy and Understory Reinitiation, 4) Dry Forest - Young Forest Multi-Story, 5) Dry Forest - Stem Exclusion Open Canopy, 6) Moist Forest -Young Forest Multi-Story, 7) Old Forest Multi-Story, and 8) Whitebark pine restoration. Desired conditions specific to each of these are provided in Table 2.

Terrestrial treatments would include stand regeneration treatments, moderate to heavy thinning, and prescribed burns. Terrestrial treatments (primarily thinning of trees) may use a variety of mechanical logging systems including ground-based, cable or skyline, or helicopter yarding. Heavy mechanical equipment used may include traditional ground-based equipment (e.g. harvesters, feller-bunchers, shovels, skidders, forwarders, and masticators), tethered ground-based equipment on slopes, yarders, log haul trucks, and helicopters. Hand equipment would include chainsaws and drip torches. Depending on the timing of actions, equipment would operate on existing and new temporary roads, over trails, over ground, or over snow.

Some treatments could occur in areas identified as “Limited Treatment” on Figure 2 – 6. These areas are NSO habitat, so the types of treatments would align with the underlying condition in Table 2 but be limited by the Project Design Features described in Table 5.

Commercial Harvest outside of RRs: Commercial harvest is proposed on 29,346 acres throughout the project area (Table 1). This includes treatments in a variety of habitat types and vegetation structures (detailed descriptions in Table 2). The overall goal of the commercial harvest is to return a more natural vegetation structure and, in many locations, encourage large tree growth. As such, commercial harvest will primarily be limited to trees between 7” and 25” dbh, unless there are large trees infected with root disease. Final canopy cover will mostly range from 50% to 30%, but some clearcutting will occur in stands with root disease or non-local genetic strains. Table 1 quantifies types of treatments and Table 2 has descriptions of the preliminary prescriptions. The project area maps (Figure 2, Figure 3, Figure 4, and Figure 5) display units based on the preliminary prescription. Prior to contracting, all units will be completely surveyed, and more detailed prescriptions will be developed. Units may have a variety of treatment types depending on conditions, access, feasibility, but, regardless of the prescription, commercial treatments will be required to meet all Forest Plan standard and guidelines and project design criteria (see Table 3,Table 5, and Table 13).

To avoid exceeding soil disturbance standards, commercial harvest will be limited during time periods of excessive soil moisture and restricted on steep slopes. Skid trails will be required to have slash mats or other methods to avoid soil damage. Skid trails and landings will be rehabbed and inspected by the district Aquatics staff. A full description of design criteria is in Table 13.

Commercial Harvest within RRs: There are a total of 2,617 acres of commercial harvest proposed within RRs. Prescriptions within RRs would be the same as described above for outside RRs, then further restricted based on the following criteria. Prior to any commercial harvest within RRs, the district staff will be required to answer no to the following questions to establish that we are meeting ACS objectives: 1) is the current RR vegetation condition within the range of desired condition? 2) will the treatment reduce in-stream shade? and 3) will the treatment reduce the availability of large wood to enter the stream channel? If the answers to these questions are "no", the district Aquatics staff will work to help develop prescriptions to meet the vegetation goals while maintaining all other ACS objectives and in-stream habitat conditions. All proposed commercial treatments within RRs will be reported to the Level 1 team prior to implementation, at the annual project meeting. Table 3 describes all RR design criteria for vegetation treatments.

Commercial harvest within RRs must adhere to strict stream buffer requirements. For perennial streams (fish bearing or non-fish bearing) and large ponds/lakes, there will be no treatment within 100 ft of the waterbody. Between 100 ft and 300 ft of the waterbody, any commercial harvest actions need to occur during winter harvest conditions, without equipment, or using other methods to reduce soil disturbance (as approved by the district soils scientist). Canopy cover within the RR will be maintained at greater than 50%, unless there are pockets of root disease or undesired genetics, as agreed upon by district Aquatics staff.

Along intermittent streams and wetlands less than one acre, there will be a no treatment buffer within 50 ft of the waterbody. From 50 ft to 100 ft, ACS objectives must be maintained, harvest must occur in winter or other non-soil disturbing methods, and canopy cover will be maintained at >50%, the same requirements as for perennial streams, above. For ephemeral draws, they will be avoided when soil conditions are too wet, dry crossings will be minimized, and no skidding will be allowed along the bottom of draws. Additional design features may include the requirement to use slash mats or other methods of avoiding soil disturbance (Table 13).

<u>Non-commercial harvest/Fuels Reduction outside of RRs:</u> The project has identified 12,684 acres proposed for non-commercial harvest and fuels reduction. The primary goal in these units is to reduce ladders fuels (primary trees less than 7" DBH) to reduce the risk of crown fire and to encourage large tree growth. Non-commercial/fuels reduction treatments can be completed either using mechanical equipment or by hand crews. Vegetative waste material ("slash") will be piled and burned under appropriate conditions to reduce the potential for soil damage.

<u>Non-commercial harvest/Fuels reduction within RRs:</u> All treatments within the RR must meet ACS objectives, as determined by the Aquatics team, using the same questions as identified above. No treatments will occur without input from the Aquatics staff. There are 708 acres of fuels reduction treatments identified within RRs. For perennial (fish and non-fish bearing) and large ponds and lakes, there will be no treatment within 50 ft of the waterbody. Within 50-100 ft of the waterbody, thinning may occur, but it will be using hand thinning methods. From 100 ft -300 ft of the waterbody, machinery may be used but soil disturbance standards must be met using winter harvest or other approved methods.

Intermittent streams and small wetlands will have a 25 ft no treatment buffer and no mechanical treatment within 75 ft of the waterbody. Ephemeral draws have no buffers but there will be no piles in the bottom of draws and minimal crossings with mechanical equipment. Full guidelines for non-commercial harvest/fuels reduction treatments in RRs are found in Table 3.

Prescribed Fire: In general, prescribed fire would be applied within each of the stand conditions to help move towards or achieve stand objectives. Prescribed fire would restore fuel patterns and fuel loading, restore understory plant diversity and composition, and re-introduce an important ecosystem process. Prescribed fire could also be used outside of the forested stands where appropriate (such as in meadows or other non-forest areas between stands) for these same reasons. In most cases, the application of prescribed fire would be conducted following mechanical treatments; however, prescribed fire as a standalone treatment could also be used in areas where access or logging system limitations inhibit mechanical treatments, strategic placement for risk reduction or stand resilience, to achieve landscape restoration objectives. Prescribed fire treatments would include broadcast burning, jackpot burning, and pile burning. Prescribed fire may be implemented during any season; however, fall and winter are the most common seasons for prescribed burning within the local area. Seasonal timing restrictions would be followed for prescribed fire unless prior exception is granted.

For all areas, the creation of handlines will be minimized by using natural or existing control features (Table 13). Prescribed fire goals include maintaining 95% of pre-treatment canopy cover and 50% of ground cover/organic material on surface.

Prescribed Fire within RRs: No active lighting will be allowed within 100 ft of perennial streams and large ponds/lakes but fire will be allowed to back into the area to reduce the need for building control lines within the RR (Table 3). In non-fish bearing perennial streams, active ignition may occur between 100 ft and 300 ft of the waterbody. No active ignition in RRs along fish bearing streams is planned as part of this project. In the event that it will be needed in the future, consultation will occur using ARBO II. In intermittent streams and small waterbodies, there will not be active ignition within 25 ft the waterbody, but active ignition is allowed from 25 ft to 100 ft of the waterbody.

Table 1. Summary of treatment types (acres), by watershed. Italics indicate treatments that are unlikely to be commercial treatments. The number in parentheses indicate the desired condition/preliminary prescription condition described fully in Table 2.

Watershed	Chiwawa River						Wenatchee River			White River-Little Wenatchee		
Subwatershed	Lower Chiwawa River			Big Meadow Creek			Beaver Creek-Wenatchee River			Lake Wenatchee		
Treatment Type*	*Total*	*RR Acres*	*Within RR 1000 ft of ESA***	*Total*	*RR Acres*	*Within RR 1000 ft of ESA***	*Total*	*RR Acres*	*Within RR 1000 ft of ESA***	*Total*	*RR Acres*	*Within RR 1000 ft of ESA***
Dry Forest, Clearcut Plantation of Off-Site (2)	72	7	4	0	0	0	71	7	0	0	0	0
Dry Forest, Understory Reinitiation, Thin to 30% (4)	250	45	30	6	6	6	210	20	4	22	2	0

Dry Forest, Young Forest Multistory, Thin to 30% (4)	2472	205	163	155	31	31	2676	438	184	1163	80	0
Moist Forest, Open Forest Multistory, Thin to 50% (7)	0	0	0	0	0	0	0	0	0	46	27	0
Moist Forest, Understory Reinitiation, Maintenance Thin (3)	*1245*	*71*	*28*	*1330*	*89*	*39*	*143*	*6*	*0*	*187*	*1*	*0*
Moist Forest, Clearcut Plantation of Off-Site (2)	222	42	14	760	63	36	306	11	0	0	0	0
Moist Forest, Young Forest Multistory, Thin to 50% (6LSR; 6M)	3497	298	144	2185	202	137	2705	193	29	755	4	0
Old Forest, Limited Treatment (7a)	*120*	*107*	*107*	*69*	*54*	*44*	*574*	*116*	*55*	*614*	*38*	*0*
Plantation or Stand Initiation, Thin to 30% (1)	2136	126	50	859	21	15	1637	119	0	240	8	0
Root Disease Pockets, Clearcut (6a)	166	15	0	290	0	0	148	11	0	0	0	0
NSO Limited Treatment (see Table 5)	4756	242	119	449	30	9	574	331	120	518	33	0
Stem Exclusion Closed Canopy, Maintenance Thin (3)	*65*	*0*	*0*	*497*	*9*	*0*	*97*	*6*	*0*	*40*	*0*	*0*
Stem Exclusion Open Canopy, Maintenance Thin (5)	*1947*	*62*	*47*	*840*	*24*	*16*	*1660*	*124*	*18*	*161*	*2*	*0*
Whitebark Pine Restoration (8)	*62*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Subtotal: Commercial Harvest	13571	980	524	4704	353	234	8327	1130	337	2744	154	0
Subtotal: Non-commercial/Fuels Reduction	3438	240	183	2736	176	99	5507	252	73	1003	40	0
Prescribed Fire Only	211	76	0	496	404	0	280	82	0	49	11	0
Total	**17220**	**1296**	**707**	**7936**	**933**	**333**	**14104**	**1464**	**410**	**3796**	**205**	**0**

*Desired condition of the treatment type is in parentheses and corresponds to categories in Table 2.
** This refers to the official Riparian Reserve area along all streams that are within 1000 ft of ESA occupied streams or designated Critical Habitat. This includes tributaries that may be fishless but are within 1000 ft of an ESA stream.

Table 2. Desired Conditions, Stand Objectives, and Preliminary Prescriptions by Stand Condition.

Desired Conditions	Stand Objectives	Preliminary Prescription
1 – Plantations Treatment type: Plantation of Stand Initiation: Thin to 30%		
• Dry and mesic Forest types– Stands where ponderosa pine and Douglas-fir are dominant species with the proportion of each determined by site conditions. • Moist Forest - Stands where Douglas-fir, western redcedar, western white pine, and western hemlock are dominant species with the proportion of each determined by site conditions. • Stands resilient to insect outbreak would have high vigor and contain at least one major non-host tree species. • Stands resilient to crown fires would have tree crown separation and limited amounts of ladder fuels.	• Encourage tree diameter growth to more rapidly attain large tree structure • Where conditions allow, set stands on a trajectory to develop spotted owl nesting habitat. If site conditions preclude nesting habitat development, grow dispersal habitat. • Reduce potential insect and disease caused mortality. • Reduce potential crown fire risk. • Meet Aquatic Conservation Strategy (ACS) objectives of maintaining and restoring species composition and structural diversity of plant communities in Riparian Reserves by improving stand conditions to encourage development of large tree structure, based on locations and specific ecotype.	• Reduce stand density to 50 to 200 trees per acre (TPA), depending on size class distribution. Stand density index (SDI) will be used as a guide to determine residual tree density at the stand level. • Retain large and old trees.[a] • Protect high valued snags.[b] • Remove ladder fuels from within 30-40 feet of overstory trees greater than 25-inch diameter at breast height (DBH). • The fine-scale arrangement of stems within stands would be determined by site conditions and generally include proportions of the stand as individuals, different sized clumps, and openings, or ICOs.[c] • Enhance huckleberry production by strategically placing openings across area where this shrub is present. • Prescribed fire would be applied as needed to modify the fuels profile and attain desired amounts of fuels loading. Specifically, in the dry forest types. • Within Riparian Reserves, apply activity-dependent design criteria to meet ACS objectives.[d, e]
2 – Plantations of Off-Site Ponderosa Treatment Types: Dry Forest, Clearcut Plantation of Off-Site (Ponderosa Pine); Moist Forest, Clearcut Plantation of Off-Site (Douglas Fir)		
• Stands that do not have Montana provenance genetic material.	• Eliminate potential for Montana provenance genetic contamination of the local ponderosa pine gene pool.	• Remove all Montana provenance overstory and all ponderosa pine understory.

Desired Conditions	Stand Objectives	Preliminary Prescription
• Stands that are fully stocked with the appropriate trees species as determined by site conditions.	• Establish or culture the appropriate conifer species for the site. • Where conditions allow, set stands on a trajectory to develop spotted owl nesting habitat. If site conditions preclude nesting habitat development, grow dispersal habitat. • In Riparian Reserves provide for early seral ecosystems, while re-establishing and placing stands on sustainable trajectory. Early seral ecosystems provide highly diverse and functionally rich habitat and are generally lacking within the moist forest. This is largely a result of past management including harvest/reforestation and fire suppression.	• Protect younger understory trees "Advanced Regeneration" that are acceptable species, health, and vigor. • Establish additional trees in areas that do not have advanced regeneration. • Desired post-treatment stocking is 150 to 200 TPA. • Within Riparian Reserves, apply activity-dependent design criteria to meet ACS objectives.[d, f]
3 – Early Seral Stem Exclusion Closed Canopy and Understory Reinitiation Treatment Types: Stem Exclusion Closed Canopy Maintenance Thin; Moist Forest Understory Reinitiation Maintenance Thin		
• Dry and mesic Forest types– Stands where ponderosa pine and Douglas-fir are dominant species with the proportion of each determined by site conditions. • Moist Forest - Stands where Douglas-fir, western redcedar, western white pine, and western hemlock are dominant species with the proportion of each determined by site conditions. • Stands resilient to insect outbreak would have high vigor and contain at one major non-host tree species.	• Encourage tree diameter growth to more rapidly attain large tree structure. • Reduce potential insect- and disease-caused mortality. • Reduce potential crown fire risk. • In Riparian Reserves, meet ACS objectives of maintaining and restoring species composition and structural diversity of plant communities by improving stand conditions to encourage development of large tree structure.	• Reduce stand density to 30 to 100 TPA depending on size class distribution. Basal area targets are generally 40 to 80 square feet per acre (ft^2/ac) for dry and mesic forest and 60 to 100 ft^2/ac for moist forests. SDI will be used as a guide to determine residual tree density at the stand level. • Retain very large and old trees.[a] • Retain snags at recommended levels, favoring high-valued snags.[b] • Remove ladder fuels from within 30-40 feet of very large trees.

Desired Conditions	Stand Objectives	Preliminary Prescription
• Stands resilient to crown fires would have tree crown separation and limited amounts of ladder fuels.		• The fine-scale arrangement of stems within stands would be determined by site conditions and generally include proportions of the stand as ICOs.[c] • Enhance huckleberry production by strategically placing openings across area where this shrub is present. • Prescribed fire would be applied as needed to modify the fuels profile and attain desired amounts of fuels loading, specifically in the dry forest types. • A portion of the younger plantations classified as stem exclusion closed canopy will be left to develop and provide this otherwise limited habitat at the landscape level within the Lake Wenatchee, and Lower Chiwawa drainages. • Within Riparian Reserves, apply activity-dependent design criteria to meet ACS objectives.[d, g, h]
4 – Dry Forest - Young Forest Multi-Story Treatment Types: Dry Forest, Understory Reinititation, Thin to 30%; Dry Forest Young Forest Multistory, Thin to 30%		
• A Stem exclusion open canopy or old forest single story where ponderosa pine and Douglas-fir are dominant species with the proportion of each determined by site conditions. Stands on the drier sites would appear more open with little conifer understory. • A low-density conifer understory that is predominately distributed in smaller even aged groups. • Resilient to insect outbreak by containing at least major non host tree species and removing the layered tree canopy from beneath large and old trees.	• Protect large trees, especially ponderosa pine. • Restore fine-scale stem distribution and density. • Reduce potential insect- and disease-caused mortality. • Reduce potential crown fire risk. • In Riparian Reserves, meet ACS objectives of maintaining and restoring species composition and structural diversity of plant communities by improving stand conditions to encourage development of large tree structure.	• Reduce density by thinning from below to a residual 20 to 60 TPA of overstory. Residual canopy cover would range from approximately 20 to 50%. Within NSO home ranges, stand treatments would retain NRF features (including more than 60 percent canopy cover) and dispersal habitat features (including greater than 40 percent canopy cover) where present. Outside of NSO home ranges, stand treatments may downgrade or remove NSO habitat. Preferred leave trees are ponderosa pine followed by Douglas-fir. • Retain very large and old trees.[a] • Retain snags at recommended levels, favoring high-valued snags.[b]

Desired Conditions	Stand Objectives	Preliminary Prescription
• Stands resilient to crown fires would have tree crown separation and limited amounts of ladder fuels.		• Remove ladder fuels from within 30-40 feet of very large trees • Maintain groups of early seral understory trees across these stands where they do not impact fire risk objectives. • The fine-scale arrangement of stems within stands would be determined by site conditions and generally include proportions of the stand as individuals, different sized clumps, and openings.[c] • Use prescribed fire to reduce surface fuels that exceed the desired ranges along with maintaining a low-density understory. • Enhance huckleberry production by strategically placing openings across area where this shrub is present. • Within Riparian Reserves, apply activity-dependent design criteria to meet ACS objectives.[d, g]
5 – Dry Forest - Stem Exclusion Open Canopy Treatment Type: Stem Exclusion Open Canopy, Maintenance Thin		
• A Stem exclusion open canopy or old forest single story structures where ponderosa pine and Douglas-fir are dominant species with the proportion of each determined by site conditions. Stands on the drier sites would appear more open with little conifer understory. • A low-density conifer understory that is predominately distributed in smaller even aged groups. • Resilient to insect outbreak by containing at least one major non host tree species	• Protect large trees, especially ponderosa pine. • Restore fine scale stem distribution and density. • Decrease potential insect and disease caused mortality. • Decrease potential crown fire risk. • In Riparian Reserves maintain a variable distributed cohort layer within the understory.	• Reduce density by thinning from below to a residual 20 to 60 TPA of overstory. Residual canopy cover would range from approximately 20 to 50%. Within NSO home ranges, stand treatments would retain NRF features (including more than 60 percent canopy cover) and dispersal habitat features (including greater than 40 percent canopy cover) where present. Outside of NSO home ranges, stand treatments may downgrade or remove NSO habitat. Preferred leave trees are ponderosa pine followed by Douglas-fir. • Retain very large and old trees.[a] • Protect high valued snags.[b]

Desired Conditions	Stand Objectives	Preliminary Prescription
and removing the layered tree canopy from beneath large and old trees. • Stands resilient to crown fires would have tree crown separation and limited amounts of ladder fuels.		• Remove ladder fuels from within 30-40 feet of very large trees. • Maintain groups of early seral understory trees across these stands where they do not impact fire risk objectives. • The fine-scale arrangement of stems within stands would be determined by site conditions and generally include proportions of the stand as individuals, different sized clumps, and openings.[c] • Use prescribed fire to reduce surface fuels that exceed the desired ranges along with maintaining a low-density understory. • Within Riparian Reserves, apply activity-dependent design criteria to meet ACS objectives.[d, g]
6M – Moist forest - young forest multi-story: Matrix Treatment Type: Moist Forest, Young Forest Multistory, Thin to 50% (matrix only)		
• Understory Re-initiation and stem exclusion open canopy stand structures with a wide canopy break between the overstory and understory layers. • Stands resilient to insect outbreaks contain at least one major non host tree species and are not multi-layered. Grand fir is not a major component. • Stands resilient to laminated root disease contain high proportion of more resistant species such as western white pine, western redcedar, and ponderosa pine. • Stands resilient to crown fires would have tree crown separation and limited amounts of ladder fuels. Trees that have a higher	• Protect existing and develop large tree structure, especially Douglas-fir. • Restore fine-scale stem distribution and density. • Reduce potential insect- and disease-caused mortality. • Reduce potential crown fire risk.	• Transition to Understory Reinitiation structure—Reduce density by thinning from below while protecting the trees less than 7-inches DBH; residual stocking for trees greater than 7-inches is 20 to 60 TPA depending on size class distribution and approximately 30 to 50% canopy cover for the overstory trees. Preferred leave trees are western larch, ponderosa pine, followed by Douglas-fir, western hemlock, and western redcedar. • Transition to Stem Exclusion Open Canopy where risk reduction is the primary objective; follow the previous overstory treatments plus remove most trees less than 7-inches DBH. • Retain very large and old trees.[a] • Retain snags at recommended levels, favoring high-valued snags.[b]

Desired Conditions	Stand Objectives	Preliminary Prescription
fire resilience include Douglas fir, ponderosa pine and western larch.		• Remove ladder fuels from within 30-40 feet of very large trees • The fine-scale arrangement of stems within stands would be determined by site conditions and generally include proportions of the stand as individuals, different sized clumps, and openings.[c] • Enhance huckleberry production by strategically placing openings across area where this shrub is present. • Prescribed fire may be used to reduce surface fuels or activity fuels. Desired prescribed fire method would be pile burning, or jackpot burning, in areas were lower intensities are desired. • Within Riparian Reserves, apply activity dependent design criteria to meet ACS objectives.[d, g]

Desired Conditions	Stand Objectives	Preliminary Prescription
6LSR – Moist Forest - Young Forest Multi-Story: LSR Treatment Type: Moist Forest, Young Forest Multistory, Thin to 50% (LSR only)		
• Young forest multi-story and old forest multi-story. • Stands resilient to insect outbreaks contain multiple tree species and are not multi-layered. Grand fir is not a major component. • Stands resilient to laminated root disease contain high proportion of more resistant species such as western white pine, western redcedar, western larch, ponderosa pine, and western hemlock. • Stands resilient to crown fires would have tree crown separation and limited amounts of ladder fuels. Trees that have a higher fire resilience include Douglas fir, ponderosa pine and western larch.	• Protect existing and develop large tree structure, especially Douglas-fir. • Restore fine-scale stem distribution and density. • Reduce potential insect- and disease-caused mortality. • Reduce potential crown fire risk.	• Variable density thinning to minimum 50% canopy cover, includes complex patches and thinned areas. • Remove ladder fuels from within 30-40 feet of very large trees. • Prescribed fire may be used to reduce surface fuels or activity fuels. Desired prescribed fire method would be pile burning, or jackpot burning, in areas were lower intensities are desired. • Thin from below to a residual density at 20-60 TPA depending on size class distribution. Preferred leave trees are western larch, ponderosa pine, followed by Douglas-fir, western hemlock, and western redcedar. • Complex patches will be retained for horizontal and vertical structural diversity. • The fine-scale arrangement of stems within stands would be determined by site conditions and generally include proportions of the stand as individuals, different sized clumps, and openings.[c] • Protect and improve resilience to large and old trees.[1] • Protect high valued snags.[b] • Within Riparian Reserves, apply activity-dependent design criteria to meet ACS objectives.[d, g]
6a – Root Disease (Primarily within the moist young forest multi-story) Treatment Type: Root Disease Pockets- Clearcut		
• Decreased incidence of laminated root rot caused mortality.	• Promote conditions for development of sustainable habitat for the northern spotted owl.	• Regeneration harvest with reserves. Remove all grand fir and Douglas-fir overstory and understory from the stand except from within identified Green Tree Retention (GTR) areas.[i]

Desired Conditions	Stand Objectives	Preliminary Prescription
• Decrease occurrence of trees that are prone to laminated root rot caused mortality.	• Emphasize stands that have elevated potential for mortality due to past management actions such as fire exclusion and past-harvest residual conditions (high percentage of Douglas-fir and grand fir)	• Leave resilient species (all western white pine, western redcedar, lodgepole pine, and ponderosa pine). Western hemlock will mostly be retained. • Post-treatment stocking should be 100 to 200 TPA and may require tree planting depending on site conditions. Preferred species for planting include western larch (if it naturally occurs within the vicinity) followed by ponderosa pine, western white pine, and western redcedar. • Application of prescribed fire may be utilized to induce mortality within the affected species. • Within Riparian Reserves, apply activity-dependent design criteria to meet ACS objectives.[d, g, j] • Treatments would not occur within LSRs
7 – Old Forest Multi-Story Treatment Type: Moist Forest, Open Forest Multistory, Thin to 50%		
• Structure is Old forest multi-story or Old forest single story. • Ladder fuels are limited and crown spacing between trees or clumps of trees is sufficient to limit the potential for crown fire.	• Protect and promote old and very large trees. • Provide defensible space near structures and private lands and along shaded fuel breaks. • In Riparian Reserves, meet ACS objectives of maintaining species composition and structural diversity of plant communities protecting old and large trees.	• Reduce density by thinning from below up to 25-inches DBH, to a residual 20-60 TPA depending on size class distribution; overstory canopy cover for trees > 25” DBH would remain greater than 30%. Preferred leave trees are ponderosa pine, Douglas-fir, western redcedar, and western white pine. • Use prescribed fire to reduce surface, and ladder fuels. • Retain very large and old trees.[a] • Retain snags at recommended levels, favoring high-valued snags.[2] • Within Riparian Reserves, apply activity-dependent design criteria to meet ACS objectives.[d, g]
7a – Old Forest Multi-Story Treatment Type: Old Forest, Limited Treatment		

Desired Conditions	Stand Objectives	Preliminary Prescription
• Structure is Old forest multi-story • Ladder fuels are limited and crown spacing between trees or clumps of trees are sufficient to limit the potential for crown fire.	• Protect old and large trees.	• Reduce density by thinning from below targeting the ladder fuels near trees greater than 25 inches DBH. Maintain total canopy cover greater than 50% and canopy cover for trees greater than 25 inches DBH at greater than 30%. Preferred leave trees are ponderosa pine, Douglas-fir, western redcedar, and western white pine. • Use prescribed fire to reduce surface, and ladder fuels. • Retain very large and old trees.[a] • Protect high valued snags.[b]
8 – Whitebark Pine Restoration - stand initiation, stem exclusion open canopy, and understory reinitiation Treatment Type: Whitebark Pine Restoration		
• Multiple aged whitebark pine exists across the landscape with a low proportion of other conifer species, subalpine fir occurrence is minimal. • Small openings are created within whitebark habitat to mimic the higher end of the mixed severity fire regime and encourage seed caching. • Low potential for wildfire cause mortality to whitebark pine. • Increased tree vigor, specifically large diameter cone producing trees, to encourage seed production. • Damage caused by mechanical harvesting or prescribed burning is mitigated. • Mimic mixed severity fire patterns across whitebark pine habitat to encourage seed caching behavior by the Clark's nutcracker.	• Promote and maintain whitebark pine as a major stand component.	• Remove all conifers less than 7 inches DBH from within 30 feet of mature whitebark pine along with reducing competition/ ladder fuels near smaller sapling and pole sized whitebark pine. • Use prescribed fire to reduce activity fuels, encourage seed caching, and reduce competition for emerging seedlings. • Create small openings between 0.5 to 2 acres in size across the whitebark pine habitat. Openings should be placed in areas that do not impact existing mature whitebark pine. • Plant whitebark pine that is blister rust resistant in openings. Mimic emerging seedlings from lost caches by planting in groups of 1-3 seedling / planting spot. • Collect whitebark pine cones and plant whitebark pine seedlings/saplings. • Within Riparian Reserves, apply activity dependent design criteria to meet ACS objectives.[d, g, k]

Desired Conditions	Stand Objectives	Preliminary Prescription

[a] Use Van Pelt (2008) as a guide.

[b] Snag retention criteria are provided in the Northwest Forest Plan Record of Decision, Attachment A (USDA Forest Service and USDI Bureau of Land Management, 1994a; see pp C-41 to C-48); the Forest-wide Assessment for Late Successional Reserve and Managed Late Successional Areas (USDA Forest Service 1997a; see table VII-1LSRA for numerical criteria by forest type); and the Late Successional Reserve and Managed Late Successional Areas Assessments (USDA Forest Service 1997b see tables I-8, IV-11, X-11, and X-13). High valued snags are defined as >20 inches in diameter, existing cavities present, or currently occupied by wildlife.

[c] The "ICO Method" (Churchill et al. 2016) would help guide this approach.

[d] Within Riparian Reserves, activity dependent design criteria would be applied to maintain existing wood recruitment along streams, retain microclimate condition, and filter activity related sediment (see Table 3).

[e] Within the Riparian Reserves the same prescriptions apply but as treatments near the riparian buffers described in Table 3, the residual density would be feathered to nearer the higher end of the resulting stocking range.

[f] Restocking would occur in a variable manner to create patches and individuals that will develop into large wood inputs to the riparian zone.

[g] Within the Riparian Reserves, apply variable retention prescription that retains undisturbed forest patches and individual live and dead trees.

[h] Residual stocking would be feathered to increase density within the riparian reserve sections that are closest to the actual riparian area. This would be measured in terms of percent SDImax and target areas with tree diameters less than 15 inches DBH.

[I] Consult the district wildlife biologist for desirable GTR sizes and locations. These areas would generally occur at a frequency of one every 10 acres and range from 0.5 to 1 acre in size.

[j] Remove portions of closed canopy conditions to: 1) Encourage the development of early seral habitat; and 2) Promote the development of and increase the resilience to large diameter trees. Development of early seral habitat would be limited within the LSR. The potential for more early-seral habitat development exists with the matrix land allocation.

[k] Whitebark pine habitat extends into the outer reaches of the riparian reserve and are primarily departed due to fire exclusion. Currently, multi-layered stands described in condition 8 are not within the historical range. Thinning treatments would remove late seral species to restore historic stand composition and structure.

Table 3. Riparian Reserves Design Features.

Water Type	Riparian Reserve Width	Activities	Design Features/Mitigation Measures
Ephemeral Draw	None (except where ephemeral draw meets the definition of an Intermittent channel, then Intermittent Design Features and Mitigation Measures apply [See NWFP])	Non-Commercial Thinning/Fuels Reduction	• Avoid hand piles in bottom of draw unless no other option is feasible. • Machine Piling - Minimize equipment crossings. When needed, cross perpendicular to draw. - Avoid Machine piles in bottom of draw. - Do not use bottom of ephemeral draw as travel way for equipment.
		Prescribed fire	• None
		Commercial Harvest	• No skidding along bottom of draws. Minimize and mitigate draw crossings • All other ephemeral draw design features apply
Intermittent Streams - Seasonally flowing or **i**ntermittent **s**treams, wetlands less than 1 acre, Unstable and potentially unstable areas	100 feet from the edge of the channel, top of the inner gorge, the edge of riparian vegetation, or one site potential tree, whichever is greatest.	Non-Commercial Thinning/Fuels Reduction	• No treatment buffer 0 to 25 feet of channel or inner gorge, whichever is greatest. • No mechanical equipment (excavators, masticators, dozers, etc) within 75 feet of channel or inner gorge, whichever is greatest. • No machine piling in Riparian Reserve.
		Prescribed fire	• No ignition 0 to 25 feet from channel. • Allow active ignition greater than 25 feet from channel, allow backing between 0 to 25 feet. • No prescribed fire in wetlands. • Maintain 95 percent of overstory trees, 2/3 of understory/shrub, and 50 percent of ground cover/organic material on surface.
		Commercial Harvest	• No commercial harvest or mechanical equipment within 50 feet of stream channel or within inner gorge and one drip line, whichever is greater. This buffer is considered the minimum and the buffer may be increased if needed, such as in areas where the slope is greater than 35 percent. • Commercial harvest outside of the 50-foot buffer where necessary to meet NWFP TM-1 c (control stocking, reestablish and manage stands, and acquire desired vegetation characteristics needed to attain ACS objectives) and ensure present and future CWD needs are met TM-1 b.

			• Maintain >50 percent canopy cover. • Full suspension required (50 to 100 feet from channel). Alternative methods of harvest may be approved by district soils scientist and Forest Plan standards for soil disturbance must be met (<20% soil disturbance in the unit). See Table 13 for additional BMPs and design criteria.
Wetlands greater than one acre - Constructed ponds and reservoirs, Wetlands greater than 1 acre	150 feet from the edge of the channel or The edge of riparian vegetation, or the extent of seasonally saturated soil, or one sight-potential tree, whichever is greatest	Non-Commercial Thinning/Fuels Reduction	• No treatment buffer 0 to 25 feet, except where treatment is designed to reduce encroachment of wetlands/wet meadows. • No mechanical equipment within 75 feet of wetland or waterbody. • No machine piling in Riparian Reserve.
		Prescribed fire	• No ignition 0 to 25 feet from waterbody. • Active ignition >25 feet, allow backing between 0 to 25 feet. • Maintain 95 percent of overstory trees, 2/3 of understory/shrub, and 50 percent of ground cover/organic material on surface.
		Commercial Harvest	• No commercial harvest within 50 feet of wetland or waterbody. • Commercial harvest outside of the 50-foot buffer where necessary to meet NWFP TM-1 c (control stocking, reestablish and manage stands, and acquire desired vegetation characteristics needed to attain ACS objectives) and ensure present and future CWD needs are met TM-1 b. • Maintain >50 percent canopy cover. • Full suspension required (50 to 150 feet). Alternative methods of harvest may be approved by district soils scientist and Forest Plan standards for soil disturbance must be met (<20% soil disturbance in the unit). See Table 13 for additional BMPs and design criteria. • No mechanical equipment within 75 feet of wetland or waterbody.
Lakes and natural ponds	300 feet from the edge of the channel, or the edge of riparian vegetation, or the extent of seasonally saturated soil, or the distance	Non-Commercial Thinning/Fuels Reduction	• No treatment within 50 feet of waterbody or the edge of riparian vegetation, whichever is greatest. • No mechanical treatment within 100 feet of waterbody. • Winter harvest or No equipment in Riparian Reserves. Alternative methods of harvest may be approved by district soils scientist and Forest Plan standards

	equal to the height of two site potential trees, whichever is greatest.		for soil disturbance must be met (<20% soil disturbance in the unit).
		Prescribed fire	• No active ignition between 0 to 100 feet of waterbody. • Allow backing fire 0 to 100 feet of waterbody. • Active ignition >100 feet of waterbody. • Maintain 95 percent of overstory trees, 2/3 of understory/shrub, and 50 percent of ground cover/organic material on surface.
		Commercial Harvest	• No commercial harvest within 100 feet of waterbody. • Winter harvest or no equipment in Riparian Reserves. Alternative methods of harvest may be approved by district soils scientist and Forest Plan standards for soil disturbance must be met (<20% soil disturbance in the unit). See Table 13 for additional BMPs and design criteria. • Commercial harvest outside of the 100-foot buffer where necessary to meet NWFP TM-1 c (control stocking, reestablish and manage stands, and acquire desired vegetation characteristics needed to attain ACS objectives) and ensure present and future CWD needs are met TM-1 b.
Fish bearing streams - Fish bearing streams and Permanently flowing non-fish bearing streams	300 feet from the edge of the channel, or The outer edge of the 100-year floodplain, or the edge of riparian vegetation, or The extent of seasonally saturated soil, or the distance equal to the height of two site potential trees, whichever is greatest.	Non-Commercial Thinning/Fuels Reduction	• No treatment within 50 feet or the edge of riparian vegetation, whichever is greatest • No mechanical treatment within 100 feet of waterbody. • Winter harvest or no equipment in Riparian Reserves. Alternative methods of harvest may be approved by district soils scientist and Forest Plan standards for soil disturbance must be met (<20% soil disturbance in the unit). See Table 13 for additional BMPs and design criteria.
		Prescribed fire	• Non-fish bearing: No active ignition between 0 to 100 feet of waterbody. • Fish bearing: No active ignition. If active ignition is needed to meet ACS objectives, ARBO II will be used (none proposed at this time). • Allow backing fire towards waterbody. • Maintain 95 percent of overstory trees, 2/3 of understory/shrub, and 50 percent of ground cover/organic material on surface.

		Commercial Harvest	• No commercial harvest within 100 feet of waterbody. • Winter harvest or No equipment in Riparian Reserves. Alternative methods of harvest may be approved by district soils scientist and Forest Plan standards for soil disturbance must be met (<20% soil disturbance in the unit). See Table 13 for additional BMPs and design criteria. • Commercial harvest outside of the 100-foot buffer where necessary to meet NWFP TM-1 c (control stocking, reestablish and manage stands, and acquire desired vegetation characteristics needed to attain ACS objectives) and ensure present and future CWD needs are met TM-1 b. All commercial harvest within RRs will be reported to the Level 1 team prior to implementation. • Maintain >50 percent canopy cover. • New landings will not be constructed within the Riparian Reserves unless other practicable locations outside the Riparian Reserves (first priority), or existing landings inside the Riparian Reserves are not available. If new landings need to be constructed within Riparian Reserves, they will occur outside of the no treatment buffer and in areas with a mean site slope of <5%. Erosion control measures such as silt fences or other retention methods would be installed prior to landing construction and would remain in place during harvest operations. All landings within RRs would be scarified, seeded, and scattered with organic debris after harvest activities are complete.

Northern Spotted Owl Habitat Treatments

The proposed action retains and protects higher priority NSO habitats over lower priority habitats. The highest priority habitat, based on a LiDAR-derived habitat map and project ranking criteria (Project file - Oka-Wen wildlife 2019), would remain functional. Fuel breaks are proposed to help protect NSO habitat.

Table 4. Acres of Disturbance in Northern Spotted Owl Habitats within the project area by Proposed Treatment Types. Additional baseline and effects details are presented in the effects section below.

Treatment Type	Inside 1.8-mile AC buffer		Outside 1.8-mile AC buffer
	Inside 0.25-mile AC buffer	Outside 0.25-mile AC buffer	
Nesting, Roosting, and Foraging			
Stand Regeneration	0	0	663
Thinning	0	0	5031
Shaded Fuel Breaks[b]	12	226	113
	(12)	(226)	(14)
Total [3]	12	226	5680
Dispersal			
Stand Regeneration	0	451	621
Thinning	383	8637	6856
Shaded Fuel Breaks[b]	0	71	342
		(1)	(28)
Total [3]	383	9090	7505
NSO Designated Critical Habitat (2012 ruling)			
Stand Regeneration	0	451	1422
Thinning	281	13,001	15,033
Shaded Fuel Breaks[b]	38	974	728
	(12)	(226)	(68)
Total [3]	293	13,872	16,523

Note that totals may not sum correctly due to rounding. Area descriptions/break-out provided in this table are based on proposed prescriptions in northern spotted owl habitats, as described in Table 5.

[a] Does not include non-forest prescribed burns or limited treatment areas.

[b] Most of the areas encompassed by the shaded fuel break treatment option overlap with areas that would also be treated via stand regeneration treatments or thinning. Therefore, the values shown without brackets indicate the total area to be treated via shaded fuel breaks including the overlap with other treatment options, while the value shown in parentheses indicated the portion of this total that would not overlap with other treatment options.

[c] The sum total excludes the overlapping areas were more than one treatment option would occur (i.e., where shaded fuel breaks would be implemented in conjunction with stand regeneration treatments or thinning).

The proposed action proposes landscape treatments designed to move current conditions closer to reference conditions and thus increase landscape resilience to disturbances. Treatments would be more aggressive outside of high-quality habitat[1] and Activity Centers[2] and may remove nesting, roosting, foraging (NRF) habitats to reduce the risk to other habitats. Habitat within high priority activity centers (those that have had spotted owl activity in the past 15 years, including activity discovered prior to implementation, and contain the greatest amount of sustainable NRF) would be prioritized for retention. All project design features, including those applied to northern spotted owl habitat, would be applied to the proposed action (Table 5).

Table 5. Project design features for the northern spotted owl (NSO) habitat.

NSO Habitat Condition	Spatial Condition			
	Within all 1.8-mile Radius Home Ranges	**Outside Home Ranges**	**Shaded Fuel Break**	**Non-Federal Boundary Interface (300-foot buffer)**
High Quality (RA 32)[a]	Treatments retain RA 32 features[a] (>70 percent canopy cover, large trees, snags, logs)	Treatments retain RA 32 features (>70 percent canopy cover, large trees, snags, logs)	Treatments retain RA 32 features (>70 percent canopy cover, large trees, snags, logs)	Treatments retain RA 32 features (>70 percent canopy cover, large trees, snags, logs)
Nesting, Roosting, and Foraging (NRF)[b]	Treatments retain NRF features[b] (>60 percent canopy cover) (may degrade, but not downgrade or remove)[c]	Treatments may downgrade or remove[c] NRF to meet reference condition and risk objectives	Treatments may downgrade[e] or remove[c] NRF to meet fuel break objectives, inside or outside home ranges.	Treatments may downgrade or remove[c] NRF features[b] to meet fuel break objectives outside home ranges, but retain NRF features within all home ranges[e]
Dispersal[d]	Treatments may remove dispersal[d], but maintain landscape connectivity objectives	Treatments may remove dispersal, but maintain landscape connectivity objectives	Treatments may remove dispersal to meet fuel break objectives.	Treatments may remove dispersal to meet interface objectives.
Old Forest Multi-Story (Condition Treatment 7A)	Treatments retain NRF features[b] (>60 percent canopy cover)	Treatments must retain NRF features[b] (>60 percent canopy cover)	Treatments may downgrade NRF (>40 percent canopy cover) to meet fuel break objectives.	Treatments must retain NRF features[b] (>60 percent canopy cover)

[a] High quality habitat is defined in the *Revised Recovery Plan for the Northern Spotted Owl* (USFWS, 2011) as older, multi-layered structurally complex forests characterized as having large-diameter trees, high amounts of canopy cover, and decadence components such as broken-topped live trees, mistletoe, cavities, large snags, and fallen trees. Recovery Action 32 (RA 32) recommends this be mapped at the project scale and retained or restored. Treatments would only occur to retain or restore spotted owl habitat and are expected to be very limited
[b] Nesting, roosting, or foraging (NRF) include nesting/roosting or foraging habitat. Nesting and roosting habitat is defined as forested stands with high canopy closure, a multi-layered, multi-species canopy with larger overstory trees and a presence of nesting platforms such as

[1] High quality habitat is defined in the Revised Recovery Plan for the Northern Spotted Owl (USFWS 2011) as older, multi-layered structurally complex forests characterized as having large diameter trees, high amounts of canopy cover, and decadence components such as broken-topped live trees, mistletoe, cavities, large snags, and fallen trees. Recovery Action 32 (RA 32) recommends this be mapped at the project scale, and retained or restored.

[2] Activity centers are a location or point representing „the best of" detections" such as nest stands, stands used by roosting pairs or territorial singles, or concentrated nighttime detections. Activity centers are within the core use area and are represented by this central location. (USFWS 2012)

mistletoe clumps or abandoned goshawk nests. Foraging habitat is defined as lands that provide foraging opportunities for spotted owls. It includes the forest conditions that meet the definition of nesting/roosting habitat, but without the structure to support nesting and roosting, and has > 60% canopy cover with a component of large snag and logs (USFWS, 2011).

[c] Treatments that downgrade or remove NRF would be consistent with descriptions of Vegetation Stand Conditions described above, would generally be thinning from below and retaining the largest trees in the stand, and would help meet restoration objectives for HRV and resiliency. "Degrading" is defined as lowering the quality of the habitat, but not to an extent that it no longer functions in the current category. "Downgrading" habitat is defined as lowering the quality of NRF to dispersal habitat. "Removing" habitat is defined as lowering. the quality of NRF or dispersal to the extent that it no longer functions as habitat for the NSO, such as reducing canopy cover below 40%, or removing most snags or logs. In the longer term (20-30 years), many of these areas would grow into NRF. See descriptions above for details.

[d] Connectivity of spotted owl dispersal habitat would be maintained across the landscape. In addition to mapped dispersal habitat, NRF functions as dispersal also. Maintain connectivity between all LSRs/MLSAs and all activity centers in and adjacent to the Project area. Riparian Reserves provide landscape connectivity for owls in many cases.

[e] Suitable spotted owl habitat would be retained within all high priority activity centers, defined in Recovery Action 10 (RA 10) of the *Revised Recovery Plan for the Northern Spotted Owl* (USFWS, 2011) as sites and habitat that provide additional demographic support to the spotted owl population. For this project, all activity centers (sites) active within the past 15 years, including new activity discovered prior to implementation, are "high priority".

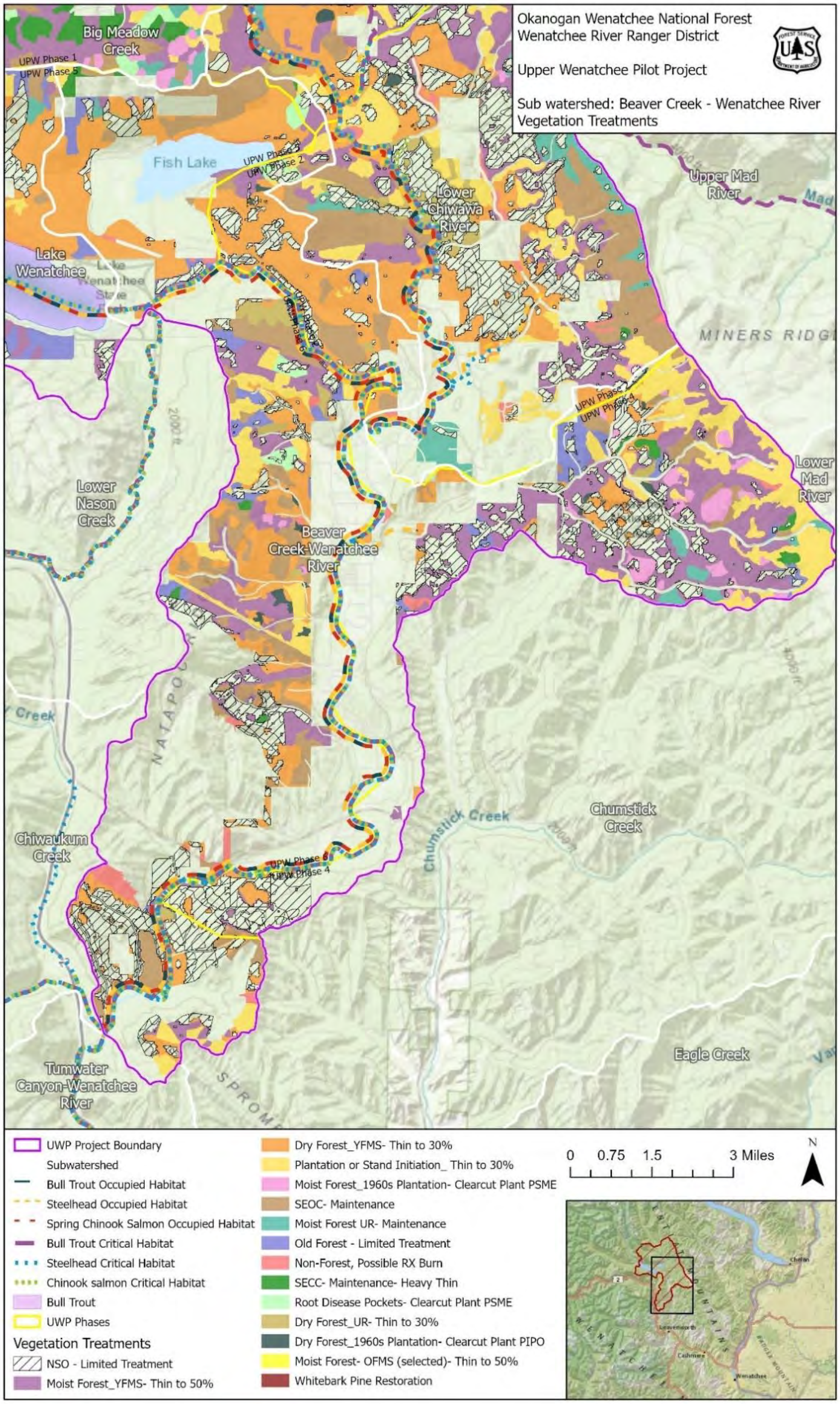


Figure 2. Vegetation Treatments in the Beaver Creek-Wenatchee River Subwatershed.

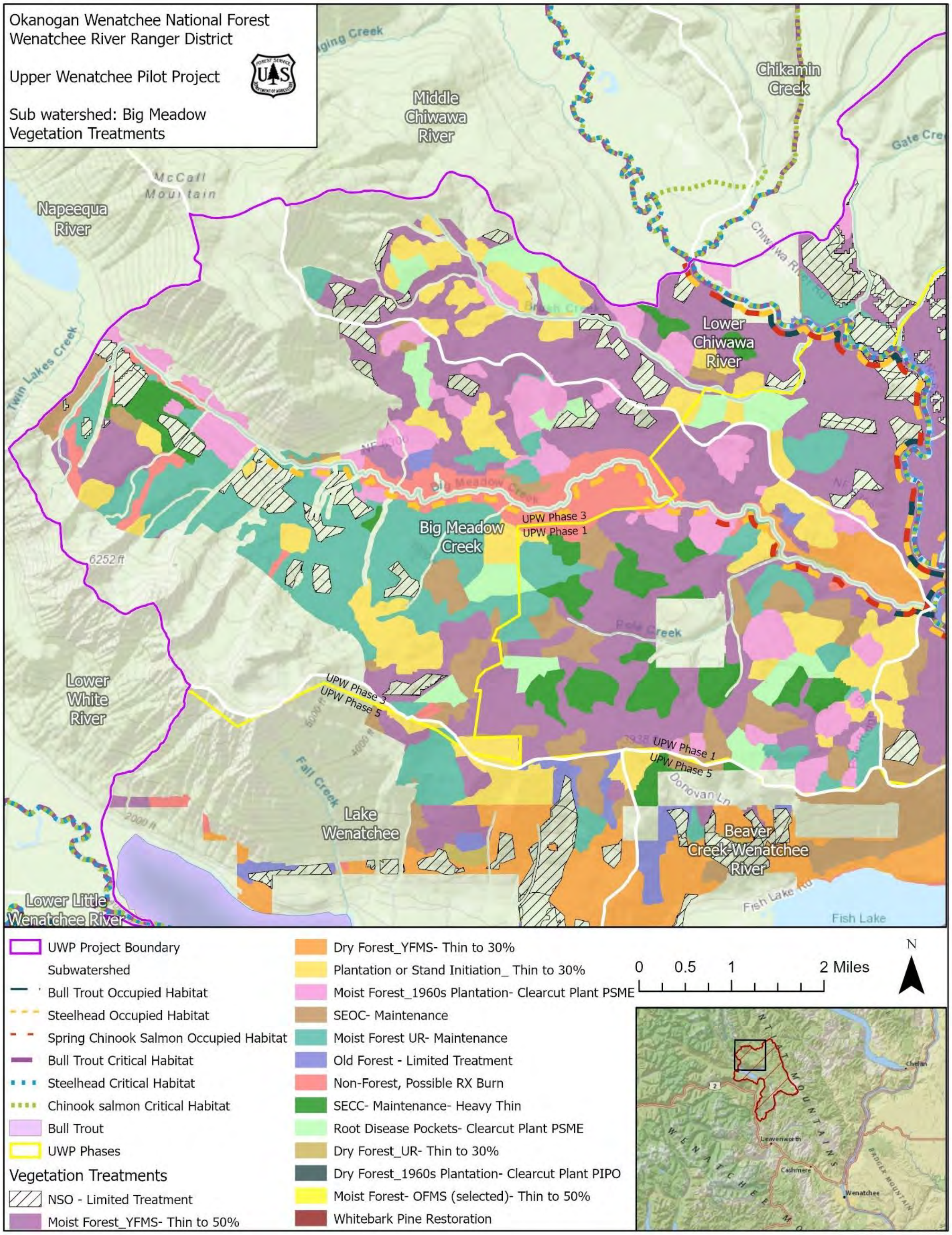


Figure 3. Vegetation treatments in the Big Meadow Creek Subwatershed.

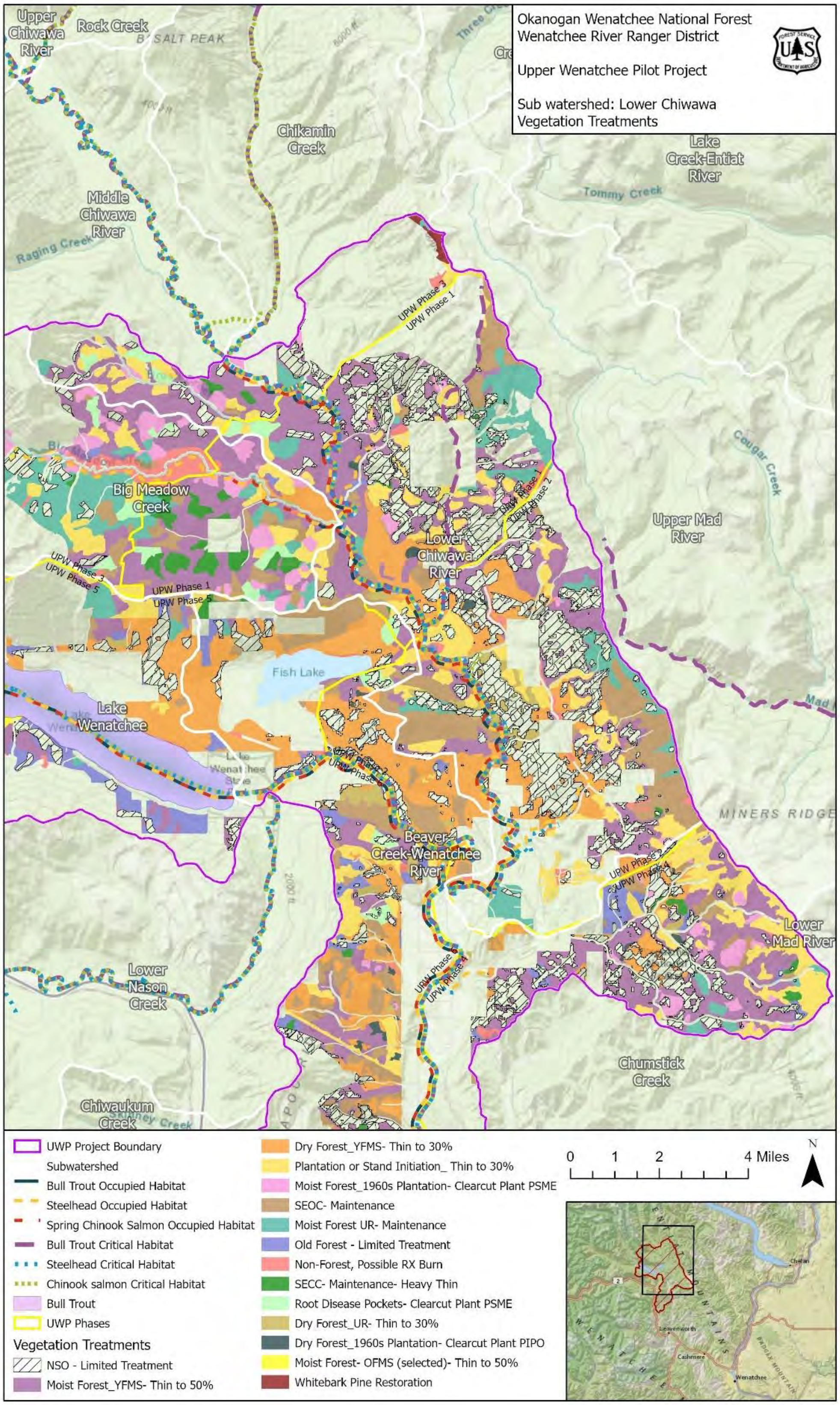


Figure 4. Vegetation Treatments in the Lower Chiwawa River Subwatershed.

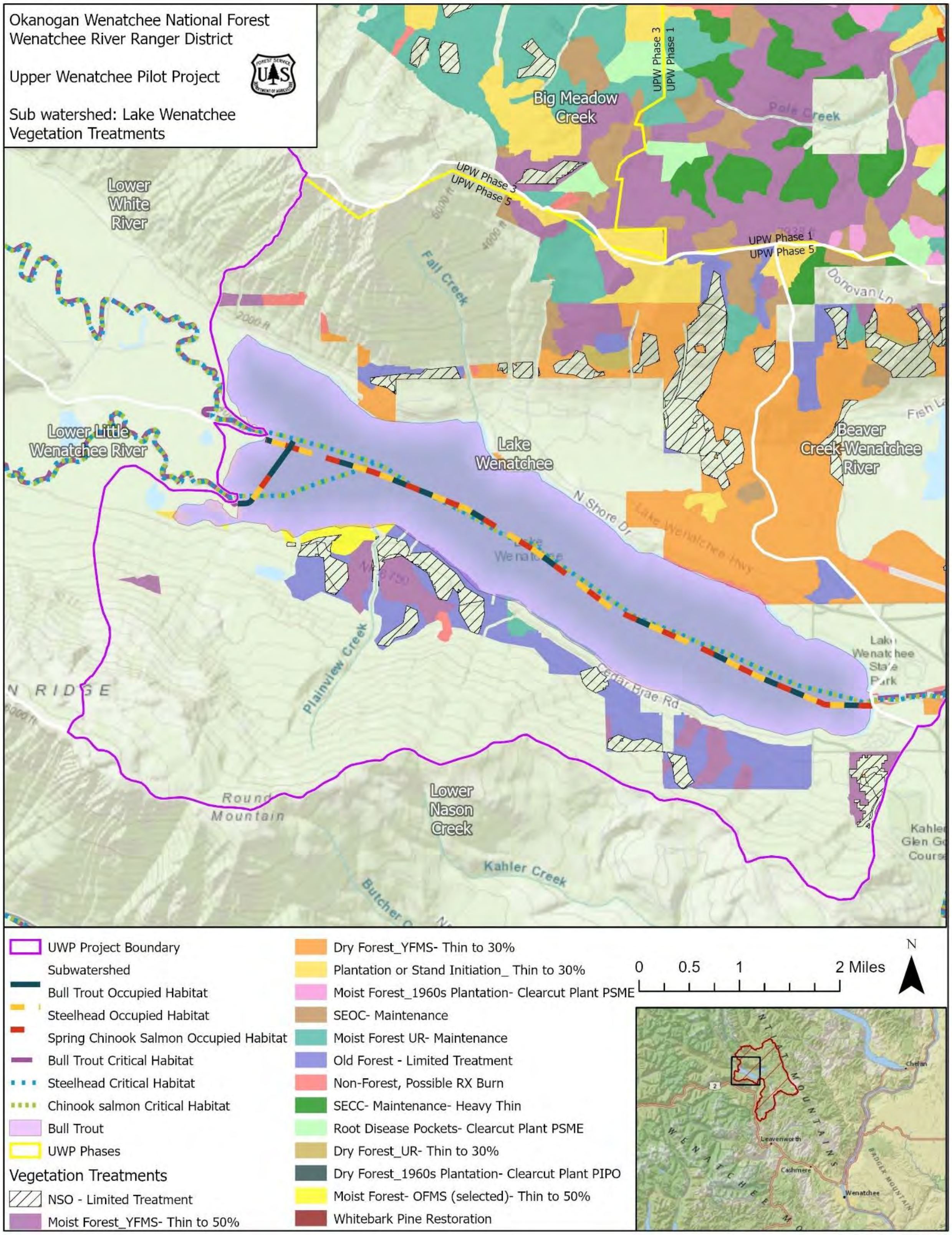


Figure 5. Vegetation Treatments in the Lake Wenatchee Subwatershed.

Implementation Timeline for Vegetation Treatments

Vegetation treatments would be implemented in six phases based on location and amount of potential harvest (Table 6 and Figure 2, Figure 3, Figure 4, and Figure 5). Harvest actions and associated prescribed burning would occur in years 1-12 of the project, potentially extending to 18. Road work would continue after the vegetation treatments and is projected to be fully completed by year 20. Scheduling depends on a variety of factors, including winter conditions for harvest, appropriate conditions for prescribed fire, and other environmental factors. The schedule will be continually updated and presented to the Services during the annual coordination meeting.

Table 6. Estimated timeline of vegetation and roads treatments. Dark shading: ideal timeline; light shading: potential years.

Activity	Project Year																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
"Meadow DxP" Harvest (1350 ac)	▓	▓	▓	▓	░	░	░													
Meadow Stand Improvement (700 ac)		▓	▓	▓	▓	░	░	░												
*Meadow Rx Burn (2,000 ac)		▓	▓	▓	▓	▓	░	░	░	░										
Meadow Road close/decom				▓	▓	▓	▓	▓	░	░	░									
***Meadow Monitoring	▓	▓	▓	▓	▓	▓	▓	▓	▓	░	░	░								
"Alder DxP" Harvest (900 ac)		▓	▓	▓	▓	░	░	░												
Alder Stand Improvement			▓	▓	▓	▓	░	░	░											
*Alder Rx Burn			▓	▓	▓	▓	▓	░	░	░	░									
Alder Road close/decom					▓	▓	▓	▓	▓	░	░	░								
Alder Monitoring		▓	▓	▓	▓	▓	▓	▓	▓	▓	░	░	░							
Block 2 "Goose DxP" Harvest (1600 ac)			▓	▓	▓	▓	░	░	░											
Block 2 Goose Stand Improvement				▓	▓	▓	▓	░	░	░										
Block 2 Goose RxB Burn				▓	▓	▓	▓	▓	░	░	░	░								
Block 2 Goose Road Close/decom						▓	▓	▓	▓	░	░	░								
***Goose Monitoring			▓	▓	▓	▓	▓	▓	▓	▓	░	░	░							
Block 3 "Brushy DxP" Harvest (900 ac) 5-8 MMBF				▓	▓	▓	▓	▓	░	░	░									
Block 3 Brushy Stand Improvement					▓	▓	▓	▓	▓	░	░	░								
*Block 3 Brushy Rx Burn					▓	▓	▓	▓	▓	▓	▓	░	░	░						
Block 3 Brushy Road Close/Decom							▓	▓	▓	▓	▓	▓	░	░						
***Block 3 Brushy Monitor			▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	░	░					
Block 4-" Beaver DxP" Harvest (800 ac); likely 2 sales					▓	▓	▓	▓	░	░	░	░								
Beaver Stand Improvement						▓	▓	▓	▓	░	░	░	░							
*Beaver Rx Burn						▓	▓	▓	▓	▓	░	░	░	░	░					
Beaver Road close/decom								▓	▓	▓	▓	░	░	░	░					
Beaver Monitor					▓	▓	▓	▓	▓	▓	▓	▓	░	░	░	░				
Block 5 "Lakes DxP" Harvest(700 ac)						▓	▓	▓	▓	░	░	░	░							
Lakes Stand Improvement							▓	▓	▓	▓	░	░	░	░						
*Lakes Rx Burn							▓	▓	▓	▓	▓	░	░	░	░	░				
Lakes Road close/decom									▓	▓	▓	▓	░	░	░	░				

Lakes Monitor																				
Block 6 "Plain DxP" Harvest (700 ac)																				
Plain Stand Improvement																				
***Plain Rx Burn**																				
Plain Road close/decom																				
Plain Monitor																				
****Retained Receipt Road Close/Decom**																				

*Note: Rx Burns primarily address activity fuels from Harvest and Stand Improvement thinning within the Sale Area Boundary

** Note: Retained Receipt Road Close/Decom to focus on roads not associated with a Timber Sale, but are identified in the TAP to close or Decom

*** Monitor - BMP, ARBO, Terrestrial effectiveness (Sale Admin, post sale, pre RxB, Post RxB) (Stand Improvement- Contract Admin, pre and post RxB)

Fuel Breaks

There are two types of fuel breaks that are proposed and will follow the project design features for treatments within NSO habitat and Riparian Reserves (Table 3 and Table 5). Fuelbreaks are proposed throughout the project area (Figure 6) and total acres/miles of fuel breaks are summarized in Table 7.

Table 7. Fuel breaks, by type.

Fuel Break Type	Total Acres	Length of Fuel Break (in miles)
Shaded Fuel Breaks	1921	54.0
Wildland Urban Interface Fuel Breaks	2870	79.8
Total	**4791**	**133.8**

Shaded Fuel Breaks

Shaded fuel breaks would be developed to slow fire movement, reduce the potential for crown fire initiation, protect habitats, and decrease the resistance of control on small, and large fires. This would require the modification of forest structures to reduce surface and ladder fuels. In general, the objective would be to raise the canopy base height and reduce canopy closure. Residual stand density would be dependent on the existing tree size class and distribution. Generally, stand condition objectives would be similar to stand condition 5 (Dry Forest - Stem exclusion open canopy), retaining the largest and most fire tolerant tree species, with residual canopy cover between 40 and 60 percent. The shaded fuel breaks would be developed along ridgelines, near system roads, and over pre-existing firelines. The fuel break footprint would generally overlap existing or planned treatment areas and would be integrated with silvicultural treatments to achieve desired stand conditions. The width of the fuel breaks would be between 100 and 300 feet. Over time, vegetation within these fuel breaks would continue to develop and periodic non-commercial thinning and prescribed fire would be used to maintain the integrity of these control features. About 54 miles (1,900 acres at 300-foot width) would be treated and maintained as fuel breaks. Treatments of shaded fuels breaks would follow all applicable design criteria and buffer for any treatments in RRs (Table 3).

Wildland Urban Interface Fuel Break

Similarly, 300-foot-wide fuel breaks are proposed around non-federal lands to further reduce risk and provide increased fire fighter safety, increased defensible space to non-federal lands, and at-risk communities. Approximately 2,870 acres (79.8 miles) would be treated to reduce surface and ladder fuels, raise the canopy base height, and reduce canopy closure. General stand condition objectives, retention, and canopy cover would be like the shaded fuel breaks. Periodic non-commercial thinning and prescribed fire would be required to maintain the fuel break. Fuel break maintenance would include pruning (hand saws), non-commercial thinning (chainsaws) and hand piling that typically occurs outside of winter.

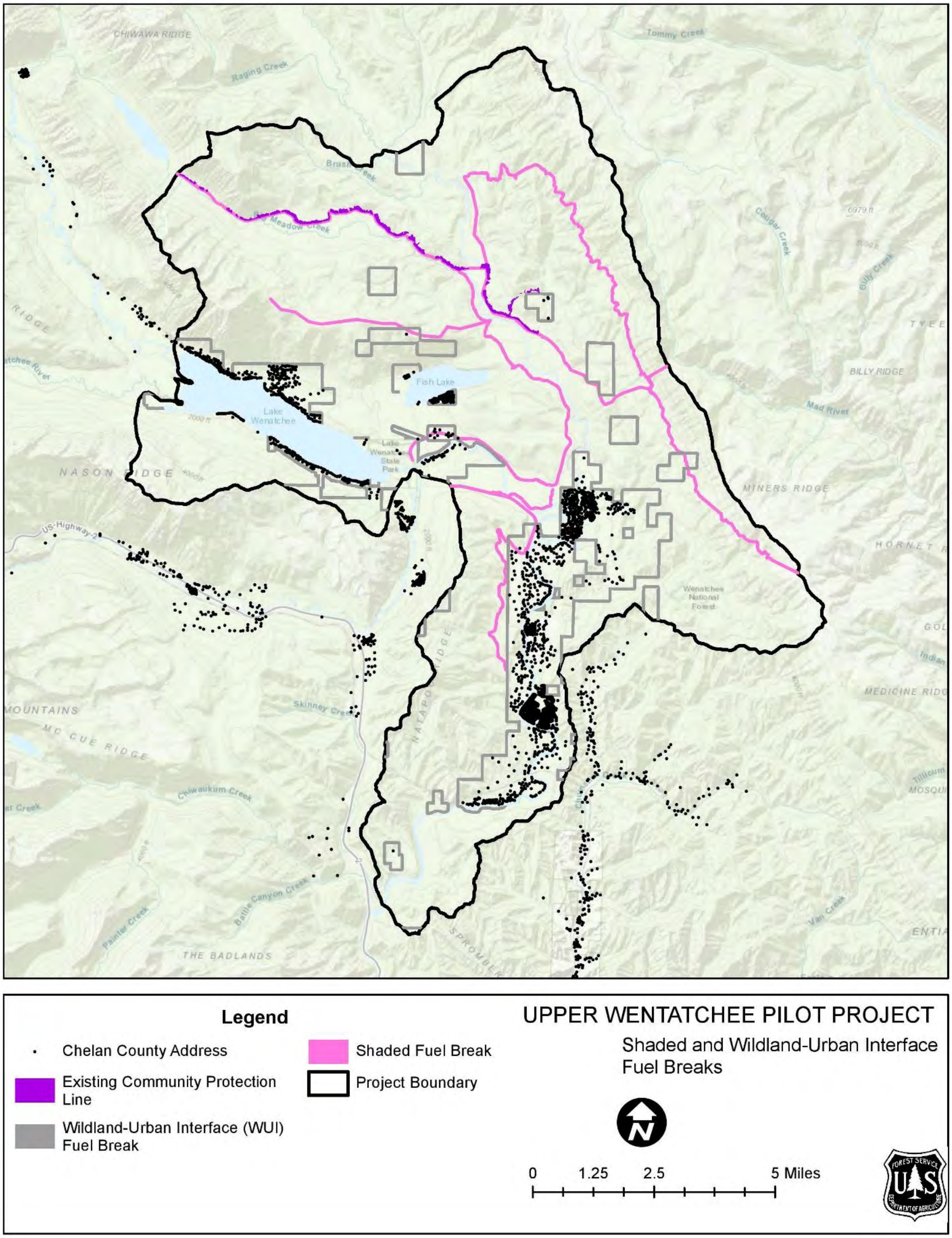


Figure 6. Shaded and Wildland-Urban Interface Fuel Breaks

Decommissioning Existing Roads/ Reducing Road Densities

Opportunities have been identified to reduce road densities in subwatersheds where Effective Drainage Network and Watershed Road Density and Reach-based Ecosystem Indicators (REI) have been identified as *at Risk* or *Poor* condition (Cramer Fish Sciences, 2019). Reduction in road densities and valley bottom road densities would be beneficial to riparian habitat that has been physically displaced by valley bottom roads; with a reduction in drainage network, hydrologic impacts to streams would be lowered and sediment delivery would be reduced to area streams.

Implementation of the Transportation Analysis Process (TAP; see Appendix B) recommendations would improve REI indicators to varying degrees within the Project area. Road reductions would include only those roads identified in the project TAP (see Appendix B). Travel analysis is a science-based process used "to inform decisions related to a) identification of the minimum road system needed for safe and efficient travel and for administration, utilization, and protection or National Forest System (NFS) lands per 36 CFR 212.5(b)(1) and b) designation of roads, trails and areas for motor vehicle use per 36 CFR 212.51" (FSH 7709.55, section 20.2). The TAP was developed through an interdisciplinary approach to examine the existing forest transportation system to determine appropriate management direction for each road. Considerations included road maintenance level (ML; see Appendix B for definitions of MLs), closure or decommissioning recommendations, resource needs or concerns, maintenance costs, motorized access restrictions, and new access needs, among others.

The TAP has identified about 65 miles of roads for decommissioning, and about 54 miles of road to be closed (i.e., placed in storage in ML 1 status). About 1 mile of closed road would be opened. Of the approximately 22 miles of unauthorized roads identified in the TAP, almost half (10.5 miles) would be decommissioned, and the remaining 11.7 miles would be converted to NFS roads in either ML 1 or ML 2 status. Post-project, there would be a net reduction of about 50 miles of open NFS roads within the Project Area. See Appendix B for a complete list of proposed maintenance level changes. All road actions will be covered under this BA, regardless of whether the action is considered for the benefit of "aquatic restoration" or "vegetation management". All road actions (openings, temporary construction, maintenance, closures, decommissioning) will follow Forest Service BMPs (see Design Criteria section below) and any actions within RRs will follow ARBO II and WDFW guidelines, even though they are being consulted with this BA.

Table 8. Summary of watershed metrics and road densities.

Watershed	Subwatershed	Type	Subwatershed Area (mi²)	Existing		During Project		Post Project	
				Length (mi)	Road Density (m/mi²)	Length (mi)	Road Density (m/mi²)	Roads (mi)	Road Density (m/mi²)
Wenatchee River	Beaver Creek-Wenatchee River	*All Roads*	44.3	223.9	5.1	254.6	5.7	202.3	4.6
		Open Roads	44.3	155.3	3.5	186.0	4.2	84.0	1.9
White River-Little Wenatchee River	Lake Wenatchee	*All Road*	16.9	51.8	3.1	58.1	3.4	49.7	2.9
		Open Roads	16.9	34.9	2.1	41.2	2.4	17.5	1.0

Chiwawa River	Lower Chiwawa River	*All Roads*	38.8	160.3	4.1	180.6	4.7	129.1	3.3
		Open Roads	38.8	122.0	3.1	142.3	3.7	75.8	2.0
	Big Meadow Creek	*All Road*	15.8	61.6	3.9	78.3	5.0	53.7	3.4
		Open Road	15.8	41.7	2.6	58.4	3.7	28.4	1.8

Table 9 lists road segments that have been slated for decommissioning that are in RRs within 1000 feet of ESA-listed fish species. While we are covering decommissioning as part of this BA, any road decommissioning in a RR will follow the design criteria in ARBO II and the Forest Service's MOU with WDFW, which include, but are not limited to, silt fencing requirements, in-water work windows, construction isolation, fish salvage, and revegetation.

Table 9. Riparian roads within 1000 ft of ESA-listed fish species that will have on-the-ground changes to road status.

NFS Road Number	Length (miles)	Action Recommendation	Species	Subwatershed	Comments
6102230	0.17	Decommission Closed Road	BLT; STH	Lower Chiwawa	outside edge of Elder Cr RR; 1000 ft upstream of BLT and STH CH (unoccupied)
6105130	0.44	Decommission Closed Road	STH	Lower Chiwawa	no crossings, adjacent to unnamed Clear Cr Trib, less than 50 ft from potential STH
6105140	0.79	Decommission Open Road	STH	Lower Chiwawa	no crossings, adjacent to Clear Cr, less than 50 ft from occupied and CH for STH
6121120	0.21	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	Outer edge of Chiwawa River RR, 250 ft from ESA fish and CH
6121120	1.13	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	Outer edge of Chiwawa River RR, only 300 ft of road in RR, 200 ft from ESA fish and CH
6121120	0.09	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, 150 ft from ESA fish and CH
6121125	0.20	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, 100 ft from ESA fish and CH
6121127	0.57	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, only 250 ft of road located in RR, 100 ft from ESA fish and CH
6121917	0.25	Decommission Open Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR, 200 ft from ESA fish and CH
6122674	0.09	Decommission Closed Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR, 200 ft from ESA fish and CH
6122912	1.35	Decommission Closed Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR, minimum of 100 ft from ESA fish and CH
6122918	0.31	Decommission Closed Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR, only 100 ft of road in RR, 200 ft from ESA fish and CH
6200202	0.11	Decommission Open Road	STH; BLT	Lower Chiwawa	Outer edge of Alder Cr RR, 300 ft from STH CH
6200310	0.19	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, 200 ft from ESA fish and CH
6200330	0.76	Open for Haul/Decommission Closed Road After Haul	STH	Lower Chiwawa	Crosses fishless Twin Cr intermittent side channel. Greater than 500 ft from STH but potential for STH access during high flows, culvert install/removal will occur during low flow isolation

6200340	0.90	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, 200 ft from ESA fish and CH
6200380	0.04	Open Closed Road	BLT; STH; CHK	Lower Chiwawa	Adjacent to Grouse Cr, in campground. 750 ft from occupied habitat and no change to on-the-ground conditions
6200385	0.29	Close Open Road	BLT; STH; CHK	Lower Chiwawa	Adjacent to Chiwawa River, 150 ft from ESA fish and CH
6300151	0.11	Decommission Closed Road	BLT; STH; CHK	Lower Chiwawa	Adjacent to Chiwawa River, 25 ft from ESA fish and CH
6304114	0.20	Decommission Open Road	BLT; STH	Big Meadow Creek	Adjacent to Big Meadow Cr, 50 ft from STH and BLT
6304115	1.89	Close Open Road	STH	Big Meadow Creek	Only 800 ft located in outer edge of Big Meadow Creek RR (marsh area). Over 700 ft from STH.
6309000	1.97	Decommission Closed Road	STH	Big Meadow Creek	Crosses unnamed tribs to Big Meadow Creek, 750 ft from STH
6309117	0.32	Decommission Closed Road	STH	Big Meadow Creek	Adjacent to unnamed Big Meadow Creek tributary, 500 ft from STH
6606103	0.28	Decommission Open Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR, 150 ft from ESA fish and CH
7906000	0.39	Decommission Closed Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR; no change on ground
6200125-0.3R-1	0.09	Decommission Unauthorized Route	BLT; STH; CHK	Lower Chiwawa	Adjacent to Chiwawa River, 100 ft from ESA fish and CH
6200130-0.08R-1	0.06	Decommission Unauthorized Route	BLT; STH; CHK	Lower Chiwawa	25 ft from Chiwawa R and 50 ft from Alder Cr. Dispersed campsite along route will be rehabbed using ARBO II.
6200200-2.8L-1	0.18	Decommission Unauthorized Route	STH	Lower Chiwawa	Outer edge of Alder Cr RR, 250 ft from STH and CH
6200310-0.2R-1	0.06	Decommission Unauthorized Route	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, 150 ft from ESA fish and CH
6300000-2.5L-1	0.05	Decommission Unauthorized Route	BLT; STH; CHK	Big Meadow Creek	40 ft from Big Meadow Cr, dispersed campsite at end of the route will be rehabbed using ARBO II.

While some roads slated for closure or decommissioning will have to wait until implementation is complete in that area, over 50 miles of roads will not be used for implementation of the vegetation treatments and can be closed or decommissioned as soon as funding allows. See Table 10.

Table 10. Closures and decommissioning on roads NOT used for haul or vegetation implementation (in miles).

Watershed	Close Open Road	Close Unauthorized Route	Decommission Closed Road	Decommission Open Road	Decommission Unauthorized Route
Chiwawa River	5.8	0.0	5.1	5.4	0.6
Wenatchee River	8.6	0.9	8.2	5.3	2.5
White River-Little Wenatchee River	0.0	4.5	3.3	0.0	0.2
Total Miles	**14.4**	**5.4**	**16.6**	**10.7**	**3.3**

Changes to Road Management Levels: Specific opportunities have been identified to change the management level of roads to reduce road densities and reduce road-related impacts on aquatic resources. These changes will result in an overall reduction of approximately 3 miles of road currently in ML 3 status (low clearance vehicles), which will convert to ML 2 status (high-clearance vehicles only), and a reduction of approximately 356 miles of roads currently in ML 2 status, including approximately 12 miles converting from ML 2 to ML 2a (only open for administrative use), 38 miles converting from ML 2 to ML 1 (closed), and 22 miles converting from ML 2 to decommissioned. As noted, approximately 12 miles of unauthorized roads would be converted to NFS roads in either ML 1 or ML 2 status. Roads scheduled for closure would be monitored prior to October 1st annually to ensure work is completed and that the drainage facilities are adequate and self-maintaining.

New Permanent Road Construction: No new permanent roads will be constructed as a part of this project, but some segments of unauthorized roads will be officially added to the roads system (see below).

Unauthorized Roads Management: Unauthorized roads are primary roads that were built by the FS or FS contractors but never were officially entered into our database. Four segments of unauthorized roads will be added to the system as ML2 (open) roads, for a total of 2.5 miles. Only one segment (0.3 miles long) is partially within a RR near Lake Wenatchee and is the access road for a rock pit. The other 2.2 miles are outside of RRs. These roads are in open drivable condition currently and, by adding them to the system, will ensure that they stay in good condition. Additionally, 9.2 miles of unauthorized roads will be added to the system in ML1 (closed) status. These roads will be hydrologically closed and blocked with a gate or other physical structure.

Temporary Road Construction: This project proposes 23.0 miles of temporary roads to be constructed at different phases of implementation. Only 0.6 miles of temporary roads are being proposed within Riparian Reserves (RR) and none of those are within 1000 ft of ESA occupied or Critical Habitat. The remainder of the RR temporary reserves are in unnamed intermittent headwater stream RRs. All temporary roads would be constructed to the minimum standards necessary for safe use. The construction of each road will follow the National BMP for temporary roads (Road-5. Temporary Roads). Each of these would be fully decommissioned as part of the timber sale contracts within 1 year of construction. Decommissioning methods include current standards and Best Management Practices.

Watershed	Total Miles	Miles in RR	Miles in RR within 1000 ft of ESA
Chiwawa River	13.8	0.1	0.0
Wenatchee River	6.9	0.5	0.0
White River-Little Wenatchee River	2.3	0.0	0.0
Total	**23.0**	**0.6**	**0.0**

Opening of Closed Roads for Vegetation Treatments: Up to 60.6 miles of currently closed roads may be opened for treatment purposes. This re-opening can range from removing a berm or opening a gate to clearing vegetation and resurfacing the road prism. Additionally, there are two closed roads that will need to have a culvert replaced before haul can occur. Both are in the Twin Creek drainage: one is downstream of the Chiwawa River Road and on an intermittent tributary to Twin Creek with no evidence of fish use and the other is above fish distribution. 4.5 currently closed roads in RRs will be open for haul. Only 0.4 miles of those are within 1000 ft of ESA occupied or Critical Habitat: 0.1 miles in the Wenatchee River Watershed (on the outer edge of an intermittent stream over 600 ft from the Wenatchee River) and 0.2 miles in the Chiwawa River Watershed (across a intermittent tributary to Twin Creek over 500 ft from occupied steelhead habitat in Twin Creek and in the outer edge of the Big Meadow Creek RR, over 600 ft upland from occupied steelhead habitat).

All closed roads that are opened for treatment will be either returned to their original status or changed to reflect the decision of the project TAP (i.e. decommissioning a road that was previously closed).

The following BMPs would be used when opening closed roads:

- Temporary and long-term erosion control
- Measures to reduce erosion and maintain overall slope stability
- No side casting in RRs
- Avoiding deposition of materials outside of the roadway limits.
- To minimize runoff effects, the roads would be outsloped and drain dips would be constructed.

Watershed	Total Miles	Miles in RR	Miles in RR within 1000 ft of ESA
Chiwawa River	44.2	2.7	0.2
Wenatchee River	14.9	1.8	0.1
White River-Little Wenatchee River	1.5	0.0	0.0
Total	**60.6**	**4.5**	**0.3**

<u>Open Roads Used for Commercial Harvest</u>: Open roads may also be used for commercial harvest haul. Roads used for haul may need to receive maintenance before and after use to avoid resource damage. The primary road that will be used for haul that crosses ESA occupied or critical habitat is the Chiwawa River Road (6200), which is a paved and well-maintained road. In general, ML2 roads are more likely to receive maintenance, which may include drainage ditch construction/clearing, road armoring, vegetation clearing, or resurfacing in places. In the Wenatchee River watershed, 0.2 miles of ML2 roads in RR within 1000 ft of ESA occupied or Critical Habitat will be used for haul, all adjacent to unnamed intermittent streams over 500 ft from the Wenatchee River. In the Chiwawa River watershed, there will be a total of 2.8 miles in RRs within 1000 ft of ESA occupied or Critical Habitat: 0.9 miles along Clear Creek with 3 crossings (occupied steelhead habitat); 0.7 miles along Twin Creek with one crossing 600 ft above occupied steelhead; 0.7 in the Big Meadow Creek RR (no crossings); 0.2 miles adjacent to Goose Creek (just upstream of Spring Chinook Critical Habitat); 0.3 miles along Alder Creek with 3 crossings (one over bull trout Critical Habitat and occupied steelhead habitat, two over bull trout Critical Habitat); the rest on the outer edges of RR adjacent to the Chiwawa River.

Table 11. Summary of haul routes by road maintenance level.

Watershed	ML2 Roads (RR)	ML3 Roads (RR)	ML4 Roads (RR)	ML5 Roads (RR)
Chiwawa River	70.9 (2.7)	8.1 (1.4)	3.5 (0.5)	0.0 (0.0)
Wenatchee River	45.5 (1.8)	0.4 (0.0)	0.0 (0.0)	2.1 (0.7)
White River-Little Wenatchee River	9.5 (0.0)	1.3 (0.1)	0.04 (0.0)	0.0 (0.0)
Total	**125.9 (4.5)**	**9.8 (1.5)**	**3.5 (0.5)**	**2.1 (0.7)**

Table 12. Summary of unpaved road crossings used for haul routes that may affect ESA listed fish species.

Creek Crossing	Road Number	Stream Mile	Likely Species	Comments
Alder	6208	0.8	STH, BT	
Alder	6102-200	1.3	STH, BT	
Alder	6104	4	BT	Upper end of BT CH
Twin	6209	1.1	STH	
Trib to Twin	6200-330	0.3	STH	Intermittent trib, may have seasonal steelhead use
Gate	6200	0.1	STH, BT	
Brush	6306	1	STH	
Clear	6105	1.5	STH	
Clear	6105	1.7	STH	
Clear	6105	1.9	STH	
Goose	6100	0.4	CHIN	Crosses at upper extent of Chinook CH, unoccupied

To control dust from roads during log haul, lignin or water would be applied to the road surface as needed. Water drafting sites for dust abatement and road compacting would be identified by a hydrologist or fish biologist to avoid adverse de-watering effects to fish. Water drafting would maintain a continuous surface flow of the stream without altering the original wetted width. Any draft suction hose used in fish-bearing waters would be equipped with a screen of 3/32-inch or less mesh and would have an intake flow of less than 1 cubic foot/second to prevent entraining juvenile fish.

Prior to log haul occurring on any roads, all identified maintenance needs must be addressed (Figure 7 displays known issues). In addition to the known issues, the district aquatics team (hydrologist, fish biologist, and/or soils scientist) must inspect the roads for any additional areas of concern for rehabilitation prior to log haul. Some examples of these maintenance needs could include adding in additional cross drains or water bars, ditch cleaning, road resurfacing or other stabilization. Special care will be taken to inspect unpaved road crossings over fish bearing streams, especially ESA listed fish (see Table 12) and gravel will be placed over these crossings prior to haul occurring. The district aquatics staff will monitor road conditions during use. Contractors will be required to keep the haul routes in good condition and will be required to halt haul if additional repairs are needed.

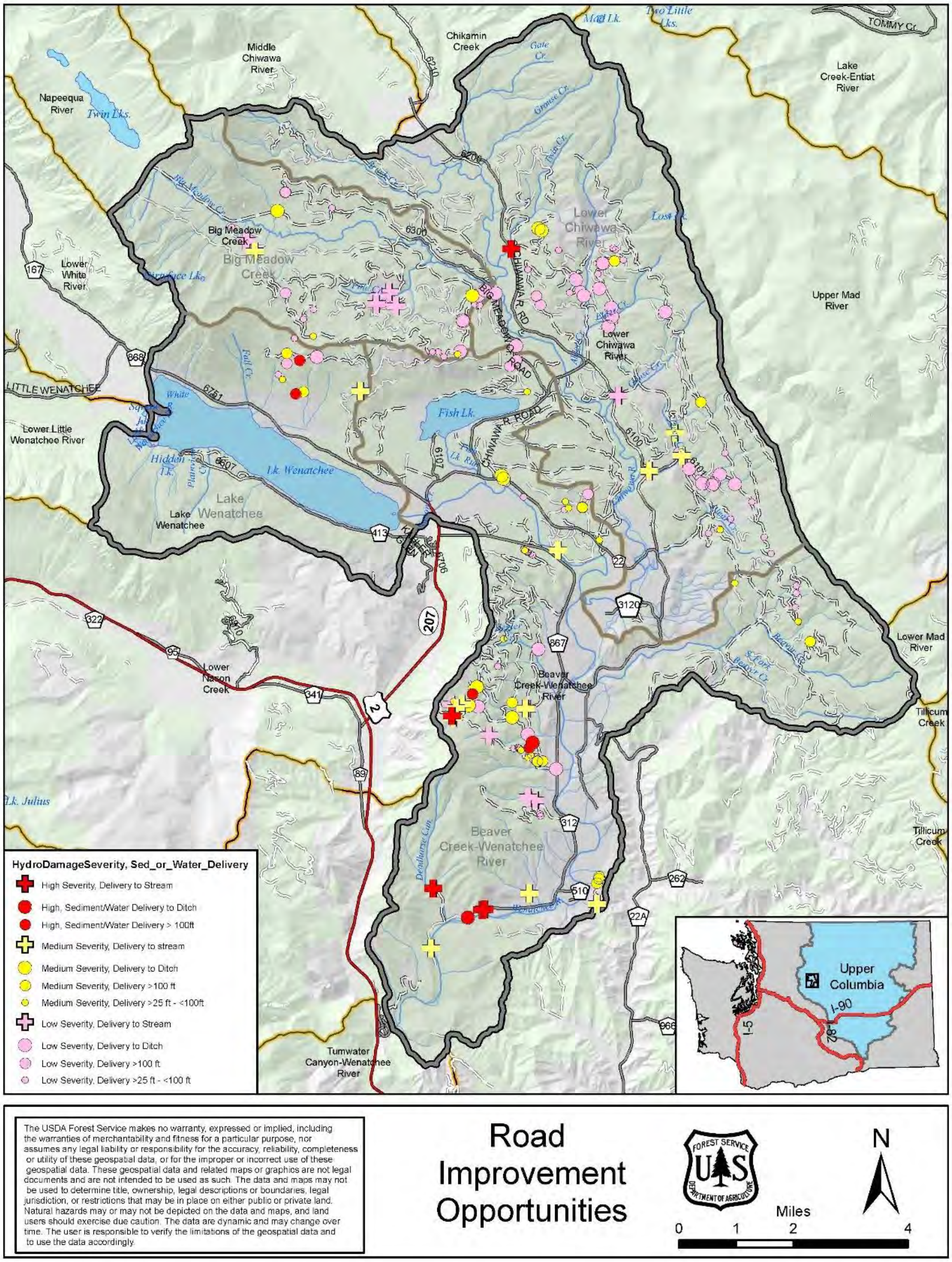


Figure 7. Road Maintenance Opportunities. These locations will be repaired as either part of vegetation activities (prior to log hauling) or independent of vegetation treatments, as funding is available.

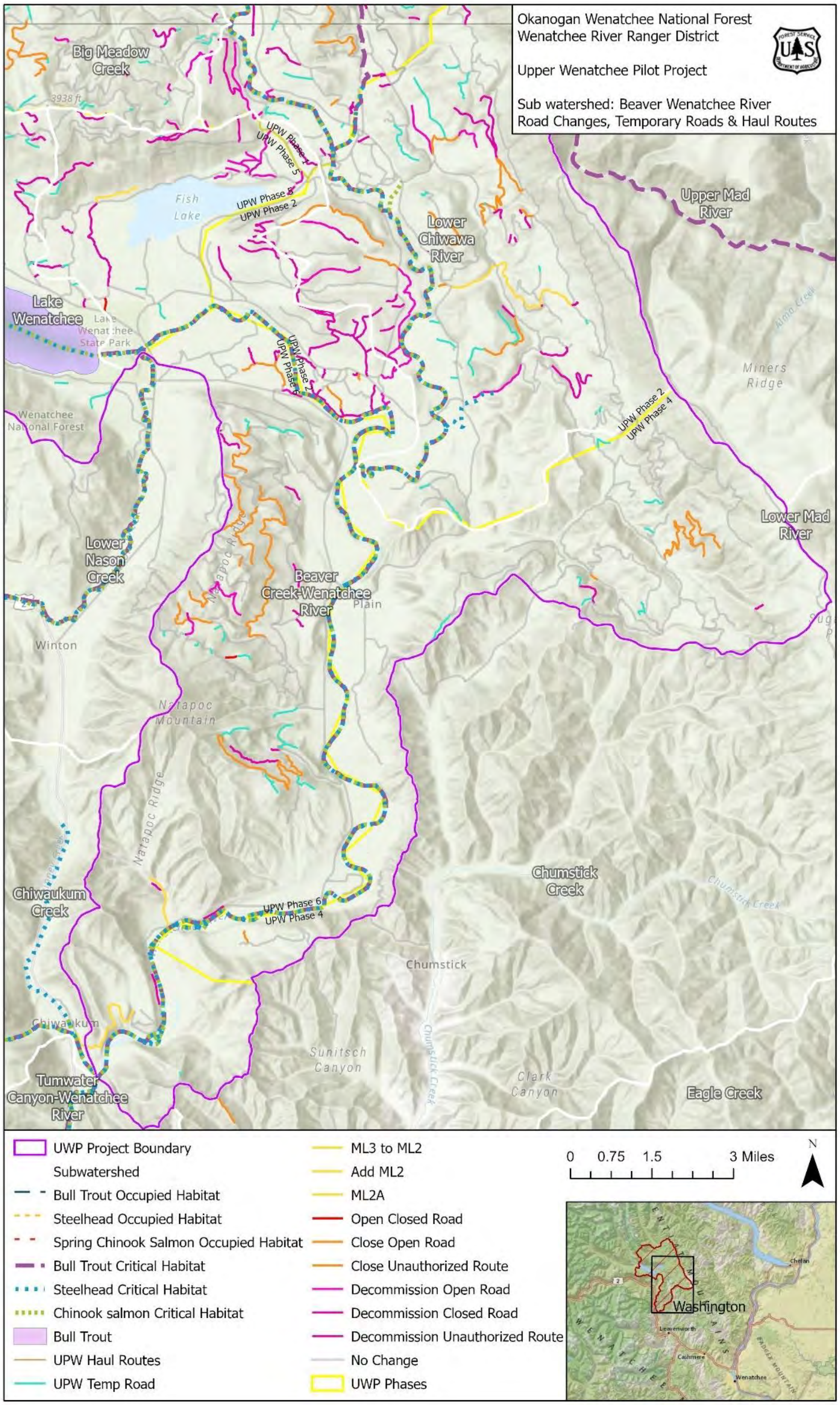


Figure 8. Road Changes in the Beaver Creek-Wenatchee River Subwatershed.

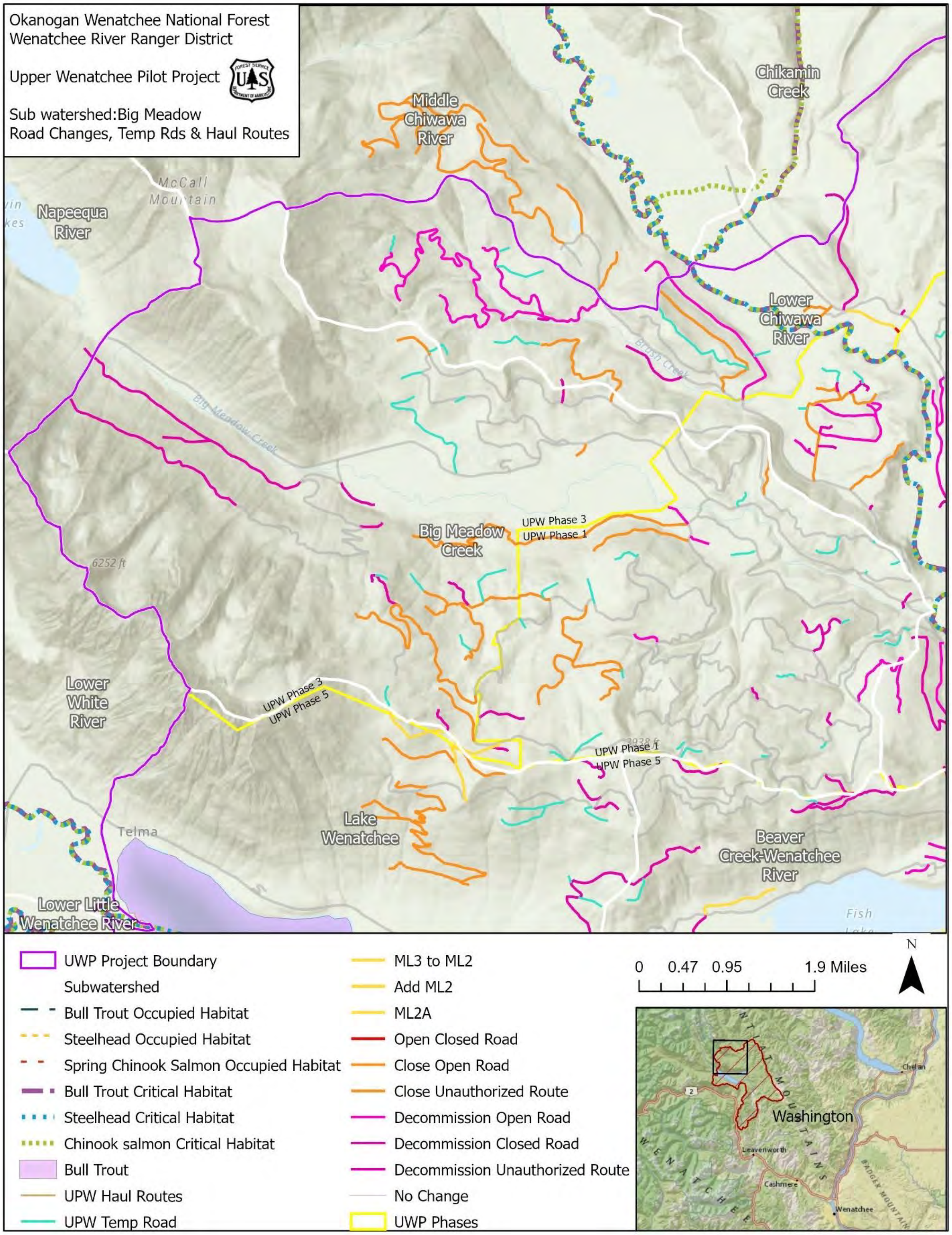


Figure 9. Road Changes in the Big Meadow Creek Subwatershed.

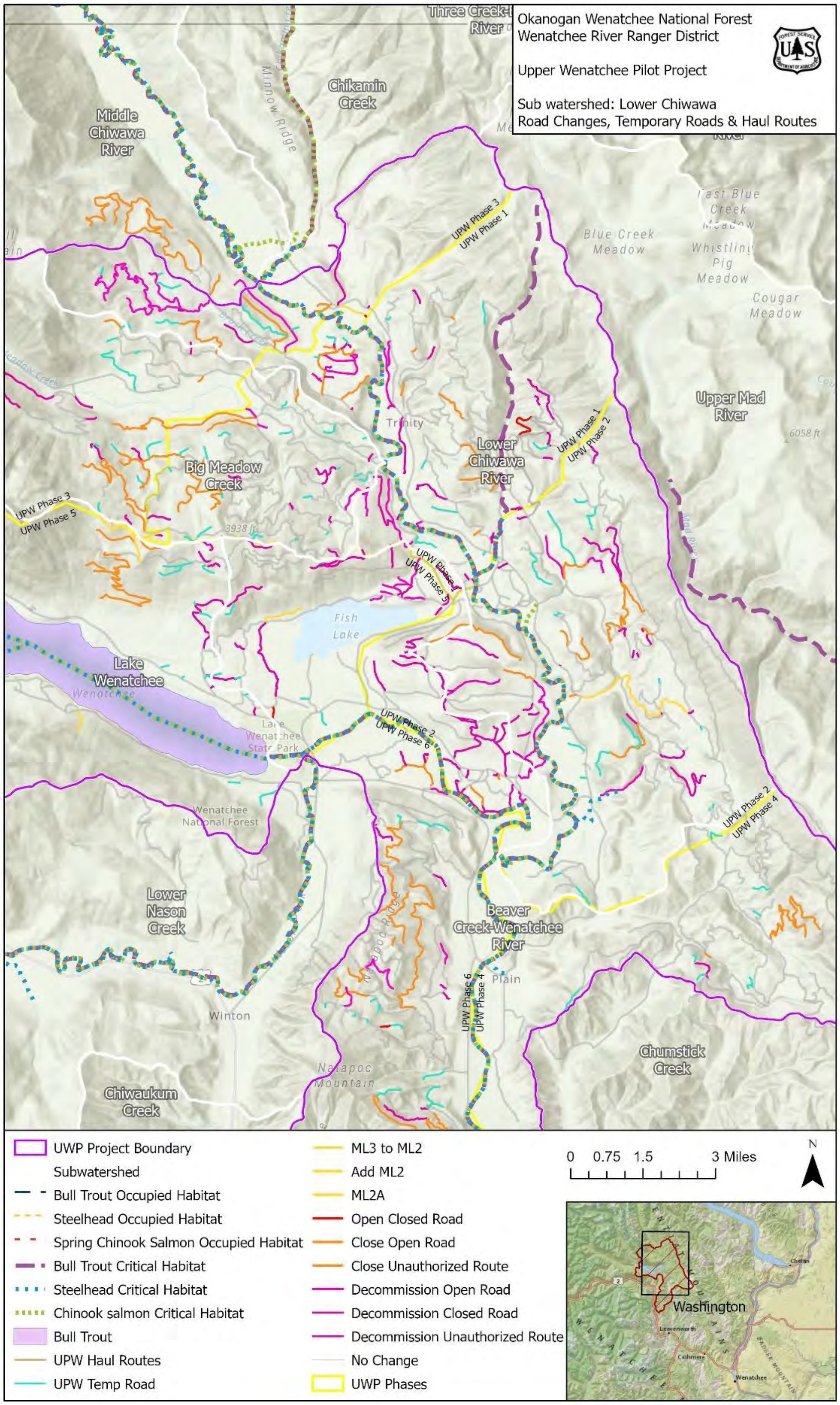


Figure 10. Road Changes in the Lower Chiwawa River Subwatershed.

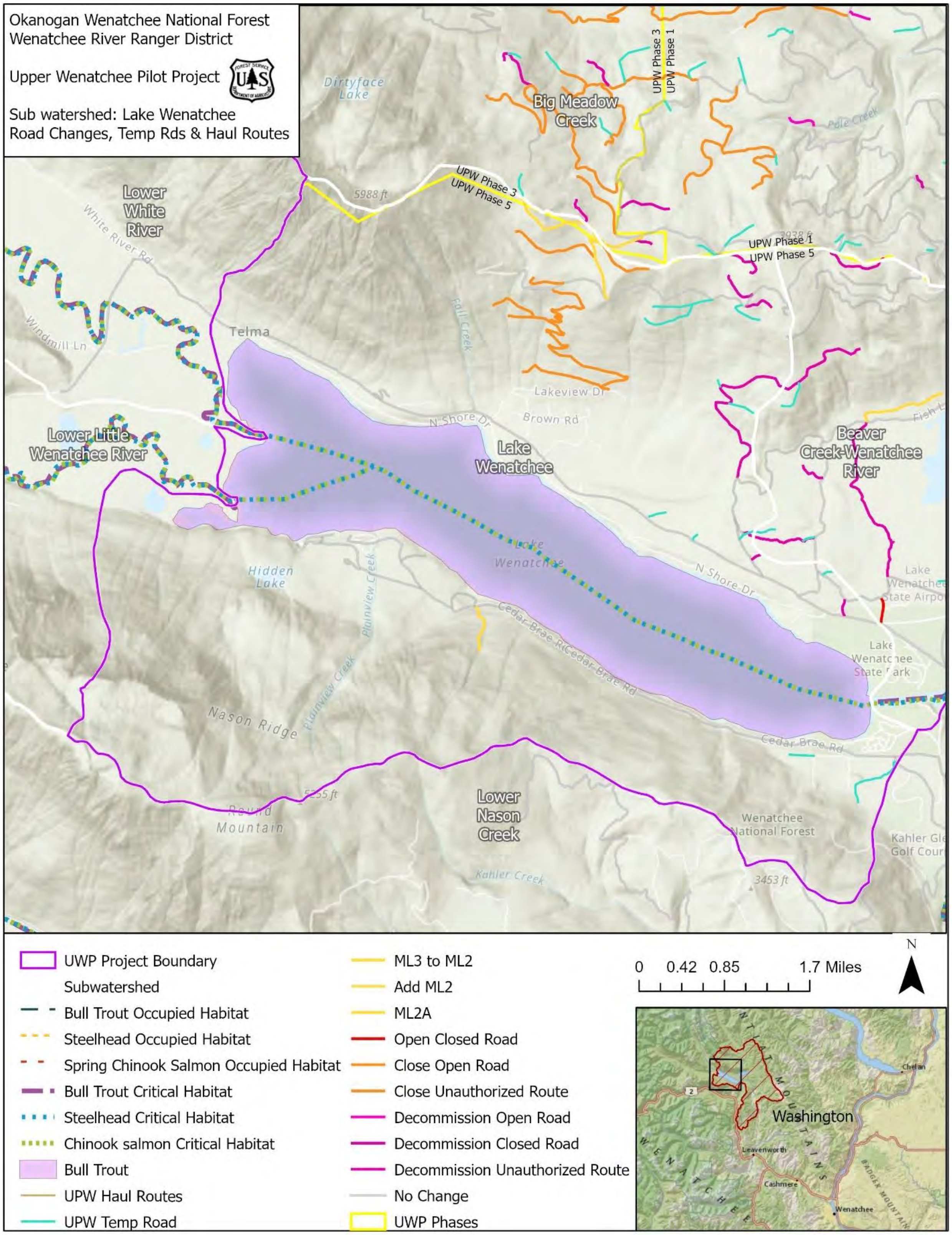


Figure 11. Road Changes in the Lake Wenatchee Subwatershed.

Invasive Plant Treatments
Treatment for invasive plants will occur, where needed, prior to any road closures, decommissioning, rehab of landings, and other areas of disturbance within the project area. The invasive plant Design Criteria (Table 13) include requirements for project activity areas to be monitored for new infestations, and if they are found, to be treated before they can become established and spread (Early Detection Rapid Response - EDRR). In addition, we are required to monitor and continue treatments of existing populations, prioritizing recently disturbed areas near existing populations. These actions were described in the Forest-wide Site-specific Invasive Plant Management FEIS and ROD (USDA Forest Service 2016 and 2017), and consultation was completed under ARBO II (USFWS 2013: FWS Reference: 01EOFW00-2013-0090). Conservation measures described in these documents would be followed.

Internal Project Development

Prior to final project design, contracting, or implementation, the district Interdisciplinary Team (IDT) will review and ensure all design criteria and mitigation measures will be met during implementation. The IDT will also ensue the proposed action is consistent with the project EA, BA, and all applicable laws, standards, and regulations.

Implementation Monitoring, Reporting, and Coordination with Level 1 Team

Implementation monitoring, reporting, and coordination will occur with the Level 1 team because of the conditional nature of the project, general designs, and data gaps. We will work with the USFWS/NMFS to develop the details in the monitoring plans to address these areas of uncertainty in the BA and effects analysis. The on-going reviews, coordination, monitoring and reporting will serve as a form of adaptive management to ensure the UWPP stays concurrent with the BA. All monitoring data/reports will be provided to the Level 1 team at the annual meeting or as needed. After each phase of the project is completed (or as requested by the Level 1 team) a detailed review of actions will occur and recommendations for future implementation may be made as part of the adaptive management plan. Several types of monitoring to get at implementation, uncertainty, and data gaps are described below:

1. Annual Project Review/Coordination - An Annual Coordination Meeting with the Level 1 team will occur in March of every year for the project duration. The Forest Service will provide locations and maps of upcoming actions (i.e., restoration, vegetation treatments, temporary roads, landings, haul routes, fire application, etc.) and other pertinent information or issues pertaining to actions that will be occurring in or near the streams, RRs, LSRs, and NSO habitat. This meeting will provide a review/check-in to ensure compliance with all design criteria in the BA. It will also provide opportunity to review the most recent monitoring data. If the Level 1 team has concerns about the proposed actions for the upcoming year, the proposed action may be changed to reduce impacts.

- Because of the use of the existing and new roads in the watershed and riparian reserves, the Forest Service will also keep a record of roads actions (opening, closures, decommissioning) and provide annual summary reports to the Level 1 team of existing road densities and upcoming roads actions. This will serve to update existing watershed baselines and will inform BA development for future management and ESA consultations.

- Partners, contractors, and other collaborators/implementers may be invited to participate in this annual review as well to review design criteria and BMPs. The Level 1 team will determine if additional meetings are needed throughout the year and will schedule appropriately. The Level 1 team may also request field trips to observe/monitor project activities.
- Monitoring of projects will take place during implementation and at various stages post-implementation following BMP standards, and other ARBO, WDFW, NMFS, USFWS monitoring requirements, and other monitoring plans, such as the proposed Upper Wenatchee Collaborative Group's monitoring plan and /or the NWFP or Land and Resource Management Plan.
- This annual coordination meeting will also provide a time for the Forest Service to review upcoming ARBO II projects within the project area.

2. Additional Focused Monitoring - Additional meetings may be necessary to help set up a focused monitoring scheme that addresses uncertainty in areas with a) information gaps (i.e. commercial and non-commercial treatments in RR and LSRs, near water and wetlands, etc.); b) in areas of potential high risk to natural resources (i.e. high road miles, <100 feet from streams/wetlands/lakes, areas with steep slopes in the RR, etc.); and c) in areas where effects may occur simultaneously with other forest actions which could cause additional or aggregated effects (i.e., ARBO, road/recreation use, fires, etc.).

- During the annual coordination meeting, the Level 1 team would come up with a list of potental focused monitoring, centered around the potential for larger disturbance in higher risk areas, for example, actions implemented in sensitive areas (i.e., Higher risk areas due to high erosive soils, high road densities, RR, steep slopes, within 100 feet of stream/lake, etc), or areas where there may be cumulative/aggregated effects from ongoing activities (i.e. ARBO, roads, recreation, fires, etc.).
- A focused subgroup may be developed to identify these areas of uncertainty and a list of key questions prior to implementation. These may be updated annually or prior to each phase of work through the duration of the project.

3. Pre-Implementation contractor meeting/checklist – The district IDT will develop a pre-implementation checklist to ensure all relevant conservation measures, design criteria, and BMPs are included in the project contract/agreement. This checklist can be made available to the Level 1 team. The Level 1 team may request contractors or other partners attend a pre-implementation meeting to review and discuss design criteria and specific resource concerns. This meeting may occur at the annual meeting or separately as needed to share the information.

Aquatic Restoration Actions

The aquatic restoration projects are described in Appendix A and will not be analyzed as part of this BA as they fall under ARBO II and will follow all applicable design criteria and conservation measures.

Best Management Practices, Design Criteria and Monitoring

Monitoring would occur during implementation and to assess potential impacts caused by project activities. Depending on the impacts observed, specific mitigation measures would be implemented to reduce negative effects. Design criteria, monitoring, and mitigation measures are detailed in Table 13.

The Forest Service would monitor implementation throughout the Project to ensure the desired conditions are being achieved. Some of these monitoring components may include the balance of road decommissioning and temporary road construction; soil conditions; air quality effects (smoke); BMP compliance and effectiveness; invasive plant control; and compliance with regulations and agreements (e.g., Section 106 consultation requirements for phased projects). Some known monitoring that would occur includes the following:

- Operations: Contract administrators would monitor treatments during implementation to ensure contractors are in compliance with their contract. Contract elements monitored would include harvest specifications, bole damage to residual trees, downed wood and snag retention, skid trail spacing, and use of designated skid trails. Contractors may be responsible for selecting leave trees under the Designation by Prescription (DxP) sale administer by the sale administrator. Small tree thinning contracts provide cutting specifications (e.g. leave tree preference, minimum and maximum cut diameters) to the contractor and the Contracting Officer's Representative (COR) ensures that these specifications met.
- Fuel treatments: Fire and fuels personnel would informally monitor fuel loading during and following the fuel treatments. Fuel treatment results would offer data to use in the future.
- Invasive Plant Monitoring: Monitoring for invasive plants would take place for 3 to 5 years after the treatment is completed. Identified priority weed populations would be treated.
- Spotted Owl Monitoring: For spotted owls, protocol surveys would continue during implementation. This would be a subset of the Project area, and generally need to occur annually prior to treatments occurring in or near NRF habitat during the breeding season.
- Road closures: (ML1 and decommissioning) would be monitored for effectiveness relative to grizzly bear core and security habitat.
- Forest Plan Implementation Monitoring: The Forest Supervisor's staff performs annual project monitoring at each Ranger District and compiles the results in the bi-annual Forest Monitoring Report. Implementation of treatments from this project would be subject to Forest Plan Implementation monitoring. Other implementation monitoring elements may include temporary road decommissioning, snag and large downed wood abundance, prior to mitigation and enhancement and any seeding or planting of vegetation.
- Reforestation: Ensure regenerated stands are sufficiently stocked within 5 years. Forest Service Manual 2470 directs the agency to conduct first and third year stocking surveys to determine if the site can be certified.
- National Aquatic Best Management Practice Monitoring: The National Best Management Practices Program provides a standard set of core BMPs and consistent documentation of the

use and effectiveness of the practices. Post-implementation BMP monitoring may include review of aquatic management zones, erosion prevention and control measures, cable and ground-based yarding operation effects, and site treatment.

- Aquatic Restoration Projects: The Forest Service would follow all applicable monitoring and reporting as described in ARBO II.

Additionally, the Forest Service is working with its partners in developing a broad monitoring strategy for implementation of the UWPP, effectiveness of the treatments and restoration actions, and validation of the projects underlying assumptions. While this program is still in development, it is expected to result in a monitoring partnership with collaborators and regular reporting of monitoring results. Early monitoring results can be used to modify future treatments to better achieve the desired conditions.

BMPs, Standards and Guidelines, and project design criteria are an integral part of both Action Alternatives and serve to minimize the impacts of activities on natural resources. They are considered to be part of the proposed action. The content and effects analyses for each resource are dependent upon adherence to the BMPs, Standards and Guidelines, and design criteria during project implementation.

The NWFP (USDA Forest Service and USDI Bureau of Land Management, 1994b), which amended the Wenatchee LRMP (USDA Forest Service 1990) in 1994, provides standards and guidelines that apply to actions within the Project. Some standards and guidelines apply across all land allocations, while others are specific to one or more specific land allocations.

Forest Service Handbook (FSH) 2509.25, Watershed Conservation Practices Handbook (USDA Forest Service, 2006), and *National Best Management Practices for Water Quality Management on National Forest System Lands* (USDA Forest Service 2012b) provide guidance and BMPs concerning impacts to streams. BMPs for water quality and timber sale contract provisions would be followed to prevent or reduce adverse impacts to water quality from forest activities and meet the requirements of the Clean Water Act (PL1.1972, Federal Water Pollution Control Act and later amendments).

BMPs for water quality are methods, measures, or practices selected by an agency to meet its nonpoint source control needs. BMPs include, but are not limited to, structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters (36 CFR 219.19).

On the Okanogan-Wenatchee National Forest, use of BMPs is an LRMP standard for protection of water quality, as follows: “Comply with state requirement for protection of waters through planning, application, and monitoring of BMPs in conformance with the Clean Water Act, regulations, and federal guidance issues thereto” (USDA Forest Service, 1994b; see pp. IV 94-95). Other important project design features and BMPs are detailed in the environmental effects discussion. Table 13 lists the BMPs, Standards and Guidelines, and design criteria for each resource type in the Project.

Table 13. Best Management Practices, Standards and Guidelines, and Design Criteria

Resource Type	Best Management Practices, Standards and Guidelines, and Design Criteria
Soils	**Soil compaction, displacement, puddling**

	• Use designated skid trails to minimize the area subject to soil disturbance and compaction. • Use existing roads, skid trails, old landings, and skidding networks to the extent practicable. • Design and locate skid trails and skidding operations to minimize soil disturbance to the extent practicable. • Avoid soil-disturbing actions during periods of heavy rain or wet soils. Operate heavy equipment within unit boundaries only when soil moisture is below the plastic limit. Soil moisture exceeds the plastic limit if the soil can be rolled into 3mm threads without breaking or crumbling. • Avoid pockets of high soil moisture, such as natural depressions and seepage areas. • Consider using winter logging operations or other methods when necessary to avoid soil impacts, especially to hydric soils. • On multipass skid trails place and maintain slash mats of sufficient depth, or other methods, to prevent compaction, displacement, or puddling. • If crossing of a stream, swale or wet meadow is required during yarding, have it approved in advance by the Sale Administrator with the assistance of the district hydrologist, fish biologist, botanist, or soil scientist. Design the crossing to minimize disturbance to ground cover, streambanks and vegetation. • Obliterate skid trails after project completion by covering with slash, building waterbars and check dams where needed, placing barriers within skid trails, or other methods to prohibit mechanized and motorized use.
	Productivity and erosion • Meet or exceed coarse woody debris and ground cover requirements in all treatment units at project completion. • In areas of high erosional risk, minimize disturbance and encourage patchy disturbance of understory vegetation. • Areas that are determined to have "highly" or "severely" unstable soils will be excluded from unit boundaries during layout. Continuous slopes greater than 45% will be excluded from ground-based logging unless systems with reduced ground disturbance methods can be used. • Assure that water control structures are installed and maintained on skid trails that have grades ≥ 10%. Ensure erosion control structures are stabilized and working effectively. • Ground-based harvest in Riparian Reserves requires that all perennial, intermittent, and ephemeral streams be identified on the Sale Area Map as "Protected Stream Courses" and that wetlands or saturated swales be identified as "Protected Areas."
	Temporary roads and landings • Avoid constructing temporary roads in Riparian Reserves. If temporary roads are necessary, minimize stream crossings and other sensitive areas. • On temporary roads, place and maintain slash mats of sufficient depth, or other methods, to prevent compaction, displacement, or puddling. • Rehabilitate temporary roads and landings by methods such as installing water bars, ripping soil to 18 inches deep, and seeding with native vegetation. • Minimize the width and area cleared around roads. • Prior to implementation, the Forest Service must approve temporary roads, landings, skid trails and concentrated use-site locations to minimize potential damage to soils. • Minimize the size and number of landings as practicable to accommodate safe, economical, and efficient operations. Avoid locating landings near any type of likely flow or sediment transport conduit during storms, such as ephemeral channels and swales, where practicable. Locate landings to minimize the number of required skid roads. Re-use existing

	landings where their location is compatible with management objectives and water quality protection. • Use suitable measures as needed to restore and stabilize landings after use: o Remove all logging machinery refuse (e.g., tires, chains, chokers, cable, and miscellaneous discarded parts) and contaminated soil to a proper disposal site. o Reshape the surface to promote dispersed drainage. o Install suitable drainage features. o Mitigate soil compaction to improve infiltration and revegetation conditions – this can be done by bucket or scarification. o Apply soil protective cover on disturbed areas where natural revegetation is inadequate to prevent accelerated erosion before the next growing season. o Use suitable measures to promote rapid revegetation. o Use suitable species and establishment techniques to cover or revegetate disturbed areas in compliance with local direction and requirements per Forest Service Manual (FSM) 2070 and FSM 2080 and the Pacific Northwest Region Invasive Plant Program Preventing and Managing Invasive Plants Final Environmental Impact Statement (USDA Forest Service, 2005c) for vegetation ecology and prevention and control of invasive species.
	Prescribed burns • Use existing barriers such as roads and streams for fuel breaks when possible. • Construct prescribed burn fuel breaks by hand, not by bulldozer. • Use Minimum Impact Suppression Techniques (MIST) for prescribed burn operations. Burn high-intensity sites when soil moisture is >20% by volume and forest floor layers are >65% moist by volume. • Encourage patchy burning so that duff consumption is incomplete and soil damage is spatially heterogeneous. • Monitor soil for detrimental burning as defined by the Forest Plan on the units first burned, so as to aid in prescribing other burns. Keep detrimental burning to a minimum.
Botany	• Survey treatment units for Interagency Special Status / Sensitive Species Program, and survey and manage plants prior to implementation. • Locally adapted native plant material or seeds are the first choice in revegetation or restoration where timely regeneration is not likely to occur. Under no circumstances will non-native invasive plant species be used for revegetation purposes (FSM 2070, 2008; USDA Forest Service, 2005c; and ROD Standard 13). • Minimize the travel of machinery through meadows. If necessary, designate route in consultation with botanist. • Protect rare plant populations in all treatment units. Follow BMPs and standards and guidelines from the Pacific Northwest Region Invasive Plant Program Preventing and Managing Invasive Plants Final Environmental Impact Statement (USDA Forest Service, 2005c) to reduce the risk of invasive species introduction and spread.
Invasives	• Minimize soil disturbance with all operations consistent with the standards and guidelines in the Pacific Northwest Region Invasive Plant Program Preventing and Managing Invasive Plants Final Environmental Impact Statement (USDA Forest Service, 2005c) and the NWFP (USDA Forest Service and USDI Bureau of Land Management, 1994b). • Monitor treated areas for infestations and treat them before they can become established and spread. (Early Detection Rapid Response). • Use weed-free seed in all seeding operations.

	• Avoid burning where invasive annual grasses are present and likely to become dominant post-burn. • After burning slash piles, add arbuscular mycorrhizal inoculum (living soil amendment) and seed with native species. • Monitor and continue treatments of infestations, prioritizing recently disturbed areas near existing infestations (USDA Forest Service, 2017b). • Follow standards and guidelines in the Forest-wide Site-Specific Invasive Plant Management Record of Decision (USDA Forest Service, 2017b)

Wildlife	• Operation of tracked machinery, heavy equipment, and chainsaws within 1⁄4 mile of active raptor or spotted owl nests will be seasonally restricted, unless field surveys indicate that birds are not nesting. In the absence of surveys, or if birds are nesting, there will be no operation of equipment between March 1 and August 31.
	• Operation of helicopters within 1 kilometer (km) of known raptor or spotted owl nests will be seasonally restricted, unless field surveys indicate that birds are not nesting. In the absence of surveys, or if birds are nesting, there will be no operation of equipment between March 1 and August 31.
	• Spring burning operations within 1 km of active spotted owl nests will not result in smoke accumulation in core nesting areas. Burning conditions must be such that smoke trajectories will not fall within 45 degrees of active nests. A test fire will be lit to verify smoke trajectory.
	• Manage road opening and closing to achieve no-net-loss of grizzly bear core area within any grizzly bear management unit (BMU) in the Project area during implementation (USDA Forest Service, 1997).
	• Protect wolf dens or rendezvous sites detected within or near the Project area. Buffer the site by 1 mile and delay or modify project activities to avoid disturbance until site use by wolves is complete for the season. Notify USFWS and develop a site-specific plan.
	• In deer or elk winter range, from December 1 to April 15, limit activities to one drainage at a time, so ungulates could move to adjacent undisturbed winter range area. Avoid burning more than 30% of the winter range in a subwatershed, or 2,000 acres, whichever is smaller, in a single year.
	• Restrict activities that remove NSO nesting, roosting, or foraging habitat to outside the breeding season (March 15 to August 31), unless the area is surveyed to protocol and no spotted owl nests are located. If surveys to protocol do not detect nesting spotted owls, activities can proceed until survey currency expires (generally until the next breeding season). If nesting spotted owls are detected, modify treatments to retain nesting, roosting, and foraging habitat above threshold levels (40% suitable habitat within the 1.8-mile radius home range and 50% in the 0.7-mile radius core area).
	• Restrict activities that create smoke or noise above ambient forest conditions to outside the breeding season (March 15 to July 31) or beyond disturbance distance from nesting or roosting habitat, unless the area is surveyed to protocol and no nesting spotted owls are detected. If surveys to protocol do not detect nesting spotted owls, activities can proceed until survey currency expires (generally until the next breeding season). If nesting spotted owls are detected, conduct activities outside the breeding season, or restrict activities to areas outside the 0.7-mile core-use area buffered by a distance associated noise levels from the activity. Distance buffers to limit noise disturbance during the breeding season include the following:
	  o Light maintenance (e.g. road brushing and grading) at campgrounds, administrative facilities, and ML 3-5 roads: none
	  o Chainsaws (includes felling hazard/danger trees): 66 yards

	o Heavy equipment for logging, road construction, road repairs, bridge construction, culvert removal or replacement, maintenance of ML 2 roads, etc.: 66 yards o Pile Driving (steel H piles, pipe piles); rock crushing and screening equipment: 120 yards o Heavy Helicopter similar to Chinook 47d: 266 yards o Heavy Helicopter similar to Boeing Vertol 107 or Sikorsky S-64 (SkyCrane): 151 yards o Helicopters similar to K-MAX, Bell 206 L4, Hughes 500: 111 yards o Small fixed-wing aircraft (Cessna 185, etc.): 111 yards o Tree Climbing: 26 yards o Prescribed Fire: 0.25 mile (In addition, avoid smoke accumulation in the 0.7-mile nesting core area and avoid smoke plume trajectories that fall within 45 degrees of the nest site. Light a test fire to verify smoke trajectory.) • Avoid disturbance to nesting or winter roosting bald eagles by restricting activities within 200 meters (660 feet) from January 1 through August 31 (nesting/fledging for bald eagle), or October 31 to March 31 (bald eagle winter roosting). Nest sites are assumed to be active until surveys verify otherwise. If surveys indicate nesting is not occurring, or nestlings have fledged and left the area, activities can commence near the site. There are four known nest sites in the Project area. • For northern goshawk, 30 acres of the most suitable habitat surrounding the nest tree and establish a 400-acre post-fledging area where greater than 50% canopy cover is retained on 60% of the area on all nest sites located before or during project implementation (Reynolds, 1983; USDA Forest Service, 1990a:IV-81). Avoid disturbance to nesting goshawks by restricting activities with 400 meters (1/4 mile) from ground-based and aerial activities (log haul is permitted) annually from March 1 to August 31 (Reynolds, 1983). If follow-up surveys are not conducted, all nests would be assumed to be active between March 1 and August 31. If further surveys are conducted and confirm no nesting activity by May 15, restrictions could be waived for the season. Prescribed burning would be prohibited within the nest stand, or approximately 200 meters from a nest while active. • Avoid disturbance to osprey during the nesting season by restricting activities within 200 meters of active nest sites from April 1 through August 31. Nest sites are assumed to be active until surveys verify otherwise. If surveys indicate nesting is not occurring by 20 May, or nestlings have fledged and left the area, activities can commence near the site for the season. There are approximately 20 known nest sites in the Project area. • Protect raptor nest sites (not listed above) located prior to or during implementation with a 0.25-mile buffer from aerial, and ground-based activities from March 1 to August 31 (USDA Forest Service, 1990a:IV-81; Reynolds, 1983). Hauling would generally be permitted in this zone, if the nest is screened from traffic. If no nesting is documented, seasonal restrictions could be waived based on nesting phenology of the species, generally after June 1. All active roost sites would be protected from treatment activities (USDA Forest Service, 1990a:IV-81). • The preceding buffer widths for the above-mentioned species could vary slightly depending on topographic position of the nest tree/stand to the treatment unit. Timing restrictions could vary slightly depending on climate conditions and presence of species. Raptor nest sites would be visited annually to determine occupancy when activities are scheduled in the vicinity during the life of the project. • Manage snags and down wood at levels within the natural range of variability to contribute to the viability of species dependent on this habitat (USDA Forest Service 1997b:A-205; Harrod et al. 1998, Mellen et al., 2012). Manage LSR/MLSA at the higher end of the range. The goal is to retain sufficient snags in the appropriate size classes to meet species needs

	until stands reach an age that snag recruitment is occurring at natural-historic levels. Snag levels at that point would reflect the "natural disturbance" regime and be based on the ecological capability of the site. Design the burn plan to retain or protect larger snags and hard logs to meet these goals. Leave snags cut for safety reasons on the ground as logs, if below these levels
Aquatic Resources	**Temporary Road Construction and Reconstruction** • Temporary road alignments should avoid Riparian Reserves and be located to minimize disturbance to wetlands, streams, and groundwater emergence and recharge. • New or reconstructed road segments originating from existing roads within Riparian Reserves should not exceed a 10% slope gradient within the first 200 feet of the road segment in order to avoid or minimize the risk of concentrating and channeling runoff and sediment down road surfaces and into streams. • Cross-drain road surfaces through a vegetative filter strip prior to the road approach reaching a stream-crossing structure. • All temporary roads would be decommissioned to a standard which prevents use by all motorized vehicles, including OHVs, and effectively returns the road to a stable hydrologic state.
	Road Management • Appropriate erosion control measures such as: seasonal closures, gravelling, maintenance, ditching water routing structures, sediment traps, water bars, and drivable dips would be employed to minimize erosion. Route water off road prisms and fills and disperse across a vegetated slope. • Unpaved haul routes crossing fish bearing streams must be maintained appropriately before and during haul operations, including graveling road surface and installing any needed water bars. Log haul should not occur while road surface is saturated. • Cross drain and ditch cleanout would be used to remove sediment, debris, and other blockages which impede surface water routing. • Road edge berms would not be left after cleanout. Mechanized cross drain and ditch cleanout would not occur within 25 feet of stream channels or crossings. • Avoid cutting the toe of cut slopes when grading roads or pulling ditches. • Water drafting sites for dust abatement and road compacting would be identified by a fish biologist and/or hydrologist to avoid adverse dewatering effects to fish. Water drafting/pumping would maintain a continuous surface flow of the stream without altering the original wetted width. Any draft suction hose used in fish-bearing waters would be equipped with a screen of 3/32-inch mesh or less and would have an intake flow of less than 1 cubic foot/second to prevent entraining juvenile fish. • Lignin-based products may be used for dust abatement but avoid use within 100 feet of fish-bearing streams or stream crossings and within 25 feet of non-fish-bearing streams or stream crossings. Ensure that migration will not impact the oxygen needs of the aquatic community
	Landing Construction and Rehabilitation • Minimize landings within Riparian Reserves • The size of landings in the Riparian Reserves should be kept to a minimum and protect riparian soils and trees. • Landing locations on roads within Riparian Reserves shall minimize encroachment into the Riparian Reserve (outside of existing road bed) and be constructed in the treatment unit to the extent feasible

	• A native vegetation filter strip, sediment control devices, or concentrations of logging slash would surround the perimeter of all landings located within Riparian Reserves to serve as a sediment trap. • Landings would be located in upland portions of the reserves, on flat terrain, and disconnected from surface or groundwater flow paths. Landing construction locations would avoid seeps, springs and wetlands, as well as draws and ephemeral channels. • Post-logging soil scarification and reseeding would be done on landings to restore infiltration and ground cover on all compacted soils.
	Felling and Yarding • Avoid downhill yarding and skidtrail layout converging into Riparian Reserves, particularly where skidtrails converge onto a road surface within the reserve. This action increases the risk of capturing and concentrating overland flow and storm runoff and delivering it to streams, which affects peak flows downstream. • Designate skidtrails at a minimum of 100-foot spacing to minimize risk of overland flow. • No logging equipment, skidding, or yarding within the no-treatment portions of Riparian Reserves, and, to the extent feasible, avoid downhill yarding onto roads located in Riparian Reserves, using either ground or skyline yarding systems, in order to prevent soil movement into Riparian Reserves. • Install waterbars on all skidding corridors, or other methods to divert surface water as needed, upon completion of yarding operations.
	Fuels Management/Slash Disposal • Slash would not be piled or concentrated within the no treatment portions of the Riparian Reserves. • Firelines would have waterbars (ditches or dips built into the fireline, not berms) constructed to divert surface water off of the line and onto vegetative surfaces. Waterbars would be constructed at the time of fireline construction. • Hand firelines may need to be constructed within 100 feet of streams to tie in suppression needs with anchor points. Wherever possible, fireline within 100 feet of streams should be avoided. No handline would be constructed within inner gorges of stream channels. • Fireline would be rehabilitated using methods that prevent public use as hiking trails, bike routes, motorcycle routes, etc. • Locate re-fueling and fuel storage areas outside of Riparian Reserves or on a road, away from water and drainage areas, in locations where the largest possible spill can be contained before entering water. In the event of a fuel spill during a burn project, the Forest Hazardous Materials Coordinator would be contacted to coordinate clean up. • The use of pumps would not involve any streambed alteration, and pump chances would not pose any barrier to fish movement. Intake screens would be used on all pumps. Fuel would be located in containment basins, and hazard materials spill kits would be available for spill containment. • No surfactants or foams would be used within 100 feet of the edge of wetted channels or wetlands. Engines which have had surfactant would not draft from fish-bearing waters. The deployment of hose will not require any ground disturbance, and in many cases the use of hose for wetline could reduce the need for hand fireline construction. • Pump locations would be identified by a fish biologist and/or hydrologist to avoid adverse dewatering effects to fish. Coordination of pump locations will occur with resource specialists. Water drafting/pumping would maintain a continuous surface flow of the stream without altering the original wetted width. Any draft suction hose used in fish-bearing waters would be equipped with a screen of 3/32-inch mesh or less and would have an intake flow of less than 1 cubic foot/second to prevent entraining juvenile fish.

	Herbicide use • Follow all standards and guidelines and BMPs in the Forest-wide Site-Specific Invasive Plant Management Record of Decision (USDA Forest Service, 2017b).
Recreation	• Log haul and moving heavy equipment would be restricted weekends and holidays from Memorial Day through Labor Day and during the general rifle deer hunting season, without prior approval, to facilitate public use during these periods. • During periods of winter log haul, NFS roads would be closed to the public, except for access to private property. Log haul would be restricted on weekends and holidays during the snowmobile route-grooming season. If winter logging/log haul occurs, the contractor would retain at least 4 inches of snow on plowed routes. • Warning signs regarding logging traffic would be posted at the Forest boundary and on any NFS Road where public access is not restricted and logging traffic is expected. • Winter logging operations would be coordinated with winter sports activities. Alternate routes for winter sports would be provided as possible. • If winter trails are used for operations, affected trails would be returned to usable condition within 1 week of the last use of the trails for logging operations. Alternate routes would meet the requirements and specifications of the trail to be impacted. • Education efforts would be ongoing to inform the public on the rationale for the seasonal trail closure. • Segments of roads and trails would be temporarily closed to public use during active timber harvest, non-commercial thinning, prescribed burning operations, or construction work. • In mechanized thinning units along system trails: o Trees would be directionally felled away from the trail. o Damaged whips would be felled 50’ on either side of the trail centerline. o Slash would be piled and burned 50’ on either side of the trail centerline. o On flatter ground where the landscape is opened up (due to tree thinning), trees would be felled and left on the ground as appropriate, to discourage off-trail motorized use. o When skid trails for ground-based logging cross trails, the Timber Sale Administrator would designate these crossings, and the trail template would be rehabilitated to trail specification after harvest. • In non-commercial thinning units along system trails: o Trees would be felled away from the trail and branches would be lopped 50’ on either side of the trail centerline. • In prescribed burning units along system trails: o Heavy fuels and/or organic material on or adjacent to the trail would be pulled back to protect the trail tread and reduce future tree windfalls across the trail. o Fuels would be pulled back from trail structures (bridges, puncheons, culverts) to protect these facilities. o As possible, prescribed fire lighting patterns would minimize fire intensity along trail corridors. • When temporary roads used for logging would be built on system trail locations: o The trail tread would be re-established to specifications with appropriate drainage after logging activities. o The remaining road template would be de-compacted, contoured, and seeded with species that are appropriate to the trail use.
Scenic Resources	• Changes in form, line, color and texture resulting from management activity should not be evident for more than one season in ST-1 areas and two seasons in ST-2 prescriptions areas (WNFP, page IV 205-215). Rehabilitate area to be natural appearing by methods including

	earth re-contouring, removal of woody materials from site, area smoothed out and grass seeded with appropriate grass mix. • Enhancement of large tree viewing opportunities from travel routes and rural interface homes, by thinning and removing smaller trees around large trees. • Blend earth mounds and large boulders adjacent to the existing landscape for road closures, rehabilitate landings along all main roadsides. • Locate landings outside of seen areas or leave vegetation screening where possible. When landings are located on Forest Roads, keep them within the existing road prism and do complete cleanup of roadside when done.
Transportation	• Temporary roads would be constructed no sooner than necessary, with logging and closure scheduled for completion within a single season. Temporary roads would be constructed to minimal standards necessary for safe use and would be decommissioned/rehabilitated upon completion of harvest activities. Rehabilitation activities would include de-compaction, re-contouring, and seeding. Entrances would be blocked to prevent all motorized use. Roads would be generally out-sloped and constructed with drainage structures. Temporary roads located in an area with risk of unauthorized use would maintain a closure to public use. • Closing roads (Change to Maintenance Level 1) could include the following: blading and shaping the road surface to restore side-slopes, removing culverts, reinstalling drain dips and waterbars, spreading slash over the road surface, and placing an effective closure device. Appropriate level of hydrologic road closures will be approved by Forest Service hydrologist or aquatic specialist. • Roads scheduled for closure would be monitored prior to October 1st annually to ensure work is completed and that the drainage facilities are adequate and self-maintaining. • To control dust from roads during log haul, lignin or water would be applied to the road surface as needed. Water drafting sites for dust abatement and road compacting would be identified by a hydrologist or fish biologist to avoid adverse de-watering effects to fish. Water drafting would maintain a continuous surface flow of the stream without altering the original wetted width. Any draft suction hose used in fish-bearing waters would be equipped with a screen of 3/32-inch or less mesh and would have an intake flow of less than 1 cubic foot/second to prevent entraining juvenile fish. • Appropriate erosion control measures, such as seasonal closures, gravelling, maintenance, ditch water routing structures, sediment traps, water bars, and drivable dips, would be employed to minimize erosion. Route water off road prisms and fills, and disperse across a vegetated slope. • Snow plowing would include water drainage outlets (not placed on erodible fills), constructed and maintained in the dike of the berm caused by the snow removal operation.

Status of Listed Fish Species

The Upper Wenatchee Pilot Project area contain the following anadromous and resident fish species listed for protection under the ESA: Upper Columbia River steelhead, (*Oncorhynchus mykiss)* and Upper Columbia River spring Chinook, (*Oncorhynchus tshawytscha) and* Columbia River Bull trout (*Salvelinus* *confluentus)*. Fish species for which Essential Fish Habitat (EFH) has been designated under the Magnuson-Stevens Fishery Conservation and Management Act, were also identified. Over the four sub-watersheds, up to 48.1 miles of stream have one or more of these focal species (Figure 12).

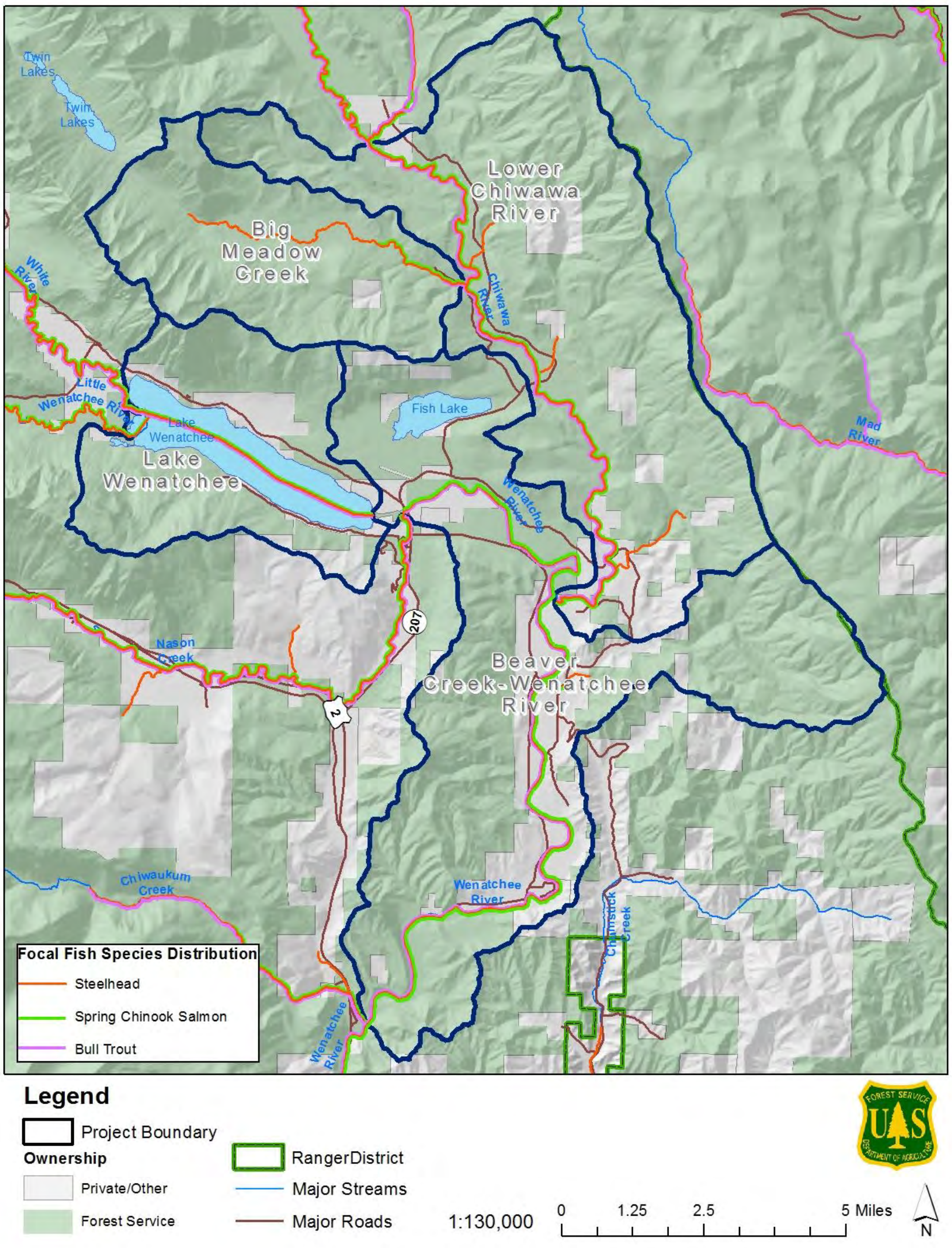


Figure 12. Current distribution for focal fish species in the Upper Wenatchee project area

Table 14 lists the fish species and habitats considered in this analysis and their distribution status within the project or action area. Unless otherwise noted, fish presence/absence was determined from the Okanogan-Wenatchee National Forest Fish Distribution GIS Database, other District records, the web-based NatureServe database, Washington Department of Fish and Wildlife's computer mapping system (SalmonScape) and observations by local biologists.

Table 14. ESA-listed aquatic species present on WRRD including status and distribution within the action area for the Upper Wenatchee Pilot Project Area.

Species/Habitat	Status	Distribution
UCR Spring-run Chinook Salmon	Endangered, CH	Spring Chinook and their Critical Habitat occur in all project area watersheds.
UCR Steelhead	Threatened, CH	UCR steelhead and their Critical Habitat occur in all project area watersheds.
CR Bull Trout	Threatened, CH	CR bull trout and their Critical Habitat occur in all project area watersheds.
Coho Salmon	EFH	Coho salmon occur in all project area watersheds. Coho were historically endemic to the Wenatchee River but were eradicated by a combination of damming, overfishing, hatchery influences and habitat degradation throughout their range. Coho salmon were reintroduced into Wenatchee River beginning in 1999 and spawning/rearing has been documented in subsequent years. In 2016, a yearly total of 257 coho were counted at the Tumwater dam fish ladder on the Wenatchee River.
Chinook Salmon	EFH	Spawn, rear, and migrate in all project area watersheds

UCR Spring-run Chinook ESU: UCR Spring-run Chinook salmon were listed as an endangered species on March 24, 1999 (64 FR 14308) and their endangered status was reaffirmed on June 28, 2005 (70 FR 37160).

Upper Columbia River Steelhead DPS: UCR steelhead were listed an endangered species on Aug. 18, 1997; status upgraded to threatened on Jan. 5, 2006; reinstated to endangered status per U.S. District Court decision in June 2007; status upgraded to threatened per U.S. District Court order in June 2009.

Columbia River Bull Trout: The Fish and Wildlife Service (FWS) listed the Columbia River population of bull trout as threatened on 06/10/1998 (63 FR 31647).

Critical and Intrinsic Potential Habitats

Critical habitat is defined in Section 3(5)(A) of the ESA as "the specific areas within the geographical area occupied by the species ... on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection." NMFS designated critical habitat for UCR spring-run Chinook and UCR steelhead on September 2, 2005 (70 FR 52630). The FWS designated critical habitat for CR Bull Trout throughout their U.S. range on September 30, 2010 (75 FR 63897).

Intrinsic Potential Habitat was classified based on stream gradient. Stream gradients can be extracted easily using GIS, and then classified by gradient thresholds to map areas potentially capable of supporting fish populations. The gradient thresholds for each species has been determined as follows:

<4% for spring Chinook, <7% for steelhead, and <10% for bull trout (2017 Chelan Pilot Restoration Project Upper Wenatchee Landscape Evaluation). Non-use of potential habitats may be attributed to passage barriers in the affected stream (Figure 13).

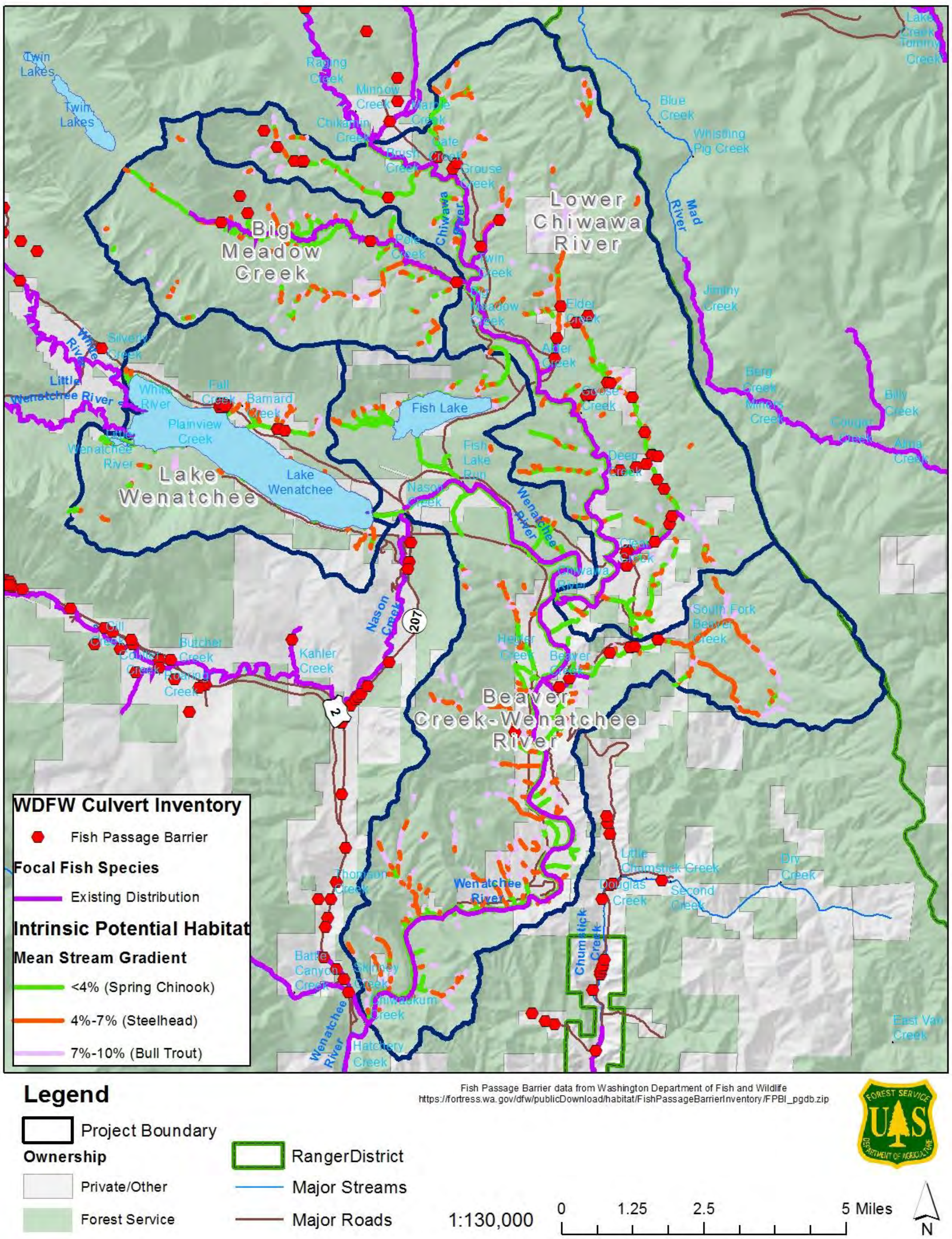


Figure 13. Fish intrinsic potential habitat based on stream gradient and probable blockage locations

Table 15 lists miles of project area streams including perennial streams with designated CH and Intrinsic Potential habitat for Chinook, steelhead, and bull trout.

Table 15. Subwatersheds (HUC 12) within the Action Area for the Upper Wenatchee Pilot Project Area

HUC 10 Watersheds	HUC_12_ Subwatersheds	Sub-watershed Square Miles/Acres	Perennial Stream Miles	Intermittent Stream Miles	Miles of Critical Habitat*	Miles of Intrinsic Potential Habitat*
Wenatchee River 1702001107	Beaver Creek-Wenatchee River	44.6/28,600	56.1	81.3	BT- 18.1 ST- 20.4 SCH- 20.1	BT- 28.7 ST- 26.7 SCH- 22.1
Chiwawa River 1702001103	Big Meadow	15.8/10,133	34.8	46.8	BT- 0 ST- 0 SCH- 0	BT- 9.7 ST- 8.4 SCH- 7.4
	Lower Chiwawa	39.2/25,088	43.6	62.8	BT- 19.9 ST- 16.4 SCH- 15.1	BT- 28.6 ST- 26.2 SCH- 21.6
Little Wenatchee and White Rivers 1702001101	Lake Wenatchee	17.2/10,992	12.4	4.1	BT- 0.05 ST- 5.5 SCH- 5.5	BT- 0.9 ST- 0.9 SCH- 0.7

*BT- bull trout; ST- steelhead; SCH – spring Chinook

Essential Fish Habitat

Essential Fish Habitat (EFH) is defined in the Magnuson-Stevens Act as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity” (16 U.S.C. 1802(10)). EFH regulations further interpret the EFH definition as follows:

Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary is defined as the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species’ full life cycle.

The amended Magnuson-Stevens Act requires NOAA to minimize damage to EFH from fishing practices, to the extent practicable. Additionally, the Act requires Federal agencies that authorize, fund, or conduct activities that “may adversely affect” EFH to work with NMFS to develop measures that minimize damage to EFH. The Table below identifies EFH and life history sages for salmonid species occurring in the action area.

Species	Adult	Spawning/ Mating	Juvenile	Larvae	Eggs/ Parturition
Chinook salmon	X	X	X	X	X
Coho salmon	X	X	X	X	X

Upper Columbia Spring Chinook- Endangered

The Upper Columbia spring Chinook run is dominated by four- and five-year-old fish that have spent two and three years at sea, respectively. Adult spring Chinook salmon migrate into the Columbia River in the early spring (peak migration in mid-May), move into upper Columbia River tributaries from April through July and hold until spawning begins in the late summer, peaking in mid to late August (UCSRP 2007). Spring Chinook salmon eggs remain in the gravel until hatching in December and fry emergence occurs in January and/or February (Mullan 1992). Juveniles spend approximately one year in fresh water before smolting and migrating to the Pacific Ocean between April and June.

Subpopulation size and Distribution:

The lower Wenatchee River is a migration corridor for spring Chinook to reach spawning areas in the upper Wenatchee River and tributaries. Major spawning areas are identified in the mainstem Wenatchee River from Tumwater Canyon to Lake Wenatchee, the Chiwawa River, Nason Creek, the Little Wenatchee River and the White River (UCSRB 2007). Spring Chinook are also known to spawn in Chiwaukum Creek, tributaries to the Chiwawa River; Phelps, Rock, Chikamin, and Meadow Creeks and tributaries to the White River; Panther Creek and Napeequa River. Spring Chinook do not generally spawn in the mainstem Wenatchee River downstream from Tumwater Canyon, however in recent years re-introduction efforts have occurred in Peshastin Creek and a number of spring chinook spawn in Icicle Creek below the hatchery dam.

Spring Chinook returns have increased since the extreme lows of the early 1990’s (23 redds found in 1995), and, while populations fluctuate interannually, they remain depressed relative to historical abundances (Table 16). In addition, the majority of spawners are of hatchery-origin. In 2008 and 2009, WDFW estimated the number of natural origin spring Chinook that spawned in the Wenatchee subbasin to be just 16% and 27% respectively. The Interior Columbia Technical Review Team (ICTRT) has classified the Wenatchee River spring Chinook as a “Very Large” population in size based on its historic habitat potential. A “Very Large” population is one that requires a minimum abundance of 2,000 wild spawners and an intrinsic productivity greater than 1.75 recruits per spawner (R/S) to be viable (HSRG 2008).

Table 16. Summary of spring Chinook redd counts in Wenatchee Subbasin 2001-2018.

	Number of spring Chinook							
Survey Year	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River[1]	Icicle	Peshastin	**Total**
2001	1,078	374	74	104	218	88	173[1]	**2,109**
2002	345	294	42	42	64	245	107[1]	**1,139**

2003	111	83	12	15	24	18	60	**323**
2004	239	169	13	22	46	30	55	**574**
2005	333	193	64	86	143	8	3	**830**
2006	297	152	21	31	27	50	10	**588**
2007	283	101	22	20	12	17	11	**466**
2008	689	336	38	31	180	116	21	**1,411**
2009	421	167	39	54	5	32	15	**733**
2010	502	188	38	33	47	155	5	**968**
2011	492	170	30	20	12	122	26	**872**
2012	880	413	43	86	73	199	10	**1,704**
2013	714	212	51	54	17	107	4	**1,159**
2014	485	115	25	26	23	211	0	**885**
2015	543	85	28	70	55	132	10	**923**
2016	312	85	22	44	17	72	2	**554**
2017	222	68	10	15	9	40	3	**367**
2018	331	90	8	20	20	3	2	**474**

*Hillman et al. 2017, Hillman et al. 2019

[1]Redd counts in Peshastin Creek in 2001 and 2002 were elevated because the U.S. Fish and Wildlife Service planted 487 and 350 spring Chinook adults, respectively, into the stream. These counts were not included in the total or average calculations.

Assuming two spawners per redd and 25% are of natural origin, redd counts in Table 16 would indicate that a range of 238-853 natural origin spring Chinook have returned annually to spawn in the Wenatchee subbasin over the last 10 years. The fluctuation in the range is likely due primarily to out of basin factors affecting the population. The Wenatchee River spring Chinook subpopulation size and distribution is **not properly functioning** based on out of basin factors affecting the population, a low abundance of natural origin spawners, and the loss of naturally produced spring Chinook spawning in tributaries downstream from Tumwater Canyon. The Upper Columbia Salmon Recovery Plan (2007) considers the Wenatchee spring Chinook population not viable, with a greater than 25% chance of extinction in 100 years.

Growth and Survival:

Based on current estimates of abundance and trends in abundance over the past 18 years, the productivity of the spring Chinook population in the Wenatchee subbasin is not increasing. The growth and survival of spring Chinook is largely dependent on the habitat conditions in the stream environment prior to smolting. The mainstem upper Wenatchee River through Tumwater Canyon provides important overwinter rearing habitat for spring Chinook and some early rearing occurs in three functionally connected streams; Little Wenatchee, White and Chiwawa River, however instream habitat conditions and resiliency to disturbance in the remainder of the subbasin is of some concern therefore this indicator is determined to be **not properly functioning.**

Life History Diversity and Isolation:

The dominant life history strategy for salmon is to "home" in on their natal streams for spawning, thus subpopulations are generally thought to be fairly isolated from other subpopulations despite occasional straying. However, based on expanded carcass recoveries from spawning ground surveys, strays from other basins have comprised 3-27% of the spring Chinook spawners in the Wenatchee River above Tumwater Canyon (Upper Columbia Salmon Recovery Plan 2007). The nearest source populations of spring and summer Chinook salmon exist in the Entiat and Methow subbasins. Unfortunately, spring Chinook salmon populations have also declined to very low levels in those locations and would not likely contribute substantially to recolonization after a major disturbance. Thus, Wenatchee River subpopulations of spring Chinook salmon are considered to be **not properly functioning** due to overall low subpopulation sizes throughout the Upper-Columbia region at this time.

Subpopulation Trend

Based on factors that determine diversity and spatial structure, the Wenatchee Population is at high risk of extinction because of the loss of naturally produced spring Chinook spawning in tributaries downstream from Tumwater Canyon. Abundance and productivity for spring Chinook is also not considered viable with a >25% chance of extinction in 100 years (UCSRB 2007). Subpopulation trend is **not properly functioning.**

Persistence and Genetic Integrity:

The genetic integrity of spring Chinook throughout the Upper Columbia has been altered through several past and ongoing management practices. Spring Chinook eggs from as far away as Oregon were planted in this area in 1914 and 1915 (Craig and Suomela 1941) and from 1939-1944, all migratory fish were trapped at Rock Island Dam under the Grand Coulee Fish Maintenance Project (GCFMP) and relocated to various streams including the Wenatchee River for spawning. Given this information, it seems unlikely that any "native" salmon stocks could have persisted in the Wenatchee subbasin and genetic integrity was undoubtedly compromised many years ago.

Currently, there are three in-basin hatchery programs in the Wenatchee subbasin: the Chiwawa supplementation program collects adults from the Chiwawa River and Tumwater Dam (where a genetic marker identifies the fish as Chiwawa origin); the White River captive broodstock program collects eggs from redds in the White River; and the Icicle Creek (Leavenworth Hatchery) uses non ESU broodstock returning to the hatchery. Based on past out-of-basin transfers, the current hatchery influence and low population abundance, genetic integrity of the population in the subbasin is likely to be compromised.

Due to the low abundance of natural-origin spawners and low productivity the persistence of the population is also likely compromised. Overall, spring Chinook are considered **not properly functioning** in regard to persistence and genetic integrity.

Upper Columbia Steelhead- Threatened

Wenatchee River steelhead are inland (vs. coastal) steelhead of the "stream maturing" reproductive ecotype (NMFS 1996). Steelhead enter and begin to ascend the Columbia River in late summer and early fall. The peak upstream steelhead movements nearest the Wenatchee River (i.e. at Rock Island and Rocky Reach) occurs in early September (English et al. 2001). Most adult steelhead moved into tributary streams by November, however, some adults hold in the mainstem Columbia River until February or March before moving into natal streams to spawn (English et al. 2001). Juvenile steelhead generally spend one to three years rearing in freshwater before migrating to the ocean. Mean smolt age is considered to be 2.65 years with migration generally occurring from April through June with peak migration in early May (Mullan et al. 1992).

Subpopulation size and Distribution:

The mainstem Wenatchee River above Dryden Dam and all of its major tributaries, with the exception of Chiwaukum Creek, are major spawning areas (MaSA's) for steelhead (UCSRB 2007). Within the subbasin steelhead spawn in the mainstem Wenatchee River between Tumwater Canyon and the outlet of Lake Wenatchee (RM 53.5). Steelhead also spawn within the Chiwawa River (RM 48.2), Nason Creek, Icicle Creek, Peshastin Creek (RM 17.8), Chumstick Creek, and Mission Creek (RM 10.4) (UCSRB 2007). Steelhead redds have also been observed during BPA funded work in Beaver Creek and Skinney Creek (RM 35.8).

From the late 1980's to the early 2000's most spawning steelhead in the Upper Columbia were of hatchery-origin (UCSRP 2007). The return of hatchery fish was 2 to 3 times as high as natural returns but that has shifted somewhat in favor of wild born fish over the past few years. Based on redd counts the average number of steelhead returning to the Wenatchee subbasin for spawning has averaged 868 fish in the last eighteen years (Table 17) and natural-origin steelhead have outnumbered hatchery origin fish since at least 2014. To illustrate, most recently wild fish have comprised 59.4% of the steelhead that passed Tumwater dam in 2016 (Hillman et al. 2017); 50.1% in 2017 (Hillman et al. 2018); and 66.5% in 2018 (Hillman et al. 2019). Hatchery fish in the upper Wenatchee Basin are regulated through surplusing (removal) at the dam (Hillman et al. 2017).

Table 17. Summary of Steelhead Redd Counts in the Wenatchee River subbasin 2001-2018*.

	Number of Steelhead Redds							
Survey Year	Chiwawa	Nason	Little Wenatchee	White	Wenatchee River[1]	Icicle	Peshastin	**Total**
2001	25	27	--	--	116	19	--	**187**
2002	80	80	1	0	315	27	--	**503**
2003	64	121	5	3	248	16	15	**472**
2004	62	127	0	0	151	23	34	**397**
2005	162	412	0	2	459	8	97	**1,140**
2006	19	77	--	0	191	41	67	**395**
2007	11	78	0	1	46	6	17	**159**
2008	11	88	--	1	100	37	49	**286**
2009	75	126	0	0	327	102	32	**662**
2010	74	270	4	3	380	120	118	**969**
2011	77	235	2	0	323	180	115	**932**
2012	8	158	0	0	137	47	65	**415**
2013	27	135	--	--	200	48	62	**472**
2014	5	0	--	--	195[2]	--	5	**205**
2015	1	1	--	--	258[2]	--	1	**262**

2016	0	0	--	--	126[2]	--	0	**126**
2017	0	1	--	--	189[2]	--	1	**191**
2018	0	0	--	--	37[2]	--	1	**38**

*Hillman et al. 2017, Hillman et al. 2019
[1] Includes redds in Beaver and Chiwaukum creeks.
[2] Steelhead redd counts in the mainstem Wenatchee River were expanded based on estimated observer efficiency

The subpopulation size over the past 20 years indicates that numbers of steelhead are within the NMFS functioning appropriately category (>500), although numbers over the last three years are depressed. However, the upper Columbia Salmon Recovery Plan (2007) states that the Wenatchee steelhead population is considered to be at a moderate risk of extinction (>25% chance of extinction in 100 years) due to a high proportion of hatchery produced spawners, which is still applicable in 2018; therefore, Wenatchee River Steelhead are considered to be **not properly functioning**.

Growth and Survival:
Steelhead production within the upper Wenatchee River is increasing, based on annual redd counts by the WDFW, however natural steelhead smolt to adult returns appears to be low. Steelhead are believed to be found in all accessible habitat. Habitat connectivity is good, but escapement of natural fish is poor. The upper Columbia Salmon Recovery Plan (2007) states that the Wenatchee steelhead population is considered to be at a moderate risk of extinction (greater than 25% chance of extinction in 100 years) due to a high proportion of hatchery produced spawners, which is still applicable in 2018. Therefore, Upper Wenatchee River Steelhead are considered to be **functioning at risk**.

Life History Diversity and Isolation:
Resident rainbow trout are widely distributed throughout the Wenatchee subbasin and are believed to reproduce with anadromous steelhead. NMFS concluded that the resident form remained “markedly separated” from the anadromous form as a consequence of physical, physiological, ecological, and behavioral factors, and as part of its decision to list steelhead as endangered, stated that the collective contribution of the resident life history form to the persistence of the steelhead is unknown, and may not substantially reduce the overall extinction risk of the steelhead (UCSRB 2007).

Wild steelhead stocks have been supplemented with hatchery smolts for many years and it is unclear what role hatchery supplementation has had on reproduction and recruitment for steelhead trout in the Wenatchee Subbasin. A study of a depressed wild population of steelhead in Oregon (Chilcote 2002, *Draft*) found that hatchery supplementation had reduced wild recruitment and wild genetic fitness without significantly increasing total population size. Because of the uncertainty surrounding the contributions of the resident population and the supplementation program to the fitness of the naturally produced steelhead population in the Wenatchee subbasin, the population is considered to be **not properly functioning** at this time.

Subpopulation Trend:
Due to factors that determine diversity and spatial structure, the Wenatchee steelhead population is at high risk of extinction. Based on abundance and productivity, the naturally produced steelhead

population is also not viable and has a greater than 25 percent rate of extinction in the next 100 years. (UCSRP, 2007). Subpopulation trend is **not properly functioning.**

Persistence and Genetic Integrity:
Introduction of hatchery steelhead began in 1899 from the Chiwaukum hatchery. A hatchery near Leavenworth, below Tumwater dam, began releasing steelhead in 1915. The biggest introduction of hatchery steelhead began with the GCRP in 1939. Under GCRP, adults, fry and parr of a mix of upper- and mid- Columbia stocks were released throughout the Wenatchee (and other) basins. Native anadromous populations were depressed at this time, possibly due to over-fishing, habitat degradation, small dams, and irrigation diversions; thus the influx of non-natives may have had a greater impact than it would have had on a healthier steelhead population.

The Wenatchee basin currently has a population of wild (naturally reproducing but not necessarily genetically native) steelhead. This population may be genetically different from the original native stock due to extensive hatchery introduction (Peven 1991). Hatchery releases of rainbow trout may also have affected steelhead genetics and survival (Peven 1991).

Steelhead subpopulations are considered to be **not properly functioning** due to possible loss of genetic integrity due to hatchery supplementation with co-mingled stocks. Connectivity exists between multiple populations but natural production has been low.

Columbia River Bull Trout- Threatened

The Wenatchee subbasin is identified as one of three core areas in the Upper Columbia Critical Habitat Unit (USFWS 2010). The Wenatchee core area is comprised of seven local populations (Peshastin, Icicle, Chiwaukum, Nason, Chiwawa, Little Wenatchee, and White). Bull trout in these local populations exhibit resident and migratory life history patterns. Resident bull trout complete their entire life cycle in a tributary stream. Migratory bull trout spawn in tributary streams where juveniles rear for up to four years before migrating to a river or lake. Migrating bull trout return to spawning tributaries from the end of June into October. Spawning occurs between mid-September and early November. Resident and migratory bull trout can be found together on spawning grounds, can spawn together, and offspring can express either life history. Bull trout can live longer than 12 years, and of the three listed species, prefer the coldest water (typically 15^0 C or less). All life stages of bull trout are associated with complex forms of cover and pools (UCSRB 2007). Bull trout typically over-winter from December to May, migrate up the Wenatchee River to spawning grounds from May to mid-October, and adult bull trout migrate back to overwintering habitat from October to December (Kelly-Ringel and DeLaVergne 2005).

Subpopulation size:
Bull trout are known to utilize habitat (spawning, rearing, foraging, migration, and over-wintering) in the Wenatchee river system. Bull trout are not known to spawn in the mainstem Wenatchee River. Many of the small, lower tributaries of Wenatchee River lack many of the characteristics thought to be

important to bull trout spawning, including spawning substrate and cold water temperatures, and it is thought that most never provided bull trout habitat.

When considering redd counts over the last 25 years, adult bull trout population numbers appear to be steady or increasing within the Wenatchee Core Area (Table 18). Based upon redd counts the adult population alone is over 500 fish, therefore the subpopulation size in the Wenatchee basin as a whole is considered to be **properly functioning. However, only one population, the Chiwawa is supporting the core area, while the other seven remain lower in abundance.**

Table 18. Bull trout local population redd count data in the Wenatchee Core Area 1995-2019*.

Year	Peshastin	Icicle	Chiwaukum	Chiwawa	Nason	Little Wenatchee	White	Total
1995	--	--	--	405		--	26	431
1996	--	--	--	358	3	--	29	390
1997	--	--	--	324	1	--	18	343
1998	--	--	--	347	9	--	35	391
1999	--	--	--	462	15	--	41	518
2000	0	--	--	400	13	--	62	475
2001	1	--	29	254	3	3	21	311
2002	5	--	35	432	7	1	119	599
2003	9	--	42	411	3	4	64	530
2004	--	--	23	371	15	--	49	458
2005	--	--	31	249	3	5	59	347
2006	--	--	32	546	17	--	122	717
2007	--	--	35	484	0	3	70	592
2008	--	8	33	430	2	--	104	577
2009	--	3	34	685	3	--	102	827
2010	--	2	18	352	0	--	40	412
2011		4	29	204	8	--	67	312
2012		2	37	--	--	--	89	128
2013		--	57	250	0	5	138	450
2014		--	--	768	--	3	119	890
2015		21	14	635	11	15	67	1,653
2016		0	14	--	--	3	133	150
2017		--	--	814	--	--	178	--
2018		--	24	441	10	--	120	--
2019		--	34	407	10	--	122	--

**USFWS 2017,* Mittelsteiner et al. *2019*

Growth and Survival

Adult bull trout are iteroparous spawners (migrate and spawn more than once) and may spawn annually or in alternate years (Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1993). Bull trout reach sexual maturity between four and seven years of age and are known to live as long as 12 years (Fraley and Shepard 1989; Brown 1992; Mullan et al. 1992). Adult bull trout population numbers appear to be steady or increasing within upper Wenatchee River tributaries, particularly in the Chiwawa Basin, but spawning redd counts within tributaries to the mid to lower Wenatchee River are depressed (Kelly Ringel and DeLaVergne, 2005). Therefore, the growth and survival of bull trout in the Wenatchee basin as a whole is considered to be **functioning at risk**.

Life History Diversity and Isolation:

Bull trout in the local populations exhibit resident, fluvial, and adfluvial life history types. The population appears to be strong in the upper Wenatchee and habitat connectivity exists between local populations. Recent genetic studies (DeHaan and Neibauer, 2011) suggest that the Peshastin and Icicle local populations may be isolated from others local populations in the Core Area; access to these local populations has been altered by the Leavenworth National Fish Hatchery on Icicle Creek and habitat alteration and irrigation withdrawal on Peshastin Creek, especially in late summer; however, access is still possible.

Stream habitat alterations including increased stream temperatures and the alteration of natural streamflow patterns may interfere with migrations, and therefore this indicator is believed to currently be **functioning at risk** within the Wenatchee River subbasin.

Subpopulation Trend:
The Wenatchee River bull trout subpopulation is one of the stronger subpopulations within the Upper Columbia River. Bull trout spawn in these Wenatchee subbasin watersheds: Chiwawa River (RM 48.5), Nason Creek (RM 53.5), Chiwaukum Creek (RM 35.8), Icicle Creek (RM 25.5), and Peshastin Creek (RM 17.8) (UCSRB 2005). Spawning also occurs in the Little Wenatchee River and the White River, both of which are tributaries to Lake Wenatchee. The Wenatchee River basin bull trout redd counts have averaged 445 redds for the 10 year period beginning in 1995 (1995-2004) as compared to 616 redds for the past 10 years (2010-2019), with the Chiwawa watershed forming the strong-hold for bull trout in the upper Wenatchee. The 10-year average (2010-2019) of redds in Chiwawa River index reaches is 483 (Mittelsteiner et al. 2019). This indicator is **properly functioning.**

Persistence and Genetic Integrity:
Migration is important to the persistence of bull trout populations because it facilitates gene flow between populations and allows extirpated populations to be reestablished and small populations to expand (Rieman and McIntyre 1993; Rieman et al. 1997; Rieman and Allendorf 2001). Persistence of migratory life history forms and maintenance or re-establishment of stream migration corridors is crucial to the viability of bull trout populations (Reiman and McIntyre 1993). Connectivity within the upper Wenatchee basin subpopulation appears excellent. However most of the population seems to be concentrated in the upper Wenatchee watersheds, with the Chiwawa River being the strongest.

Telemetry research by the Chelan County PUD to define the migratory patterns of bull trout that pass through Rocky Reach, Rock Island, and Wells Dam indicates that bull trout in the Wenatchee subbasin migrate to and from the main-stem Columbia River and are physically connected with bull trout populations in the Entiat River and the Methow River (BioAnalysts, Inc. 2003). However, given the distances and unknown extent of altered fluvial dynamics of the main-stem Columbia River, and the concern for hybridization with introduced eastern brook trout in the subbasin, the persistence and genetic integrity of the Wenatchee subpopulation is presumed to be **functioning at risk** (Table 19).

Table 19. Population Baseline Wenatchee Subbasin

Diagnostics/	Population

Pathways	Baseline		
	Functioning Appropriately	Functioning At Risk	Not Properly Functioning
Subpopulation Size	Bull Trout		Steelhead, Spring Chinook
Growth/Survival		Steelhead, Bull Trout	Spring Chinook
Life History Diversity/ Isolation		Bull Trout	Steelhead, Spring Chinook
Subpopulation Trend	Bull Trout		Steelhead, Spring Chinook
Persistence & Genetic Integrity		Bull Trout	Steelhead, Spring Chinook

Environmental Baseline

Matrix of Diagnostics/Pathways and Indicators

The most recent environmental baseline updates were:

- **Wenatchee River:** *2019 McKenzie-Beverly Transmission Line Special Use Permit* Baseline Update
- **White River-Little Wenatchee River**: USFS 2004 *White River Road Relocation and Bank Stabilization Project*
- **Chiwawa River:** *2019 Emergency (Wildlfire) Consultation*

To describe important habitat parameters for anadromous salmonids and the condition for each, the National Marine Fisheries Service (NMFS) developed *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (1996). The U.S. Fish and Wildlife Service (USFWS) developed a similar framework for bull trout, *A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual of Grouped Actions at the Bull Trout Subpopulation Watershed Scale* (USFWS 1998). This matrix was further modified by a Nov. 2004 memo which merged decision matrices into six pathways:

-- Water Quality
-- Channel Condition and Dynamics
-- Habitat Access
-- Flow/Hydrology
-- Habitat Elements
-- Watershed Conditions

Each of the above represents a significant pathway by which actions may affect anadromous salmonids. These pathways and indicators that are relevant to the proposed action will be addressed. Table 21,

Table 27, and Table 37 summarize current conditions in the Wenatchee River, White River-Little Wenatchee and Chiwawa River HUC 10 watersheds. Evaluation of the indicators ranks each as either Properly Functioning, Functioning at Risk or Not Properly Functioning. The effects analysis will also focus on effects to those same indicators.

Wenatchee River Watershed (HUC 1702001107)

Although impacts were identified for multiple matrix indicators, the magnitude or intensity of impacts is not expected to shift indicator trends at the HUC5 scale. Table 20 considers the effects of these actions that have occurred since 2019, to report the current condition in the Wenatchee River watershed.

Since the *2019 McKenzie-Beverly Transmission Line Special Use Permit* Baseline Update, the following actions have occurred within the Wenatchee River Watershed on both federal and non-federal lands:

Table 20. Federal actions in Wenatchee River Watershed since 2019 Baseline Update.

Project Type	Location(s) Subwatershed (HUC12)	Description(s)	Dates Implemented	Impacts to Matrix Indicators
Hazard Trees	Tumwater Derby Canyon Chiwaukum	**Campground & Trailhead Hazard Trees-** In developed recreation settings (campgrounds and trailheads), trees are surveyed annually for hazards using the protocol in the Field Guide for Hazard Tree Identification (USDA Forest Service 2012). Corrective action includes removing a portion of the tree or felling the whole tree with a chainsaw.	2019-2021	Insignificant/Discountable
Instream Habitat Improvement	Chiwaukum	**Skinney Creek Stream Restoration** Restoration of 0.5 miles of impaired stream.	2021	Insignificant

Table 21. Overview of the Environmental Baseline Conditions in the Wenatchee River Watershed*.

INDICATORS	Wenatchee River HUC 10		
	PF	FAR	NPF
Water Quality			
Temperature		X	
Sediment			X
Chemical Contaminants/Nutrients		X (Upper)	X (Lower)
Habitat Access			
Physical Barriers		X (Upper)	X (Lower)

INDICATORS	Wenatchee River HUC 10		
	PF	FAR	NPF
Habitat Elements			
Substrate Embeddedness			X
Large Woody Debris			X
Pool Frequency/Quality			X
Off-Channel Habitat		X	
Refugia		X	
Channel Condition and Dynamics			
Width/Depth Ratio		X	
Streambank Condition		X	
Floodplain Connectivity			X
Flow/Hydrology			
Change in Peak/Base Flows		X	
Drainage Network/Roads			X
Watershed Conditions			
Road Density and Location			X
Disturbance History			X
Riparian Reserves			X
Disturbance Regime		X	
Integration of Species/Habitat Conditions			X

*Note: References to Upper Wenatchee in this assessment include the mainstem Wenatchee River and tributary subwatersheds, including Chumstick and Beaver Creeks, from the confluence of Chumstick Creek (RM 23.5) to the headwaters at Lake Wenatchee. Similarly, Lower Wenatchee refers to the mainstem Wenatchee subwatersheds below Chumstick Creek which includes Derby, Olalla and Nahahum Canyon sub-watersheds.

Water Quality

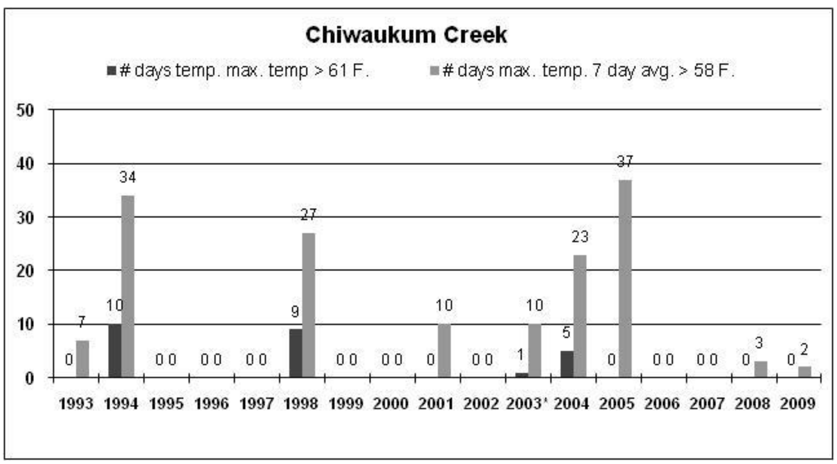
Temperature

The **mainstem Wenatchee River** was placed on the current CWA 303(d) listing for temperature in 1998. Following this listing, the WA State Department of Ecology began a Total Maximum Daily Load (TMDL) Study to evaluate temperature within the Wenatchee River Basin. Stream temperature data and Thermal Infrared Radiation (TIR) studies were conducted for the Wenatchee River in 2002-2003 (Cristea and Pelletier 2005). The TIR study showed a downstream heating pattern in the Wenatchee River with the lower river (Ollalla and Nahahum subwatersheds) experiencing more temperature excursions for longer durations. Instream temperature monitoring also showed that at several locations within the upper Wenatchee River, water temperatures exceeded the current standard of 16ºC during the months of July, August and September (Cristea and Pelletier 2005). The highest daily maximum water temperature recorded in 2002 was 20.6 ºC and the highest 7 day average daily maximum water temperature recorded was 19.9 ºC. Exceedences were of shorter duration and smaller magnitude than those in the lower river.

The Wenatchee River total maximum daily load (TMDL; Schneider and Anderson 2007) suggests that stream–shading mechanisms and connectivity to off-channel habitat contribute to temperature impairments. The goal of the Wenatchee River Sub-Basin temperature TMDL is to establish forest-wide riparian shade levels (in terms of percentage of effective shade) to maintain maximum water temperatures at, or below, the water quality standard.

Beaver Creek stream temperatures have been monitored annually on NF lands since 1997 (North Fork) and the South Fork branch has been monitored since 2000. Summer stream temperatures exceeding WNF Plan standards for maximum 7-day average have occurred in 2001 on the North Fork, and in 2003 and 2004 on the South Fork. No temperature data is available for the lower portions (private land) of Beaver Creek however, development and channel simplification likely contribute to temperatures in exceedance of matrix standards. Beaver Creek is considered functioning at risk.

Chiwaukum Creek was monitored annually 1993-2009 and during this period temperatures in exceedance of WNF Plan (1990) standards have occurred:



The 2014 Chiwaukum wildfire impacted stream shading in the watershed. Water temperatures have likely been elevated and little active management thought to be critical to stream temperature, such as clearing of riparian vegetation, road building, etc. has occurred in this watershed, therefore the Chiwaukum subwatershed is believed to be functioning at risk.

Chumstick Creek was included on the 2004 303(d) listing for temperature (WDOE 2007a). Single point (as opposed to continuous recording) water temperature measurements were taken once or more monthly from October 1992 to September 1993 by Chelan County Conservation District (Hindes 1994). A maximum water temperature of 13.6 C (56.6 F) was recorded in August 1993 at the North Road site. At Merry Canyon (RM 8.7), a maximum water temperature of 15.2 C (59.4 F) was recorded in August 1993. November 1996 water temperatures taken in Chumstick Creek during a stream survey conducted by the USFWS ranged from 39 to 45 degrees F (Titus 1997). Temperatures up to and slightly exceeding 14 degrees Celsius were again recorded by Chelan County Conservation District in 1999 and 2000, with the highest temperature of 14.7 C recorded on August 8, 2000. Although single day measurements in summer months rarely exceed state water quality temperature standards, this does not assure that state water quality standards for temperature are continually met. Given an incomplete data set, and the lack of tree canopy relative to historic conditions in significant portions of the riparian zones, water temperatures may be at risk in low water years. Chumstick Creek is rated as functioning at risk for water temperature.

Chelan County Conservation District (now Cascadia Conservation District) monitored one station located near the mouth of Eagle Creek in 1999 and 2000. The highest water temperature (14.7º C) was recorded in August 2000 (WSCC 2001). Sufficient data is lacking, however, land practices (development, water withdrawals, roading, and removal of riparian vegetation) and landforms in Eagle Creek are also of the Swauk sandstone type, therefore we consider it functioning at risk.

No temperature information is available for Derby Creek. However, road locations, rural development, and logging contribute to reduced riparian vegetation and increased stream exposure which reduce thermal regulation capabilities. Effects from salvage logging, road management and hauling, and landing construction for the Fischer Fire Recovery Project (2005) were expected to have a negative effect at a few locations where stream exposure would be increased. The increased exposure was expected to last up to five years. Lacking any other data, we consider temperature in Derby Creek to continue to be functioning at risk.

Wenatchee HUC 10 summary: Functioning at risk.

Sediment

Beaver - Wenatchee subwatershed: There is no quantitative data on fine sediment levels in the mainstem Wenatchee River. Downstream of Lake Wenatchee, the landscape consists of low relief glaciated ridges, morainal features and glacial fluvial outwash. Bedrock consists of sedimentary rocks which are covered with a thick mantle of glacial till found on lower ridges and valley walls. Valley bottoms are covered with glacio-fluvial outwash deposits, which the river has cut through, forming river terraces. The upper Wenatchee river substrate consists mainly of cobble and gravels (WNF 1999). The upper Wenatchee River has low to moderate hazard ratings for deep-seated and shallow-rapid failures depending on the susceptibility to undercutting and over-steepening of the stream bank (WNF 1999).

Roads and previously harvested units in the Beaver Creek drainage contribute to what would be a high background level of fine sediment due to the geology in the subwatershed (Swauk Sandstone that is not overlaid with glacial till). Five Wolman pebble counts conducted in 1995 found that Beaver Creek and its tributaries had surface substrate composition ranging between 10 and 39% fines <6.4mm. During the 1990's, several road surfacing, decommissioning, and closure projects were completed to help reduce elevated high sediment conditions.

In August 2013, ground disturbance associated with the Deadhorse Emergency Consultation was generated by bulldozing access routes into the area. Rehabilitation began within a couple of weeks (August 21 - September 4, 2013): USFS road maintenance crews rehabilitate FSR 7906-000, 7906-215, and portions of 7906-217. Decommissions north spur up to BNSF track from 7906-217; remove fill from Deadhorse Creek, pull fill back onto road template, scatter berms, de-compact and scatter slash. Work performed with an excavator and dozer. September 5, 2013: Storm delivers 1.4 inches of rain in 24 hours to Plain, WA. Photos from site visit to Deadhorse Canyon on 9/6/13 document recharged and turbid Deadhorse Creek and sediment plume in the Wenatchee River. September 10 – October 15, 2013: CCPUD performs road construction, re-opening, maintenance, pole repair, and road decommissioning as described in Table 1. September 28 – October 1, 2013: Daily precipitation ranging between 0.28 and 0.85 inches, cumulative 2.41 inches. October 15 – Project completed with all identified areas seeded. A short-term increase in sediment loading occurred from 2013-2014 until disturbed areas stabilize. The Beaver-Wenatchee subwatershed is considered **functioning at risk** until quantitative data is available.

Tumwater subwatershed: From 2006 to present, fine sediment has been quantitatively sampled annually. Percentage of fines less than 1mm have ranged from 12% to 17% in one reach sampled at the head of Tumwater Canyon. With this short-term dataset, conclusions are limited. Fine sediments are variable over time and can sometimes fluctuate above standards and the 2014 Chiwaukum wildfire has elevated instream sediment levels. Tumwater Canyon is considered functioning at risk (USDA and USDI, 2004).

Chiwaukum subwatershed: The Wenatchee Watershed Assessment (WNF 1999) describes Skinney Creek as severely impacted by the railroad, highway, farming, and timber harvest. Fine sediment appears to be high and may have been historically high due to the natural geomorphology of the area (WNF 1999). Recent (2021) stream restoration work ear the confluence of Skinney and Chiwaukum Creeks will contribute to more natural sediment regimes. The 2014 Chiwaukum wildfire has also contributed to the level of elevated fines. This subwatershed is considered functioning at risk.

Chumstick and Eagle subwatersheds – The Chumstick Watershed Assessment (USDA 1999) reports that fine sediment observed in riffles from the North Road culvert on Chumstick Creek to Little Chumstick Creek (RM 0.3 – 8.7) range from 29 – 36%, exceeding Forest Plan standards. The assessment concludes that high fine sediments within the Chumstick Creek watershed are linked to erosion from roads, riparian habitat degradation, erosion from burned areas, and possibly hillslope erosion from historic and continued grazing (USFS 1999). There is no quantitative sediment data for Eagle Creek, however soils in Eagle Creek are derived from the same Swauk sandstone in Chumstick Creek and the disturbance histories are similar. The elevated runoff effects of the 2013 Eagle fire have added excessive fines to Eagle Creek for several years. Based on this data, Chumstick and Eagle Creek are considered not properly functioning.

Derby subwatershed: Field observations of Derby Creek determined that sand/silt is the dominant substrate in the majority of riffle locations. Many segments Derby Creek and its tributaries are highly constrained by existing native surfaced roads and old skid trails located in draws or intermittent stream bottoms. A minor short-term (four years or the life of the project) negative effect was expected primarily from log hauling on native surfaced roads adjacent to Derby Creek during the Fishcher Fire Recovery project. In 2010, the main Derby Creek road (7400000) that parallels Derby Creek for its length was surfaced with crushed aggragate for 9.0 miles and road drainage was improved with the installation of ditch relief culverts, re-establishment of ditches, and installation of rolling dips. These improvements are expected to reduce existing sediment delivery from the use and maintenance of this road. From 2017 to present, ongoing restoration has occurred in high priority segments of Derby Creek. To date, two culverts have been replaced, riparian plantings in some areas, and a road crossing improved. Despite this improvement, road systems, non-functioning culverts, and road prisms that traverse hill slopes continue to alter intermittent stream function, especially sediment routing in this subwatershed. Derby subwatershed is not properly functioning.

Lower Wenatchee (Olalla, Nahahum): The lower Wenatchee River flows through the sedimentary rocks and terraces of the Chumstick formation which are naturally highly erodible. Sediment transport is reduced in the lower Wenatchee by the backwater influence of the Columbia River Rock Island Dam reservoir pool. In areas of the lower Wenatchee River, where spawning material are available for steelhead and spring chinook, the level of fines is believed to exceed 20% (WNF 1999). The lower mainstem Wenatchee River is considered functioning at risk, until quantitative data is available.

Wenatchee HUC 10 summary: Short-term increases in fine sediment levels are expected as a result of road activities (construction, re-opening, decommissioning) associated with several planned and on-going vegetation projects in the Wenatchee 10th field watershed, Natapoc Ridge Restoration, Canyons Fuel Reduction, and Chumstick Hazardous Fuels projects located in the Beaver, Eagle, Chumstick, and Derby subwatersheds that were incorporated into the 2010 update. Sediment increases are expected to persist over the long term for up to ten years for each project area (USFS 2006, USFS 2008, USFS 2010), or as a whole persist from the present into 2023 (Chumstick project initiation in 2013). At the conclusion of each project, fine sediment levels are expected to reduce road related sediment effects to slightly better than the current condition for each subwatershed. Considering each subwatershed's sediment rating and increased sediment delivery expected from road activities in four of the eight subwatersheds, the Wenatchee HUC 10 watershed is determined to be **not properly functioning** for fine sediment.

<u>**Chemical Contaminants / Nutrients**</u>

Beaver-Wenatchee, Tumwater, and Lower Wenatchee (Ollala, Nahahum) subwatersheds: No problems are known or suspected for this element in Beaver Creek. The upper Wenatchee River is designated as a Washington state class AA (extraordinary) water-body and the lower Wenatchee River is designated as a Washington state class A (excellent) waterbody under the Clean Water Act. In 1998, the Wenatchee River was placed on the state 303(d) list for impaired waters due to high pH and low Dissolved Oxygen (DO) as well as for temperature and instream flow (WDOE 1998, 2004). Following this listing, the WA State Department of Ecology began a Total Maximum Daily Load (TMDL) Study to evaluate DO, pH and phosphorus within the Wenatchee River Basin. During the study, DO within the upper and lower Wenatchee River was generally lower than the 8.0 mg/L designated by the US Environmental Protection Agency (EPA). Excursions below 9.5 mg/L occurred from July to September in the upper Wenatchee and were diel, indicating that low DO is mainly due to high water temperatures during the hottest part of the day. All pH values within the upper and lower Wenatchee River were within water quality standards (6.5 to 8.5 pH units) for Class AA and A rivers (Carroll et al. 2006). An excessive fecal coliform reading in October 1993 at the Monitor, WA station suggests a potential risk situation may exist on the lower mainstem (CCCD 1993). Water quality in the Wenatchee River has also been affected in the past by practices that include flood control, logging and related road construction, livestock grazing, and past agricultural uses and is currently considered functioning at risk. Recommendations from the Wenatchee River TMDL study suggest that future biochemical oxygen demand (BOD) and nutrient loadings need to be restricted to prevent pH from rising and to increase DO (Carroll et al. 2006).

Chiwaukum subwatershed: is believed to be properly functioning or this element. No problems are known or suspected for this element. The subwatershed has likely recovered from the 2014 Chiwaukum wildfire short term influx of nutrients.

Chumstick and Eagle Creeks have received a 303(d) listing by Washington State Department of Ecology for dissolved oxygen, pH, fecal coliform and instream flow (WDOE 2007b). The Wenatchee watershed ranking project (Hindes 1994) documented dissolved oxygen, pH, and fecal coliform levels in violation of state water quality standards. The ranking project concluded that Chumstick Creek was second to Mission Creek in contributing to current and future potential water quality degradation in the Wenatchee River watershed. Chumstick and Eagle Creeks are considered not properly functioning for water chemistry.

Derby subwatershed: There are no 303(d) designated reaches in Derby Creek. There is low density housing in the lower two miles of the floodplain however. Because no information is available for Derby Creek, we consider it functioning at risk until data is obtained.

***Wenatchee HUC 10 summary**: Upper Wenatchee is **functioning at risk,** lower Wenatchee **not functioning properly** due to the condition of Chumstick and Eagle Creeks.*

<u>Habitat Access</u>

<u>Physical Barriers</u>

Beaver-Wenatchee subwatershed: Beaver Creek is no longer functioning at unacceptable risk due to recent culvert upgrades to bridges on County Road 22 and private land (2007). Also, Deadhorse Emergency consultation required replacing two culverts with a drive-able ford on the 7906-215 road. Several culverts on forest were upgraded to open bottom arches in the 1990's but there are still likely potential problem culverts on abandoned roads, therefore Beaver-Wenatchee subwatershed is considered functioning at risk.

Tumwater, and Lower Wenatchee (Olalla, Nahahum) subwatersheds: The two dams on the mainstem Wenatchee River, Dryden Dam (RM 17.6) built in 1908 and Tumwater Dam (RM 30.1) built in 1909, originally had fish passage problems but were re-laddered with vertical slot fish-ways in 1986 and 1987. The fish screen for the Dryden dam was updated in 2001 by the Chelan County PUD and now meets current NMFS screening criteria. Tumwater Dam has a 5.2 m high dam face with a concrete apron. All fish ascending the Tumwater Dam are recorded by a video tape in the fish ladder. When trapping salmon and steelhead for hatchery brood-stock in the ladders at Tumwater Dam and Dryden Dam, other species including bull trout are captured and passed upstream. Because these dams do not block anadromous fish passage, the Wenatchee River is considered functioning appropriately for physical barriers.

Chiwaukum subwatershed: A water diversion located on Skinney Creek (located off of FSR 7910, behind the Winton Mill) may be impassable to juvenile fish. When last observed (1999), the pond and diversion did not hamper adult steelhead upstream passage, nor would it prevent upstream movement of adult resident trout. All age classes of all species would be able to move downstream. This indicator is considered not properly functioning until all passage barriers are addressed.

Chumstick and Eagle Creek subwatersheds: are **functioning at risk**, despite several recently replaced (within the last five years) culverts. Fish passage improvement at North Road Culvert (RM 0.25) occurred in 2009 and 12 additional culverts on Chumstick were also replaced in 2009. From 2010-2013, 6+ passage barriers were removed within the first 9.8 miles of Chumstick Creek (since 2001, 30+ removed). In 2016, eight miles of road decommissioning including removal of stream crossing culverts and cross drain culverts has been completed. The removal of an existing earthen dam on Van Creek was also completed. A barrier in Eagle Creek was removed in 2017 (Gombotz) with another planned for removal in 2018.

Derby subwatershed: Seven culverts within the first 1.8 river miles of Derby Creek were determined to be fish passage barriers (Harza/Bioanalysist 2000 and USFS Culvert Barriers Database 2000, in WSCC 2001). Within this first 1.8 miles there is also a railroad crossing and 3 small ponds on private land. Four culvert upgrades on the Forest in Derby Creek designed to pass increased run-off and debris as a result of the Fisher Fire (2004) also benefitted the passage of resident redband trout. However, the railroad crossing culvert and ponds remain as barriers to upstream passage with the exception of rare occurrences of strong swimming adult steelhead individuals (WSCC 2001). In total, an estimated 18 barriers or partial barriers still occur in this system (CCFEG 2017), therefore the Derby subwatershed continues to be not properly functioning.

Wenatchee HUC 10 summary: Upper Wenatchee is functioning at risk*. Lower Wenatchee has slightly improved for the physical barrier indicator, due to the collective removal of 30+ passage barriers in the Chumstick Creek subwatershed, but still remains* ***not properly functioning****.*

Habitat Elements

<u>Substrate</u>

Beaver-Wenatchee subwatershed: is presumed to be functioning at risk due to the lack of quantitative data in the mainstem river and the high level of fine sediment in Beaver Creek mentioned above. Tumwater and Lower Wenatchee (Olalla, Nahahum) subwatersheds: Substrate embeddedness is unknown in the lower mainstem Wenatchee River. See sediment conclusions. Functioning at risk.

Chiwaukum subwatershed: is presumed to be functioning at risk due to the condition of Skinney Creek (see sediment indicator) and the 2014 Chiwaukum fire.

Chumstick and Eagle Creek subwatersheds: Observations in a 1997 stream survey determined that the downstream section of Chumstick Creek are embedded with greater than 35% fine sediment (Titus 1997). Survey data does not exist for Eagle Creek however, conditions are assumed to be similar to those in Chumstick Creek as similar geology exists in the Eagle Creek catchment. Therefore, Chumstick and Eagle Creek subwatersheds are considered not properly functioning.

Derby subwatershed is not properly functioning due to the abundance of sand in the streams which may be related to the abundance of riparian roads and channel simplification in Derby watershed. In addition, the geology of the area lends itself to fines creation (M. Karrer personal communication). After the Fischer Fire, areas in upper Derby Canyon that had high tree mortality, along with the headwaters in Cow Canyon, a tributary to Derby, showed signs of surface erosion, including some ash and fine soil showing in cleaned ditch lines after fall rains (M. Karrer 2005 personal communication). Visual observations indicate that effects on soil and vegetative cover from the Fischer fire have diminished as a result of the vegetative response in the burn area. However, high precipitation events may still produce debris slides in this watershed due to the geology and disturbance history (road density and location, harvest history, fire history).

Wenatchee HUC 10 summary: *Not properly functioning. See previous sediment discussion.*

<u>Large Woody Debris</u>

Beaver-Wenatchee and Tumwater subwatersheds: are not properly functioning. LWD within the upper Wenatchee River (Tumwater Canyon to Lake Wenatchee) may be naturally limited by river terraces which confine the river channel. These river terraces were formed as the river cut through the glacial till that covers the upper watershed. Residential development, roads, power lines and railroads along most of the upper Wenatchee River has exacerbated the lack of LWD. In some cases, riparian vegetation has been cleared to the stream bank and some large trees have been cut, thereby reducing the potential for recruitment of LWD to the river (WSCC 2001). Three developed recreation sites are located on the banks of the Wenatchee River through Tumwater Canyon and hazard tree management can reduce LWD recruitment at these sites. Also, log drives in the early 1900's further reduced instream LWD and LWD recruitment. Introduction of LWD into Beaver Creek has been reduced by harvest practices and roads, although the 2015 Natapoc Habitat Enhancement project added a minor amount of LWD to the mainstem Wenatchee River.

The Chiwaukum subwatershed is considered functioning at risk. Although 78% of the watershed is designated as wilderness, the remainder of the watershed (including all of the Skinney Creek drainage) has been impacted by historic and on-going development including the railroad and US 2 corridor, homesteads, roading and logging which have reduced instream wood and LWD recruitment. Restoration of lower Skinney Creek has restored large wood to that reach.

Derby subwatershed is not properly functioning in regards to presence of LWD. In Derby Creek the largest contributor of LWD to this low order, low stream power system is single and multiple tree recruitment from the edge of the stream (M. Karrer 2005 personal communication). The potential for LWD recruitment in Derby Creek subwatershed is very low due to modification of the riparian area in the lower portions by agriculture and low-density development; and in the upper portions by roads and some riparian harvests.

Chumstick subwatershed - The 1997 stream survey indicated that small size LWD (greater than 20 feet in length and greater than 6 inches diameter) is relatively abundant in Chumstick Creek (95-106 pieces per mile; Titus 1997). However, there is very little larger diameter woody material: 0 pieces per mile below Eagle Creek, 1.4 pieces per mile between Eagle Creek and Sunitch Creek, and 4.9 pieces per mile above Sunitch Creek. These larger size classes of woody debris can be critical to channel morphology and processes (Meehan 1991). Because of the lack of larger size classes of woody debris, Chumstick Creek is considered to be functioning at risk.

Eagle Creek subwatershed is **not properly functioning**. According to the Chumstick Watershed Assessment (1999), LWD input comes directly from riparian areas and through hillslope processes such as mass wasting. Many harvest entries through time and agricultural/rural development in the main valley bottoms has decreased the amount and size of existing woody debris. Hillslope harvest activities and the valley bottom roads constructed for timber extraction have simplified riparian vegetation consisting of smaller second growth conifers and shrub species. This has resulted in smaller woody debris along the banks, and decreased the potential for woody debris to enter stream systems as a result of blowdown or mass wasting events.

Lower Wenatchee (Olalla, Nahahum) subwatersheds: The lower Wenatchee River has little to no wood storage capacity (USFS 1999) and from the mouth upstream to Tumwater Canyon, there is little to no woody debris within the mainstem Wenatchee River (WSCC 2001). The history of settlement and on-going development along the river has reduced instream LWD and LWD recruitment. The lower river has also been channelized through the years to control floods, protect against erosion, improve drainage and irrigation systems, and delineate property boundaries through channel relocation. These practices have resulted in the loss of most of the LWD in these reaches as flow velocities and power increase to such an extent that LWD is typically dislodged and removed from the system before it can affect any change in habitat (i.e., create and maintain pools) (CCCD 1998). Recent work to add LWD (2009-2011) has occurred but this indicator is considered to be not properly functioning, in that the lower Wenatchee River subwatersheds typically lack LWD and riparian vegetation and, therefore, potential future recruitment of LWD.

Wenatchee HUC 10 summary: Historic and ongoing activities in the Wenatchee watershed, primarily valley bottom development, many harvest entries, and road/utility/railroad corridors, have reduced instream LWD levels below what is believed to be historic levels and limited the amount and size of LWD available for recruitment. LWD is **not properly functioning**.

Pool Frequency & Quality

Beaver-Wenatchee and Tumwater sub-watersheds are considered functioning at risk with respect to pools. The upper Wenatchee River (Lake Wenatchee to the Chiwawa River) is characterized as a pool-riffle channel, with large deep pools occurring at riverbends. The Tumwater Canyon portion of the river is in a bedrock-controlled canyon, where the dominant mechanisms of pool formation (substrate and gradient) remain largely intact (personal observation). However, the loss of instream wood and large boulder substrates from historic river drives in the upper Wenatchee have reduced local scour pool habitat. Furthermore, floodplain and riparian development have reduced the potential for LWD recruitment. In the Beaver Creek drainage, wood recruitment is presumed to be low and fine sediment is presumed to be high due to road locations and development. This activity within floodplains which could reduce pool frequency and quality, but no quantitative data exists.

The **Chiwaukum subwatershed** is considered functioning at risk. Pool-forming wood recruitment is low in lower Chiwaukum Creek. Stream restoration in lower Skinney Creek has increased pool density and large wood available for future pool formation. Highway sanding practices may also reduce the quality of pools by reducing pool depth with sand accumulations. The 2014 wildfire may still be negatively impacting pool habitat.

Chumstick and Eagle subwatersheds are functioning at risk. A 1997 stream survey of Chumstick Creek found there is an acceptable amount of pool habitat (56-63% of reaches surveyed), however the depth in many pools does not provide sufficient refuge for fish during low flow periods (Titus 1997). Below Eagle Creek, there are 12 pools greater than 3 feet in depth (10.7 per mile). Above Eagle Creek there are fewer 3 feet in depth pools, 5-7 per mile. The lack of deep pools and the lack of LWD associated with pools suggest that Chumstick Creek is functioning at risk for pool frequency and quality. There is no quantitative data for Eagle Creek. Due to the recent wildfire sedimentation impact, slow stream flow, low instream LWD, reduced LWD recruitment, and similar disturbance history as Chumstick Creek, we consider Eagle Creek to be functioning at risk.

Derby subwatershed: Factors dominating number and quality of pools in Derby Creek are the existing channel confinement and lack of LWD (M. Karrer 2005 personal communication). Due to development and location of roads, Derby Creek is not properly functioning**.** Pool-forming wood recruitment is low, and predominance of riffles, based on observations while driving and walking the mainstem (no survey data).

Lower Wenatchee (Olalla, Nahahum) subwatersheds: are believed to be functioning at risk due to: 1) the lack of LWD which is an important pool-forming agent in these channel types, and 2) confinement by roads, railroads, towns and agriculture which also reduces pool frequency and quality. Pool quality in the lower Wenatchee River is relatively poor. Deep, channel spanning pools are low in abundance with pool to riffle ratios of 27:73 from the mouth to Dryden (Mullan 1992, WNF 1999).

Wenatchee HUC 10 summary: As described for the sediment indicator, short-term (through 2023) increases in sediment delivery are expected in four out of the eight subwatersheds (Beaver, Eagle, Chumstick, and Derby) are expected from road activities associated with the vegetation management projects, pool quality in these subwatersheds and subsequently at the 10th field watershed level in the near term will likely be affected. Overall the waterhsed is considered to be **not properly functioning.**

Large Pools

No quantitative data on large pool habitat is available in the Wenatchee watershed. Similar to the section above, **Beaver-Wenatchee and Tumwater sub-watersheds** are functioning at risk for deep pools, and the rest of the **Wenatchee River** is functioning at risk due to the lack of LWD, an important pool- forming agent.

Chumstick and Eagle subwatersheds: There is no data specific to large pools for Eagle or Chumstick Creeks. Average pool depth in the lower 8.7 miles of Chumstick Creek was less than 2.3 feet (Titus 1997). Based on data contained above in pool *frequency and quantity*, and an observed deficiency in LWD, we consider **Chumstick and Eagle subwatersheds** are functioning at risk.

Derby subatershed is not properly functioning due to channel degradation and absence of LWD in the channel.

Wenatchee HUC 10 summary: Because short-term (through 2023) increases in sediment delivery in four out of the eight subwatersheds (Beaver, Eagle, Chumstick, and Derby) is expected from road activities associated with vegetation management projects pool depth in these subwatersheds will likely be affected. Overall the waterhsed is considered to be **not properly functioning**.

<u>Off-Channel Habitat</u>

Beaver-Wenatchee and Tumwater subwatersheds: are functioning at risk. State Highway 207 crosses the Wenatchee River at the outlet of Lake Wenatchee and creates a "dam" which forces the river down the main channel and does not allow the use of the floodplain during high water. Beaver Valley Highway (St. Hwy. 209), from Lake Wenatchee to Plain also encroaches on the floodplain and cuts off several old oxbows. The construction of the Beaver Valley Highway also resulted in the straightening of the channel in the Wenatchee River (Andonaegui 2001). Off channel habitat in the Beaver Creek drainage is limited due to road confinement and development.

Derby subwatershed: is not properly functioning due to road confinement and development in the floodplain.

Chumstick and Eagle subwatersheds: Mainstem Chumstick Creek has no side channels; road placement, development and land use patterns are suspected to have simplified channel form. Only small perennial tributaries have minor side channel development (Titus 1997). Similar land use patterns in Eagle Creek are also suspected of simplifying channel form. Chumstick and Eagle Creek are functioning at risk for off-channel habitat**.**

Lower Wenatchee subwatershed: In the Lower Wenatchee, the presence of roads (including HWY 2/97), railroads, towns, development, and agriculture have confined the channel and reduced the degree of accessibility to off-channel habitat. Some existing but not accessible ponds and backwater areas have been reconnected or enhanced in the lower Wenatchee (2007 to present), creating high flow and overwintering habitat for juvenile salmonids. These efforts are moving the watershed toward properly functioning however, development and locations of roads within the floodplain still limit off-channel habitat in the watershed therefore it is still considered functioning at risk.

Wenatchee HUC 10 summary: Recent efforts in the watershed, primarily the lower Wenatchee are focusing on reestablishing the mainstem Wenatchee River's connection to existing ponds and historic channels; and future road management actions in the Derby, Chumstick, and Eagle subwatersheds (Canyons and Chumstick Fuels Reduction Projects) will improve some hydrologic connectivity on tributary streams improving this indicator at the project and reach scale however, at the watershed scale this indicator is considered **functioning at risk**.

<u>Refugia</u>

Beaver-Wenatchee, Tumwater and Lower Wenatchee (Olalla and Nahahum) subwatersheds: Refugia do exist in the Wenatchee River watershed but is generally considered insufficient. Pools are lacking within the lower Wenatchee River, and deep pools are very limited. Off-channel habitat and other potential thermal, flow, and predator refugia are typically lacking due to development which has reduced channel complexity, off-channel habitat, and connectivity of minor tributaries (WNF 1999). This indicator is considered functioning at risk.

Chiwaukum subwatershed: Access to acceptable refugia areas in Chiwaukum is available, though impacted by recent wildfire activity; therefore the Chiwaukum subwatershed is considered functioning at risk.

Chumstick and Eagle subwatersheds - Throughout most of Chumstick watershed, habitat refugia is limited due to the presence of major roads within or adjacent to the floodplains. The high degree of development and roads has limited the presence of refugia.

Similarly, Eagle Creek habitat is degraded and not capable of supporting significant steelhead populations. Chumstick and Eagle subwatersheds are considered not properly functioning.

Derby subwatershed: Placement of roads, railroad, culverts and development cause Derby Creek to not properly function (WNF 1999).

Wenatchee HUC 10 summary: The upper watershed maintains good connectivity to acceptable refugia areas in Lake Wenatchee, Upper Wenatchee, Chiwawa River, White River, and Chiwaukum, however refugia within the watershed is limited and this indicator is considered **functioning at risk**.

Channel Condition and Dynamics

Width/Depth Ratio

Beaver-Wenatchee, Tumwater and Lower Wenatchee (Olalla, Nahahum) subwatersheds: Localized areas of the Wenatchee River are functioning at risk with regard to width/depth ratio. Railroad revetments, urban development, State Highway 2 and the Beaver Valley Hwy, and agricultural development in the floodplain have cut off the floodplain from the channel, which has reduced the width/depth ratio, and in some reaches changed the channel type. Past activities including log drives, removal of instream and potential LWD, and riprap have affected channel-forming processes and limited the sinuosity of the main stem within the watershed. Most of the channels in the Beaver Creek drainage have been confined by roads resulting in reduced floodplain function both from a vegetative function and high flow dissipation function which often leads to channel entrenchment. This indicator is functioning at risk.

Chiwaukum subwatershed: Skinney Creek and lower Chiwaukum Creek are affected by many of the same floodplain impacts listed for the mainstem Wenatchee River reducing width:depth ratios. This indicator is also considered functioning at risk in this subwatershed.

Chumstick and Eagle subwatersheds: All surveyed reaches of Chumstick Creek are Rosgen E5 channels (Titus 1997). Width depth ratios (8.4-9.2), entrenchment ratios (2.6-3.0), and gradients (1.2-1.4) are within typical ranges for this channel type. However, sinuosity values may be below expected values, although the report does not indicate whether sinuosity was calculated from field data. If channel confinement by roads and railroad, streambank vegetation alteration, and lack of larger sizes of LWD has resulted in lower sinuosity, this could indicate the beginning of a process of channel type conversion, with negative consequences for the aquatic/riparian condition (Rosgen 1996). Rosgen E5 channels are particularly sensitive to grazing, channelization, and bank erosion impacts (Rosgen 1996). **Chumstick Creek** is considered functioning at risk due to a possible loss of sinuosity.

We have not collected channel width data for Eagle Creek. Based on channel confinement by roads, channel alteration, and LWD manipulation, we consider **Eagle Creek** to be functioning at risk.
Derby subwatershed: The Mainstem Wenatchee River Watershed Assessment (1999) states that in Derby Creek "in places the channel is very entrenched…". Therefore we consider Derby Creek to be not properly functioning. Sediment delivery to property in Derby Canyon was reported by landowners after a significant rain event in the spring of 2007. This is likely attributable to effects from the Fishcer Fire anticipated to occur within five to ten years until vegetation re-colonized and root strength became established. Neutral effects to this indicator were documented in the Fischer Fire Recovery Fisheries BA (2005) as the project elements lacked a causal mechanism, or their affect was determined to not be significant.
Wenatchee HUC 10 summary: functioning at risk.

Streambank Condition
Beaver-Wenatchee, Tumwater and Lower Wenatchee (Olalla, Nahahum) subwatersheds: Residential development, roads, power lines and railroads built within the riparian zone along most of the upper Wenatchee River, have negatively impacted the riparian vegetation and stream bank condition along the upper Wenatchee River (Tumwater to Lake Wenatchee). Below Tumwater Canyon, floodplain development, flood control measures and bank stabilization efforts to control lateral channel migration have exacerbated bank erosion in the lower Wenatchee river valley bottom. Along the length of the Wenatchee River 35% of the bank is confined by the railroad, 31% is entirely cleared, 19% is riprapped, and 16% is in a natural vegetated state (CCPUD 1997 cited in WNF 1999). Fifty-seven percent of the bank area with little riparian vegetation is eroding, and 14% of the riprapped sections are eroding (CCPUD 1997 cited in WNF1999).

The lower drainage of Beaver Creek has been modified from historic and present development, and where there were once abundant beaver dams and side channels there are now hay fields, pasture land, and homes. On NF lands stream vegetation improves however, road location and older timber harvest units have reduced the function of riparian areas in providing streambank stability and recruiting large wood which these stream channels rely heavily upon to maintain stable channels and banks.

The Wenatchee Watershed Planning Unit has partnered with many local government and non-profit agencies that work with private landowners throughout the Wenatchee watershed to implement riparian habitat restoration projects. These projects have planted native vegetation along 8380 feet (7.7 acres) of eroding streambanks in the lower Wenatchee watershed and 0.2 acres in the Beaver Creek watershed (2010-2012), improving streambank condition at the project site scale. At the watershed scale, this indicator is considered to be functioning at risk.
Chiwaukum subwatershed: Overall Skinney Creek and Chiwaukum Creek are properly functioning. There are relatively small localized areas of streambank instability due to a poor bridge location and campground on lower Chiwaukum Creek.
Chumstick and Eagle subwatersheds: Approximately 2.1% of reach 1 is actively eroding, 7.3% of reach 2 and 1.0% of reach 3 (Titus 1997). Reach 2 has the highest percentage of erosion due to culverts and

riparian disturbance being found there. The vegetative condition of the banks has been substantially changed from the historic condition, and an invasive weed (reed canary grass; *Phalaris arundinacea*) is abundant on disturbed sites. Thirteen culverts were replaced in 2009 on Chumstick Creek and the Chelan County Natural Resources Department has been working with landowners for the several years to plant riparian areas with native vegetation.

Approximately 1.6 acres of Eagle Creek riparian restoration was completed in 2012, although no culvert replacements have been accomplished to date. Despite the recent restoration efforts on Chumstick Creek (2.5 acres in 2009-2014), road placement and development within the riparian and floodplain areas of the drainage continue to negatively influence streambank stability, sometimes by artificially containing the channel unaturally. Therefore streambank condition in Chumstick and Eagle Creek continues to be functioning at risk.
Derby subwatershed: Due to road placement and development in the drainage, Derby Creek is considered not properly functioning (USFS 2008).

Wenatchee HUC 10 summary: *functioning at risk.*

<u>Floodplain Connectivity</u>
Beaver-Wenatchee, Tumwater, and Lower Wenatchee (Olalla, Nahahum) subwatersheds: The level of development that has occurred along the Wenatchee River and Beaver Creek over the past 100 years has increased and disconnected most of the historical floodplain from all but the most severe flood events. Additionally, channelization of the Wenatchee River has decreased the sinuosity and significantly affected the hydrologic regime of a few acres (<2) of floodplain in Nahahum watershed from 2012-2014. This indicator is considered not properly functioning due to significant reduction in floodplain connectivity and associated hydrology and wetland and riparian functions.

Chiwaukum subwatershed: Due to floodplain constriction from US 2 and private development on Skinney Creek in addition to channelization of the lower reaches of Chiwaukum Creek, this subwatershed is considered functioning at risk.

Chumstick and Eagle subwatersheds: The Chumstick Highway (HWY 209), Burlington Northern Railroad, forest roads, and urbanization are common next to Chumstick Creek and tributary streams, including Eagle Creek. These activities have channelized numerous reaches within these sub-watersheds, limiting the width of the riparian zone and restricting floodplain access. High densities of riparian roads do the same thing in the tributaries. Due to the high road density and restriction of the floodplain, Chumstick and Eagle subwatersheds are not properly functioning.
Derby subwatershed: Derby Creek is believed to be not properly functioning as a result of roads and development confining the stream channel (WNF 1999).
Wenatchee HUC 10 summary: not properly functioning.

<u>Flow/ Hydrology</u>

<u>Peak/Base Flow</u>

Beaver-Wenatchee, Tumwater and Lower Wenatchee (Olalla, Nahahum) subwatersheds: The USGS has operated stream gaging stations at various locations and for various lengths of time on the Wenatchee River since 1910 (USFS 1998). The most extensive period of record for the upper Wenatchee River is from the gaging station near Plain (1912-1979, 1990 to the present). The timing and magnitude of flows appear to be relatively unchanged from historic records. Peak annual flows occur from May to June with rain on snow events in December and January and range from 1,500 to 9,000 cubic feet per second (cfs) in the upper watershed and 9,410 to 47,500 cfs as recorded at Monitor. Mean annual low flows occur from late August to early October and range from 190 to 287 cfs in the upper watershed and 749 to 1141 cfs in the lower watershed. The upper Wenatchee River has adequate instream flow however, the lower portion of the river is on the 303(d) list for inadequate instream flows (WDOE 1998). No flow data exist for Beaver Creek however high road densities in the drainage may impact the timing and characteristics of peak and base flows. In 2013, an estimated 38 cfs was added to Lower Wenatchee River as part of an instream flow enhancement project. Spring Chinook, steelhead and bull trout migrate through the lower river and are hindered by low instream flows, therefore these mainstem subwatersheds are considered functioning at risk for flow.

Chiwaukum subwatershed: No flow information is available. There appears to be no records of how much water is diverted from a pond and presumed irrigation withdrawal on Skinney Creek (located behind the Winton Mill), or what the maximum permitted volume would be (USFS 1999). It may be possible that no water has been diverted in recnt years. We suspect that relatively little water is withdrawn and note that lower Skinny Creek does not appear to be de-watered nor flowing below its channel capacity (Biological Assessment for On-going Activities in the Wenatchee Watershed, 1999); this coupled with watershed road densities less than 1 mi/sq mi, peak and base flows are presumed to be functioning appropriately.

Chumstick and Eagle subwatersheds: Chumstick Creek has a 303(d) listing for instream flows (WDOE 2007). Inadequate stream flows have been recognized in the Chumstick valley since at least the 1980's when water rights in the Chumstick valley were adjudicated, and presently data is lacking to evaluate available water and recommend allocation strategies (WRIA 45 Planning Unit). Given possible effects of extensive vegetation conversion and high road densities on peak and base flows, Chumstick and Eagle Creek subwatersheds are considered to be functioning at risk.

Derby subwatershed: Lacking flow data, Derby Creek is considered to be functioning at risk due to moderate harvest levels (<15% Equivalent Clear-cut Area) and high road densities (4.4) miles road/square mile) in a sensitive landtype. As suspected and discussed in the Fischer Fire Recovery Fisheries BA (2005), peak flows in the spring of 2007 increased, flooding adjacent property and depositing sand onto pastures (USFS 2008). Vegetation (grasses and shrubs) in the Fischer Fire area is recovering and conifer seedlings have been planted which will begin to regulate the amount of moisture escaping to the soil. However, higher amounts of preciptiation reaching the forest floor without interference from the canopy will continue in areas of high tree mortality, and peak and base flows may be higher over the next few years.

Wenatchee HUC 10 summary: functioning at risk.

<u>Drainage Network Increase</u>

NetMap (Earth Systems Institute, www.netmaptools.org) analysis tools were used to determine the extent of road and stream connectivity at the subwatershed scale; these tools provide a coarse screening of aquatic risks associated with roads through ditches, ditch relief culverts, and drainage (perennial, intermittent, swales, etc.) crossings (Table 22). Field surveys are recommended for more accurate risk assessments. Also see Road Density below; road density is often used to measure overall watershed condition, and some studies have found that when road densities are between 1.7 and 4.7 miles/square mile, conditions that negatively affect fish are present (Quigley and Arbelbide (1997).

Table 22. NetMap Road Drainage Connectivity for Wenatchee Watershed 12th Field HUC's.

HUC 12	Drainage Density (miles of road/miles^2)	Road x-ing Density (crossings/stream mile)	Road x-ing Count
Beaver	2.08	1.55	179
Chiwaukum	1.86	0.34	43
Chumstick	3.36	2.95	385
Derby	2.82	2.96	220
Eagle	3.36	4.47	328
Nahahum Canyon	3.11	0.65	80
Ollala Canyon	3.02	1.99	177
Tumwater Canyon	2.67	0.63	54

Beaver-Wenatchee, Lower Wenatchee (Olalla, Nahahum) Chumstick, Eagle, and Derby subwatersheds: High road densities, and roads with ditches alongside and between roads and streams can increase the drainage network in a watershed. From 2013-2016, 3.1 miles of road was decommissioned in Chumstick Creek watershed, which would reduce the drainage density shown in Table 16, somewhat, but because these subwatersheds all have high road densities and/or high road crossing density, and stream confinement by roads, they are presumed to be not properly functioning.
Tumwater and Chiwaukum subwatersheds: are presumed to be functioning at risk due to low watershed road densities but some valley bottom roads that are hydrologically connected to the road network through ditches and culverts.
Wenatchee HUC 10 summary: not properly functioning.

Watershed Conditions

Road Density and Location

Beaver-Wenatchee, Lower Wenatchee (Olalla, Nahahum), Chumstick, Eagle, and Derby subwatersheds: are not properly functioning due to road density and location**.** As Table 17 indicates, all these subwatersheds have high road densities, and high proportion of roads in riparian areas. Highway 2/97 closely parallels the Wenatchee River from its mouth upstream to Tumwater Canyon. The highway crosses the river via bridges several times and constricts the floodplain in numerous areas (WNF 1999). A county road parallels parts of the Wenatchee River between Tumwater and Plain and from RM 46 to RM 50, the Beaver Valley Hwy parallels the river on the west side while County Road 22 (Chiwawa Loop Road) parallels the east side. Chumstick Creek is paralleled by the Chumstick Hwy and

Merry Canyon Road. Beaver, Eagle, and Derby subwatersheds each have high road densities with >0.5 miles per square mile within the riparian zone.
Tumwater and Chiwaukum subwatersheds: are functioning at risk due to low watershed road densities but some valley bottom roads.

In the table below, a riparian road is defined as a segment of road within 300 ft of a stream channel. "mi/sq. mi" is total miles of road in the subwatershed divided by total square miles in the subwatershed. "Rip mi/sq mi" is miles of riparian road in the subwatershed divided by total square miles in the subwatershed.

Table 23. Road Density Calculations for Wenatchee Watershed and its 12th field HUC's

HUC 12	HUC 12 ACRES	Road Miles Per HUC 12	Sum of Riparian Road Miles	Road Density Mi./ Sq. Mi. by HUC 12	Riparian Road Density Mi./ Sq. Mi. by HUC 12
Beaver	28,573	197.96	23.90	4.43	0.54
Chiwaukum	30,907	33.69	7.77	0.70	0.16
Chumstick	32,206	183.02	37.50	3.64	0.75
Derby	18,366	129.85	19.73	4.53	0.69
Eagle	18,143	121.75	24.89	4.29	0.88
Nahahum Canyon	30,295	155.32	24.82	3.28	0.52
Ollala Canyon	21,934	155.76	29.03	4.54	0.85
Tumwater Canyon	21,223	30.67	12.44	0.92	0.38
Grand Total	**201,647**	**1,008.03**	**180.09**	**3.20**	**0.57**

Source: 2010 ArcGIS calculations, Geodatabase available upon request.

Wenatchee HUC 10 summary: not properly functioning.

Disturbance History

The 201,646-acre Wenatchee River Watershed area includes lands managed by the USFS, Bureau of Land Management (BLM), Washington Department of Natural Resources, WDFW, Long Fibre Company, and numerous individual private landowners (approximately 120,219 or 60% acres managed by USFS). Anthropogenic disturbances in the HUC 10 watershed include establishment and operation of orchards, grazing activity, road building, stream cleaning, water diversion, stream channelization, logging, recreation (campgrounds and trails), and private development (adjacent to and within the floodplain).

For the period 2000 to present, anthropogenic disturbance on NFS lands in the watershed have included: vegetation management projects primarily focused on reducing wildfire risk and moving dry site forest ecotypes towards historic range of variation, sheep grazing, wildfires, and on-going maintenance/management of roads and developed and dispersed recreation. Wenatchee River Ranger District databases were queried for activities within the Wenatchee watershed during the period 2000-2010 and spatially located in ArcGIS. Results are displayed in Table 24.

Table 24. Activity acres on NF lands for the period 2011-2017, percent of subwatershed acres in ( ).

HUC 12	USFS Harvest Activity*	Active Allotment**	Human Caused Fires***	Total Disturbance
Beaver	**2242 (8)**	**5683 (20)**	**0.6 (<1)**	**7926 (28)**
Chiwaukum	**43 (<1)**	**0**	**0**	**43 (<1)**
Chumstick	**462 (1)**	**15,486 (48)**	**0.2 (<1)**	**15,948 (49)**
Derby	**26 (<1)**	**8661 (47)**	**25 (<1)**	**8,712 (47)**
Eagle	**1782 (10)**	**10,832 (60)**	**1473 (8)**	**14,087 (78)**
Nahahum Canyon	**0**	**0**	**1.0 (<1)**	**1.0 (<1)**
Ollala Canyon	**160 (<1)**	**7880 (34)**	**200 (<1)**	**8,240 (37)**
Tumwater Canyon	**0.1 (<1)**	**0**	**484 (2)**	**484(2)**
Total	4715 (2)	48,542 (24)	2184 (1)	55,441 (27)

* primarily shelterwood and commercial thin prescriptions, also salvage and regeneration cuts with reforestation.

** Limekiln, Switchback, Eagle-Blag, and Upper Hay Canyon Allotments.

*** Fires > 25 acres: Tumwater (2014), Tumwater Canyon (2011) Hay Canyon (2014), Eagle (2013)

Harvest activity on NF lands in the watershed equates to 2% of the total watershed acres and 10% or less in each subwatershed, thus indicating an ECA of <15%. Human-caused fires (primarily the Fischer Fire) have burned 22,527 acres in the lower watershed (downstream of Leavenworth) or 11% of the 10th field HUC. When human-caused fire is aggregated with other human caused disturbances in the watershed, an ECA >15% is reported in Table 18. Although human-caused, the Fischer Fire acted "naturally" in terms of fire pattern and behavior and restored fire regime and landscape processes on affected acres in the Ollala and Derby subwatersheds (16,300 acres) post suppression and Burned Area Emergency Rehabilitation activities, therefore we consider ECA to be <15% in the 10th field HUC.

Current grazing practices in the watershed occur on upper slopes, mostly outside of riparian areas. The Eagle-Blag and Swithcback Allotments are permitted 1000 ewe/lamb pairs each, for a 78-day season of use from approximately May 15 – July 31. The Limekiln Allotment is a 15-day trailing permit. The sheep are trailed primarily on existing roads and bed at landings and meadows in the watershed. The few stream crossings that occur are often on existing roads located in the upper watershed, where streamflow is very small. Sheep grazing is monitored to ensure that utilization standards are not exceeded and therefore is not expected to alter vegetative seral stage.

Even though recent disturbance on NF lands in the upper Wenatchee (Tumwater and Chiwaukum subwatersheds) appears <15% ECA and the River above Leavenworth is considered capable of absorbing large scale disturbances such as 100 year floods (USFS 2006), channel complexity and riparian condition have been altered from historic log drives and floodplain/streamside development resulting in reduced riparian and wetland connectivity, reduced high flow refuge, reduced sinuosity and side channel development, reduced LWD (single pieces and complexes), reduced pool frequency, and a reduction in channel roughness.

Overall the Wenatchee watershed is considered to be not properly functioning. Anthropogenic factors affecting the lower Wenatchee basin are similar to those affecting the upper Wenatchee, mainly private land development, timber harvest on both private and federally owned lands, orchards and associated land conversion (especially adjacent to the Wenatchee River), municipalities, and railroad and road building in the form of federal highways, county roads, and logging roads. Of these, railroad building and road building, orchard development and the establishment of municipalities have had the largest affects by decreasing floodplain width and reducing access to side channels, with a resulting decrease in diverse fish habitat and changes in hydrologic function of these areas.

Riparian Reserves

Beaver-Wenatchee, Tumwater, and Lower Wenatchee (Olalla, Nahahum) subwatersheds: Riparian areas in the upper watershed have been fragmented by roads, and vegetation clearing for private development and agriculture. Restoration efforts in the Beaver Creek watershed have improved 0.2 acres adjacent to the upper Wenatchee River from 2010-2012. Riparian areas within the lower watershed have been fragmented and degraded by the development of roads, orchards and residential areas. This indicator is considered not properly functioning.

Chiwaukum subwatershed: Due to US 2 paralleling Skinney Creek for most of its length affecting shade and LWD recruitment, this subwatershed is considered functioning at risk. Recent restoration will help with riparian condition but the site revegation is currently ongoing.

Chumstick and Eagle subwatersheds: Most of the Chumstick Creek valley bottom and riparian areas of the few perennial tributaries are in private ownership. Development, road building, logging and grazing have fundamentally altered the entire riparian area. The lower five miles of Eagle Creek's riparian area is located on private lands and rural/urban development, roading, and logging have fundamentally altered more than half of the valley bottom. Upslope riparian areas in the headwaters and tributaries are altered by dense road densities, grazing, and previous logging practices. Although 2010-2014 restoration efforts have restored 2.5 acres in Chumstick and 1.6 acres in Eagle Creek watersheds, overall, the Chumstick and Eagle Creek subwatersheds are not properly functioning.

Derby subwatershed: As a result of riparian roads, riparian harvest, and private development and agriculture within riparian areas, Derby Creek is not properly functioning in terms of riparian reserves.

Wenatchee HUC 10 summary: not properly functioning.

Disturbance Regime

The primary disturbance processes are fire and debris slides. Most of the watershed (Tumwater, Chumstick, Derby, Eagle, Ollala, and Nahahum subwatersheds) is considered to be in a Fire Regime Condition Class 1 and 2[3]. Beaver, Chiwaukum, and small, isolated acreages in Tumwater, Chumstick, and

[3] There are three classes that define the amount of departure from the natural (historical) fire regime. Class 1=low,

Derby are considered to be in Fire Regime Condition Class 3, meaning that the composition and structure of vegetation and fuel are highly altered and the risk of loss of key ecosystem components is high.

Mass wasting is more likely to occur after high intensity fires, rain on snow events, or high intensity thunderstorms. The location of mass wasting is more likely to occur along the steep slopes in the weaker incompetent beds usually associated with shale.

Management activities in the watershed such as fire suppression and vegetative conversion through past logging practices have influenced natural disturbance regimes. Despite recent project fires in the watershed (see Table 25 below) only 18% of the HUC 10 Wenatchee watershed has burned. Vegetation management projects designed to reduce the effects of wildfire (see Table 24 above) have affected only 2% of NF lands in the HUC 10 watershed, the potential for uncharacteristic fire still exists in much of the watershed.

Table 25. Fire History (2000-2017) in the Wenatchee River HUC 10 Watershed.

HUC 12 Subwatershed	Fire Name* and Year	Acres burned in subwatershed	% Subwatershed Burned
Tumwater	Icicle Complex 2001	779	4
	Chiwaukum 2014	2642	9
	Tumwater 2014	492	2
	Tumwater Canyon 2011	458	2
Eagle	Fischer 2004	117	<1
	Eagle Creek 2013	1465	8
Derby	Fischer 2004	5872	32
Ollala	Fischer 2004	10,428	48
	Hay Canyon 2014	200	<1
Nahahum	Easy Street 2007 Nahahum 2010	4238 1947	14 6
Chiwaukum	Chiwaukum 2014	10,826	35
Total		39,464	

* Only Fires > 25 Acres are Listed.

How an "uncharacteristic" fire in the Wenatchee watershed would behave is not known; short term negative effects are likely but long term effects to aquatic habitat and species may not be negative

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Class 2= moderate, and Class 3=high. Furthermore, risks to key ecosystem components (native species, large trees, soil) are also associated with the low, moderate, and high condition class ratings (6/20/2003).

because habitat connectivity is good in the watershed and populations are not isolated. Furthermore, fire has the potential to deliver LWD in deficient reaches.

Natural riparian and stream channel processes are negatively affected by floodplain development and roads throughout the Wenatchee watershed. Further, mass wasting and debris flow events are likely intensified due to road networks increasing the frequency and magnitude of debris slides and floodplain development limiting the capacity to absorb effects.
Wenatchee HUC 10 summary: functioning at risk.

Integration
Valley and floodplain development as well as high road densities have had a lasting negative effect on the condition of the Wenatchee watershed, contributing to poor water quality and limiting potential to develop diverse instream habitats that are resilient to disturbances.

Stream channel confinement by roads, railroads, municipalities, and other infrastructure or development has affected the ability of the mainstem Wenatchee River, Beaver Creek, Chumstick Creek, Eagle Creek and Derby Creek to migrate across and within their floodplains; a critical process for large wood input, side channel formation, pool development, wetland formation and maintenance, riparian function and development, and temperature regulation.

Further, habitat diversity is impacted by reduced flood energy diffusion, reduced channel length, reduced off-channel refugia, and reduce channel resiliency to extreme flood events.

Current conditions in the Wenatchee watershed have a negative impact on ESA listed fish in this assessment: Adult passage and connectivity is impacted by passage barriers, water quality and flow. Spawning is impacted by temperature, sediment, channel dynamics, and watershed conditions. Juvenile rearing habitat is negatively impacted by virtually every habitat parameter assessed. Perhaps the greatest risk to juvenile abundance is the isolation and reduced passage into oxbows, wetlands, side channels, and other key habitats.

Recent restoration efforts in the watershed, that are addressing passage barriers, riparian vegetative condition, and off-channel habitat, are improving these individual parameters at the project and reach scale however, more work is needed to determine if each of these individual actions have a cumulative effect on the overall watershed condition. At this time fish populations and watershed/habitat conditions are not properly functioning in the Wenatchee HUC 10 watershed.

Wenatchee HUC 10 summary: not properly functioning.

White River- Little Wenatchee (HUC 1702001101)

The environmental baseline was last updated in the USFS 2004 *White River Road Relocation and Bank Stabilization Project.* This analysis includes an update to baseline conditions and an analysis of effects for the proposed action. The effects analysis is focused on those elements of the environment identified by the USFWS in the documents titled *A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual of Grouped Actions at the Bull Trout Subpopulation Watershed Scale* (USFWS 1998) and *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (1996) prepared by NOAA Fisheries.

The last described environmental baseline:

- White River: *White River Road Relocation and Bank Stabilization Project (2004)*
- Lake Wenatchee: *Camp Zanika Lache Conversion from Septic to PUD Sewage System (2002)*
- Little Wenatchee: *Little Wenatchee Baseline Update (2001)*

Although impacts were identified for multiple matrix indicators, the magnitude or intensity of impacts is not expected to shift indicator trends at the HUC5 scale. Table 26 considers the effects of these actions that have occurred since the last baseline updates, to report the current condition in the White River-Little Wenatchee River watershed.

Table 26. Federal Actions in the White River-Little Wenatchee Watershed since 2004

Project Type	Location(s) Subwatershed (HUC12)	Description(s)	Dates Implemented	Impacts to Matrix Indicators
Special Use Permits- Rec Residence	Lake Wenatchee	**2008 Goetz South Shore Rec Residence Waterline Woodshed Improvements** **2008 Cook South Shore Rec Residence toilet & waterline improvements** **2013- South Shore Rec Residence Boat Dock** **2013- Lake Wenatchee Water District Upgrade** **2015 Renner South Shore Rec Residence Septic & Structural Improvements** **2014- Almy North Shore Rec Residence Lot 5 cabin removal** **2016 Wetherald South Shore Rec Residence- water system outhouse storage improvements** **2017- South Shore Lot #27 – holding tank**	2008-2018	No Effect or Insignificant/Discountable

		2018- Amaro/Schachter South Shore Rec Residence- cabin rebuild		
Road Maintenance (ERFO)	Middle Little Wenatchee Lower White River Upper White River	**FR 6200-1.8-** (1000 ft.) Filled eroded areas in road prism, installed two drivable dips **FR 6200-2.5-** (1800 ft.) Replaced eroded subgrade material and surfacing, reconstruct permeable fill and install 3 drivable dips to direct water off the road. **FR 6200-3.0**- (180 ft.) Filled eroded areas in road prism, installed one drivable dip & replaced eroded culvert **FR 6503 –0.7**. (1175 ft.) Replaced eroded fill material and surfacing and added a dip just below existing CMP.	2016-2017	Insignificant/Discountable
Misc. Programmatic Projects	Lake Wenatchee Upper Little Wenatchee River Lower Little Wenatchee River Lake Creek Lower White River Upper White River	**2013 Lake Wenatchee Storm Damage Hazard Trees** **2014- Little Wenatchee MCH Application** **2011-2019 Campground Hazard Trees** **2017-2019 Trailhead Hazard Trees**	2013-2019	Insignificant/Discountable
Trail Relocation	Upper Little Wenatchee	**2010 Little Wenatchee Trail Relocation-** Relocated 1 mile of trail #1525 to reduce resource damage; trail had become braided & rutted due to location. Rehabilitated abandoned trail section.	2010	No Effect
Wildfires	Lower White River Lake Creek Upper Little Wenatchee Indian Creek	**2012 Sears Creek Fire**- 654 acres in Lower White River subwatershed **2014 Shoofly Fire:** 163 acres subwatershed breakdown: • 161 Lake Creek • 2 Upper Little Wenatchee **2016 Saul Fire**: 464 acres subwatershed breakdown: • 440 Indian Creek • 24 Upper White River	2012-2016	Short term negative impacts to *Sediment/Turbidity, Chemical Contamination/Nutrients, Substrate Embeddedness, and Pool Frequency/Quality, ,Change in Peak/Base Flows*.

				Long term negative effects on *Large Woody Debris, Riparian Reserves*.
Land Acquisition / Conservation Easements	Lower White River	**White River Bjorgen Land Acquisition (CDLT):** The Land Trust acquired this 60 acre property within White River floodplain encompassing 0.5 miles of streambank, between RM 3 & 5. Purchase preempts any future land development. **2006** **White River Kincaid Land Acquisition (CDLT):** The Land Trust acquired a 53-acre property within White River floodplain encompassing 0.74 miles of streambank, between RM 1 & 2. Purchase preempts any future land development. **2006** **White River Martin Land Acquisition (CDLT):** The Land Trust acquired a 53-acre property within White River floodplain encompassing 48 acres in floodplain and 0.6 miles of streambank, between RM 3 & 4. Purchase preempts any future land development. **2005** **White River Nason View Land Acquisition (CDLT):** The Land Trust acquired fee title to 117 acres within White River floodplain containing 1.2 miles of streambank, between RM 4.25 & 5.4. Purchase preempts any future land development. **2009-2012** **White River Quintana Leon Land Acquisition (CDLT):** The Land Trust acquired 85.4-acre property within White River floodplain and 1.3 miles of streambank between RM 1.5 & 3. Purchase preempts any future land development. **2006-2008** **White River Tiegel Land Acquisition (CDLT):** The Land Trust acquired an 8.3-acre property within White River floodplain. Purchase preempts any future land development. **2008** **White River (and Little Wenatchee) Two Rivers Land Acquisition (CDLT):** The Land Trust acquired a 127-acre property within floodplains: 0.32 miles of riverbank along White River and 0.4 miles along Little Wenatchee River. Purchase preempts any future land development. **2006**	2005-2014	Potential for long term positive impacts to indicators: *Streambank Condition Off-channel Habitat, Floodplain Connectivity, Riparian Reserves, Disturbance History, Disturbance Regime*

		White River Martin Land Acquisition (CDLT): Th**e** Land Trust acquired a 53-acre property within White River floodplain encompassing 48 acres in floodplain and 0.6 miles of streambank, between RM 3 & 4. Purchase preempts any future land development. **2005** **White River Tall Timber Ranch Conservation Easement (CDLT):** Conservation easement on 60 acres of intact unconfined floodplain, channel migration zone and riparian buffer on the White and Napeequa Rivers. The easement protects 2.3 mile of streambanks on White River and 0.1 miles on Napeequa River by eliminating development rights and restricting other uses so as not to conflict with habitat conservation values.**2009-2014** **White River RM 8.5 & 9 Conservation Easements (CDLT):** Conservation easement on 53.7 acres with 52.7 of those acres in riparian, floodplain and wetlands. The easement protects 1.2 miles of streambanks by eliminating development rights and restricting other uses so as not to conflict with habitat conservation values**. 2010-2012**		
Riparian	Lower White River	**Napeequa and White River Riparian Planting**	2011	Long term positive impacts to indicators: *Riparian Reserves*
Large Wood Projects	Lower White River	**2014 Wood Atonement White River (CCFEG)**- Added 28 LWD structures over 1.6 miles to improve channel complexity **2011 White River Log Jam (USFS/CDLT):** A section of White River streambank in the vicinity of Tall Timbers Ranch was armored and planted with native vegetation as part of the White River Log Jam project. The eroding bank were improved by armoring with three engineered log jams, located along a 320-foot long segment of FS 6400.	2011-2014	Long term positive impacts to indicators: *Streambank Condition, Pool Frequency/Quality,*

Table 27. Overview of the Environmental Baseline Conditions in White River-Little Wenatchee watershed.

INDICATORS	White River- Little Wenatchee River HUC 10		
	PF	FAR	NPF
Water Quality			
Temperature			X
Sediment	X (Little Wen and White R)	X (Lake Wen)	
Chemical Contaminants/Nutrients	X (White R)	X (Lake Wen and Little Wen)	
Habitat Access			
Physical Barriers	X (Little Wen)	X (White R and Lake Wen)	
Habitat Elements			
Substrate Embeddedness	X (Little Wen and White R)	X (Lake Wen)	
Large Woody Debris		X	
Pool Frequency/Quality	X (White R and Little Wen)	X (Lake Wen)	
Off-Channel Habitat	X		
Refugia	X		
Channel Condition and Dynamics			
Width/Depth Ratio	X		
Streambank Condition	X (Lake Wen)	X (White R and Little Wen)	
Floodplain Connectivity	X (Lake Wen)	X (White R and Little Wen)	
Flow/Hydrology			
Change in Peak/Base Flows	X (White R)	X (Little Wen and Lake Wen)	
Drainage Network/Roads		X	
Watershed Conditions			
Road Density and Location		X	
Disturbance History		X	
Riparian Reserves		X	
Disturbance Regime		X	

INDICATORS	White River- Little Wenatchee River HUC 10		
	PF	FAR	NPF
Integration of Species/Habitat Conditions		X	

Water Quality:

Temperature:

White River: The White River is listed for temperature concerns on the Washington State Water Quality Assessment as Category 2 (Waters of Concern) based on samples collected in 1998. Scholz (1999) showed a 7-day mean of maximum daily temperature of 15.8° C, with a maximum daily temperature of 16.8°C. Water temperature was monitored (June through October) in the White River from 1995- 2003. Temperatures recorded at all White River sites indicate exceedances of Forest Plan standards and State water quality standards (61° F maximum, and 7-day average maximum of 58° F) over the monitoring period.

Data from 1996-1998 at White River site 2 is problematic due to equipment failure, seemingly resulting in these values that exceed temperature standards. In 1998 however, data from adjacent streams also exceeded Forest Plan standards for the period that the White River probe was out of the water and it was concluded that the White River exceeded standards for the period July 13 to July 21 (1998 Temperature Monitoring Report). For the period 1998 - 2000, monitored streams showed a warming trend throughout the Wenatchee subbasin, with increases in days above standards for both maximum and seven - day average temperatures. Since little management thought to be critical to stream temperature, such as clearing of riparian vegetation and road building occurred throughout the subbasin, it is likely that the increasing in non-compliance days reflected a regional trend of warmer temperatures (2000 Temperature Monitoring Report). Since 1995, the White River has been the coldest stream monitored in the Wenatchee subbasin. Temperature exceedances in 2001 may be a result of drought conditions; during the 2001 monitoring season, the region was experiencing one of the lowest water years on record. Consequently most streams were experiencing low flows for longer periods of time when compared to an average year (2001 Temperature Monitoring Report). Another explanation for the temperature exceedances are a function of instrument placement and temperature stratification in the stream channel; meaning that the hobos have been placed in accessible locations on the stream margins that are shallower and out of the channel thalweg where more mixing occurs (Matt Karrer, personal communication).

Temperature measurements taken with handheld thermometers in other streams in the White River - watershed have not indicated water temperature problems. These measurements were taken over a period of a few days to a few weeks and not necessarily during peak temperatures; thus a temperature problem could exist that would not be discovered with this method.

The table below lists temperature data for streams not previously discussed (* indicates stowaway or omnidata continuous recording devices):

Stream	Max. Water Temp.	Dates Surveyed
Napeequa River	56 F*	August 10, 1996
Panther Creek	66 F	August 10-27, 1990
Panther Creek	53 F	September 5-6, 1991
Indian Creek	55 F	Aug. 25-28 and Sep. 7-9, 1993

A continuous temperature sampler was installed at White River near the mouth in 2012 and 2013 in order to characterize baseline flow conditions when temperature exceedances would be most likely to occur. The results showed a maximum temperature of 13.2°C (55.8°F) in 2012 and 13.7°C (56.7°F) in 2013 (Burgoon et al. 2014). The most recent temperature data (13ºC) described maximum temperatures rather than 7-day averages for maximum temperatures, but given the temperatures described, the 7 day averages would likely not meet standards described for incubation (2-5ºC) in the Northwest Forest Plan for bull trout. Based on available information, White River **is not properly functioning** for temperature.

Lake Wenatchee: Relatively little information exists on water quality and limnology for Lake Wenatchee. Water temperatures collected in 1955 from depths of ≤10 ft. indicated that the lake does not strongly stratify into a distinct warmer upper layer and a cooler lower layer but is subjected to high winds that apparently keep the waters well mixed throughout the year resulting in more homogeneous water temperatures and levels of dissolved oxygen and pH in the upper approximately 100 feet of the water column (CCNRD 2003).

A sockeye supplementation program funded by Public Utility District Number 1 of Chelan County (for the purpose of mitigation for lost fish production associated with hydroelectric power system development in the region) included a now defunct sockeye net pen program where Lake Wenatchee temperatures were investigated. It was noted that the ambient lake water temperature was 13°C - 17°C (55.4-62.6°F) during the early summer but increased to 21°C (69.8°F) by late summer and early fall (WDOE 2016). In extreme years (e.g., 1998), high water temperatures resulted in high adult mortality (33%) due to *Columnaris* and subsequent low fertilization rates (Tonseth et al. 2002).

Tributary stream temperature data is very limited, although most tributaries located on the south side of lake Wenatchee have high canopy cover, in general and likely have adequate temperatures. Hidden Creek, tributary to Lake Wenatchee had a mean water temperature of 46.4ºF on October 4, 2018 (Hall et al. 2019).

Based on the data described, Lake Wenatchee is **not properly functioning** for temperature.

Little Wenatchee: Although water quality in the Little Wenatchee River is protected by its forested and relatively unaltered watershed, the river has a history of high water temperatures. Temperature monitoring occurred annually on the Little Wenatchee River at river mile 6.5 from 1993-2003 (Figure

14). Monitoring has showed that water temperature exceeded 61° F in all recorded years. In 1998, stream temperatures exceeded both standards more often than in any previous year, the maximum temperature recorded was 69° F on August 4 and the seven day maximum average was 67.7° F on July 26. The maximum daily standard was exceeded 51 times while the seven day average was exceeded 67 times. Lake Creek also exceeded temperature standards during 1992 stream survey with a maximum recorded temperature of 68° F and a mean high temperature of 64° F.

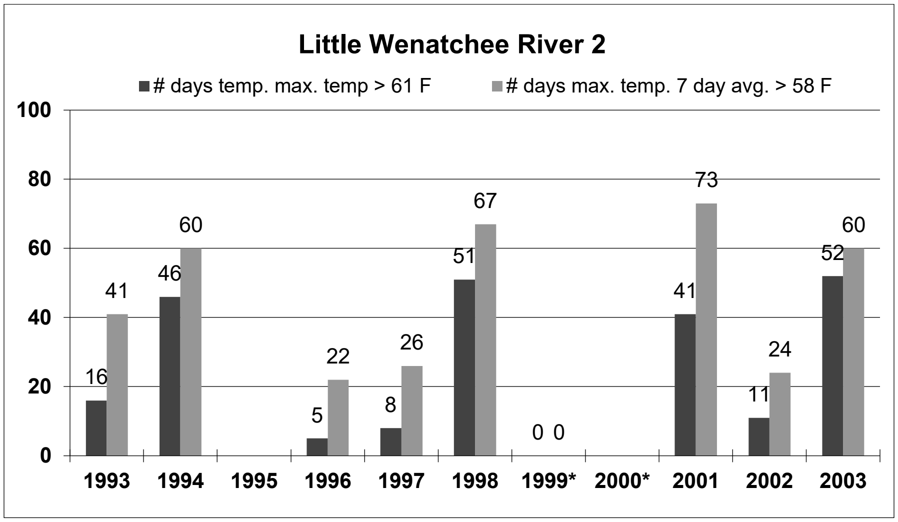


Figure 14. Water Temperature exceedances at river mile 6.5, Little Wenatchee River.

Summer water temperatures in Little Wenatchee River are warmer than Washington State water quality standards allow and do not meet Forest Plan standards, although it is unclear how much of this is natural. The Washington State Water quality Assessment lists Little Wenatchee River as Category 4a: Impaired waters that already have an EPA-approved TMDL plan in place that is being implemented (WDOE 2018). The Little Wenatchee River shows a 7-day mean of maximum daily temperatures shown in Table 28 taken from continuous measurements collected at station 6. A continuous temperature sampler was installed at Little Wenatchee near the mouth in 2012 and 2013 to characterize baseline flow conditions when temperature exceedances would likely occur.

Table 28. Little Wenatchee River Stream Temperatures.

Location	Year Sampled	Source	7-day mean of maximum daily temperature	Maximum daily temperature
Station 6	**2000**	**WDOE 2018**	16.8°C (62.2°F)	17.7°C (63.1°F)
Station 6	**2001**	**WDOE 2018**	17.7°C (63.1°F)	18.2°C (64.8°F)
Mouth of River	**2012**	Burgoon et al. 2014		16.4°C (61.5°F)
Mouth of River	**2013**	Burgoon et al. 2014		16.7°C (62.1°F)

Little Wenatchee River exceeds all standards (WA state, Wenatchee Forest Plan and Northwest Forest Plan) for all years shown in Table 28. Based on available information, Lake Creek and mainstem Little

Wenatchee River temperatures are estimated to be **not properly functioning** during the summer months.

Little Wenatchee-White River Wenatchee HUC 10 summary: not properly functioning

Sediment/Substrate Embeddedness

White River: The White River is a glacial system and is expected to produce periodic pulses of sediment. Two Wenatchee watershed reports (Hindes 1994, Davis 1996) collected information on turbidity in the White River. In reports, data was collected once a month at the Sears Creek Bridge, on the White River. Data was collected from October 1992 to September 1993 and again from August 1995 to May 1996. During the 22 months that data was collected, two turbidity spikes (values ≥ 5 NTU) were noted. One (7.1 NTU), was during peak spring runoff (May 1993), and the second was 8.5 NTU measured in September 1995. Neither of these events is outside normal processes of the watershed; July and August turbidity measured 4.7 and 4.8 respectively in 1993, in comparison turbidity in the Chiwawa River measured 0.7 and 0.9 for the same period, and Nason Creek measured 0.5 and 0.6.

In addition to glacial flour, the White River moves alluvial deposits through natural channel migration that averages 1.3 feet per year (see Streambank Condition). The Forest Service has collected little fine sediment data for the White River watershed. Our stream survey data estimated percent embeddedness (1989-1993) or included Wolman pebble counts of bankfull substrate composition at representative riffles (1994-1998). Neither of these techniques directly addresses percent fines however, Wolman pebble count data will be presented here (see substrate below for embeddedness). Wolman pebble counts as part of the stream survey report percent fines <2.0mm.

McNeill core sampling was conducted in 1991 and 1993 at various locations on the White River. This method reports fines <1.0mm. The data reported in the table below is from the 1998 Sediment Monitoring Report for Lake Wenatchee and Leavenworth Ranger Districts with the mean calculated over the reach.

In 1997, a hydrological survey was conducted on the upper White River representing an undisturbed depositional reach of stream. A Wolman pebble count at this site reports percent fines <6.0mm. There is also initial and resurvey data for the upper White River near the Indian Creek confluence. The 1996 survey was conducted after the record 1995/96 flood.

Table 29. Fine Sediment data for White River watershed.

STREAM	6TH FIELD HUC	CHANNEL TYPE	LOCATION	YEAR	METHOD	FINES
White River	Upper White River	C5	below Napeequa	1993	McNeil Core	21.4% <1.0mm
White River	Upper White River	C4/C2b	above Napeequa	1993	McNeil Core	14.2% <1.0mm
White River	Upper White River	C4/C2b	Reach 1	1997	Wolman	12% <2.0mm
White River	Headwaters White	C3	above Indian Cr	1995	Wolman	12% <6.0mm
Panther Creek	Panther	B3	on the fan	1997	Wolman	6.5% <6.0mm

Napeequa River	Napeequa	C4	Reach 1 (1996 survey)	1997	Wolman	13.5% <6.0mm
White River	Headwaters White	C3	above Indian Cr	1996	Wolman	0% <6.0mm

The table above suggests acceptable fine sediment levels throughout the White River watershed based on channel type, location (disturbed in lower watershed, undisturbed in upper watershed and headwaters), and geology (White River is a glacial system).

Recent wildfires (2012 and 2016) affected 1,118 acres, and elevated sediment loading over the short term. Any longterm impacts are discountable as ground cover begins reestablishing within the first year and is fully established within 2-3 years. Based on available information, White River is properly functioning for sediment.

Lake Wenatchee: Nason Ridge and Dirty Face Mountain are dissected by numerous high gradient, low order, intermittent streams that are considered transport reaches that deliver wood, sediment, and water rapidly downstream. Perennial tributaries to Lake Wenatchee are characterized by step-pool morphologies and are still considered transport reaches however, bedrock nick points and accumulated wood and/or sediment serves as the steps in the stream profile. The slope and energy of these tributaries flush fine sediments through rapidly. In the Mainstem Wenatchee Watershed Analysis (1999), road density and timber harvest are highlighted as major contributors to increased fine sediment production. Although road density is high in the Lake Wenatchee sub-watershed (2.3 miles/sq. mile), a significant proportion of these roads are paved county and state highways that traverse both shores of Lake Wenatchee.

Elevated sediment loads may be occurring from the increased development of land in the watershed. Visual surveys of the shoreline located several areas where high stormwater flows transport sediment into the lake and spots where landslides caused heavy sediment loads to the lake. Some landslide loadings appear to be associated with clearing of land for development. Lake Wenatchee subwatershed is estimated to be functioning at risk for the sediment indicator.

Little Wenatchee: The Little Wenatchee River is situated in the lower reaches of a glacially carved U-shaped valley but does not receive glacial melt water and it is therefore less turbid than the White River. However, sediment loads in the Little Wenatchee River from mass wasting are high, although it is unknown if this is related to natural flood-related pulses or if the rate of sediment loading is accelerated (USFS 1998). In addition, a gravel and sand mine located adjacent to the lower reach of the Little Wenatchee River is a testimony to the historical deposition of sediments in the river floodplain. In spawning areas, Matrix standards require that surface fines ≤6 mm cannot exceed 20% of the substrates; overall embeddedness values also cannot be greater than 20%.

McNeill core sampling was conducted in 1991 and 1993 at various locations on the Little Wenatchee River. This method reports fines <1.0mm. The data reported in the table below is from the 1998 Sediment Monitoring Report for Lake Wenatchee and Leavenworth Ranger Districts and the mean is calculated over the reach.

In 1997, hydrological surveys were conducted on the upper Little Wenatchee, Cady Creek, and Lake Creek representing undisturbed depositional reaches of stream. Wolman pebble counts at these sites report percent fines <6.0mm. The 1996 survey was conducted after the record 1995/96 flood.

The following table reports the available data by channel type.

STREAM	6TH FIELD HUC	CHANNEL TYPE	LOCATION	YEAR	METHOD	FINES
L.Wen.River	Lower L.Wenatchee	C4	RM 4.0	1993	McNeil Core	13% <1.0mm
L.Wen.River	Lower L.Wenatchee	C4	RM 3.5	1991	McNeil Core	17.2% <1.0mm
L.Wen.River	Lower L.Wenatchee	C4	RM 7.0	1991	McNeil Core	28.7% <1.0mm
L.Wen.River	Lower L.Wenatchee	C4	RM 9.5	1993	McNeil Core	13% <1.0mm
L.Wen.River	Upper L.Wenatchee	C4	Reach B	1997	Wolman	13% <2.0mm
L.Wen.River	Upper L.Wenatchee	F1	Reach C	1997	Wolman	8% <2.0mm
L.Wen.River	Upper L.Wenatchee	C4	Reach D	1997	Wolman	10% <2.0mm
L.Wen.River	Upper L.Wenatchee	B2/F1	Reach E	1997	Wolman	11% <2.0mm
L.Wen.River	Upper L.Wenatchee	B3	Reach G	1997	Wolman	6% <2.0mm
L.Wen.River	Upper L.Wenatchee	B3	Reach H	1997	Wolman	9% <2.0mm
L.Wen.River	Upper L.Wenatchee	B2	Reach I	1997	Wolman	4% <2.0mm
Lake Creek	Lake Creek	C3	RM 3.0	1997	Wolman	10% <6.0mm
Lake Creek	Lake Creek	C3	RM 3.5	1997	Wolman	4% <6.0mm
Cady Creek	Headwaters L.Wen	C4	RM1.5	1997	Wolman	8% <6.0mm
Cady Creek	Headwaters L.Wen	C4	Reach 2	1995	Wolman	9% <2.0mm
L.Wen.River	Headwaters L.Wen	C4	RM 20.0	1997	Wolman	15% <6.0mm
L.Wen.River	Headwaters L.Wen	C3	RM 20.1	1997	Wolman	8% <6.0mm
L.Wen.River	Headwaters L.Wen	C3	RM 20.2	1997	Wolman	1% <6.0mm

In Little Wenatchee undisturbed C channels (headwaters Little Wenatchee) range between 1 and 15% fines <6.0mm (one measurement of 9% fines <2.0mm). Data from C4 reaches in the lower watershed show higher fines than the undisturbed reaches in the headwaters and this can be expected not only from management impacts but through natural sediment accumulations from the upper watershed. Aerial photo history (1949 through 1992) indicates these lower reaches of Little Wenatchee have always been sediment rich (White-Little Wenatchee W.A. 1998). Visual observations suggest Little Wenatchee River Reach B and D may have elevated levels of fine sediment based on evidence of pool filling, embedded gravels, high percentage of sand/silt substrates, medial bars, and sections of braided channels (1997 stream survey). In the Little Wenatchee River, Rosgen F and B type channels function as transport reaches. They are typically bedrock, boulder, and cobble riffles with infrequently spaced plunge pools and numerous pocket pools. Sediment may be temporarily stored in pools however increased gradients and reduced sinuosities in these channel types are quite efficient at flushing fines through. Fine sediment is not judged to be problematic in these channel types, with the exception of Rainy Creek (Rosgen B3 channel). Although we have no fine sediment data for Rainy Creek, high and possibly accelerated rates of debris flows (Driscoll, 1996) coupled with channel types which are sensitive to high bedload movement have resulted in channel scouring and increased deposition across the fan after two major flood events (1990, 1995/96).

Wolman pebble count data from Reaches 1-4 show that fines range from 3-20%, averaging 12% from the complete surveyed section (USFS 2000). The Wolman procedures also indicate that cobble embeddedness was an issue in Reach 2 and especially in Reach 3; embeddedness cobbles in Reach 4 ranged from 6-15%. A hydrological cross-section conducted in August 1996 (at Lost Creek) revealed that 7% of the cobbles in Reach 3 were embedded at the time (USFS 1996). For spawning gravels, Reaches 1-4 appear to be within the acceptable Matrix range for fines ≤6mm; data at hand suggest that the range of cobble embeddedness also falls within Matrix and Forest Plan standards and that reaches 1-4 are functioning appropriately. A future increase in fines for Reaches 2 and3, however, may be a cause for concern.

Based on Wolman survey data, both the Little Wenatchee and White Rivers are meeting sediment standards and properly functioning, while Lake Wenatchee is rated as functioning at risk due to increased land development along the lake perimeter.

Little Wenatchee-White River Wenatchee HUC 10 summary: Little Wenatchee and White River are **properly functioning** and Lake Wenatchee is **functioning at risk.**

Chemical Contaminants/Nutrients

White River: Older data for water quality of the White River has been obtained from two Wenatchee Watershed reports, Hindes (1994) and Davis 1996. In both reports, data for the White River was collected once a month at one site, the Sears Creek Bridge, on the White River. Data was collected from October 1992 to September 1993 and again from August 1995 to May 1996. During this time, three pH readings were lower than is acceptable. In May 1993 the pH was measured at 6.28, November of 1995 it was 6.35 and in January 1996 the reading was 6.12. The May 1993 and January 1996 values were taken during peak spring runoff and during a rain-on-snow flood event respectively. More recently, a total of seventeen samples were taken in 2002, 2007 and 2008 indicated that one sample from 2002 showed low PH (WDOE 2018). A high fecal coliform reading in September 1993 is considered an anomaly (a probable sampling error).

The dissolved oxygen (DO) level was below State water quality standards (8.0 ppm) once during the 22-month study (August 1996 at 7.7 ppm) and again in 2002. The 1996 reading occurred in late summer-early fall low flows when water temperatures were at their annual peak. To protect the designated aquatic life use of "Char spawning and rearing," the lowest 1-day minimum oxygen level must not fall below 9.5 mg/l more than once every ten years on average. The Washington State Water Quality Assessment lists White River as Category 2 (Waters of Concern) for DO since excursion of the criterion has been documented, but fewer than three excursions exist from all data considered (WDOE 2018).

Recent wildfires (2012 and 2016) affected 1,118 acres, and elevated sediment and ash loading over the short term. No long-term impacts are expected. Based on available information, White River is considered functioning properly.

Lake Wenatchee: Lake Wenatchee is listed as an impaired waterbody for Polychlorinated Biphenyls (PCBs) which was found in two samples of fish (cutthroat trout and northern pikeminnow) in 2010. Rated as not properly functioning.

Little Wenatchee: Little Wenatchee River is listed as a category 4a stream for oxygen in the current State Water Quality Assessment (WDOE 2018) based on samples collected in 2002 and 2008. Ten percent or more of the samples collected in a single year were excursions of the criterion, and at least 3 excursions exist from all data considered.

Both Lake Wenatchee and Little Wenatchee River have impaired water chemistry. Lake Wenatchee with a PCB impairment and Little Wenatchee with low oxygen levels. Since both are on the current 303 (d) list, they are considered not properly functioning.

Little Wenatchee-White River Wenatchee HUC 10 summary: not properly functioning (Little Wenatchee and Lake Wenatchee); White River is **properly functioning.**

<u>**Habitat Access**</u>

Physical Barriers

White River: Culvert barriers have been identified in the White River watershed (USFS Culvert Inventory, 2000) on fish-bearing streams with potential anadromous habitat however, access for and use by spring Chinook, bull trout, rainbow trout (including redband and steelhead) or westslope cutthroat trout has not been determined. These barriers are located on FS road 6403 at milepost 0.3 and 0.7 which block access to 0.75 miles of habitat for westslope cutthroat trout. The FS road 6404 system at Sears Creek blocks 1.5 miles of habitat for juvenile and adult bull trout and steelhead. Two culverts barriers on the 6404 road were removed and passage restored in 2002 during implementation of the Oxbow project. No other anthropogenic barriers are known to be present in the White River watershed. There are several natural barriers in the White River watershed. The White River Falls, located above Panther Creek, is a barrier to migrating fish (1997 White River Report). Panther Creek has a series of 30 to 40 foot waterfalls, 0.7 miles upstream from its confluence with the White River (1991 Panther Creek Report); there are ten upstream passage barriers in the first 1.1 miles of Indian Creek (1993 Indian Creek Report); and the Napeequa River has a 15 foot waterfall barrier 2 miles upstream from its confluence with the White River (1996 Napeequa River Report).

Although fish passage through White River is good overall, three culverts in the watershed have been determined to block access to 0.75 miles of stream habitat for westslope cutthroat trout and 1.5 miles of habitat for steelhead and bull trout. These culvert barriers affect fish passage in portions of the watershed therefore; habitat access is determined to be functioning at risk in the White River watershed.

Lake Wenatchee: There are no barriers to salmonid migration on Lake Wenatchee; both the outlet and inlets are free flowing. Tributaries to Lake Wenatchee are steep and there are likely gradient barriers within the first 0.5 miles of each tributary. Anthropogenic passage barriers were identified on one of the four primary tributary streams to Lake Wenatchee that were surveyed in 2019 (Hall et al. 2019). Barnard and Plainview were determined to be intermittent while Fall and Hidden Creeks exhibited perennial flows. Cursory surveys were performed on the lower section of Fall Creek visible from the Lake Wenatchee Highway. A culvert was found under the Lake Wenatchee highway that was determined to be a barrier to fish passage, which is located downstream of USFS land. The culvert had a jumping distance of 0.98 feet. Additionally, large waterfalls were observed upstream from the road on the hillslopes that drain into Fall Creek that would be an anadromous barrier on non-USFS property. Hidden Creek was determined to not be high potential fish habitat due to the steep gradients. The reach ranged in gradient from 8% to 32% and surpassed the determined gradient barrier of 20% for 525 feet. It is unknown whether barriers exist on tributaries where they cross private lands due to culverts or other obstructions. Similarly it is unknown whether listed fish use these tributaries for spawning and rearing. One anthropogenic barrier has been identified to date in potential fish habitat and there are possibly other barriers on private lands, primarily on the north shore; therefore the subwatershed is considered to be functioning at risk.

Little Wenatchee River: Potential natural barriers occur in the Wenatchee River system. The Little Wenatchee River Falls is located eight miles upstream from Lake Wenatchee and is a barrier to upstream migration of at least some fish species (1997 Little Wenatchee Report). Steelhead can ascend the Little Wenatchee River to at least Little Wenatchee Falls. Seven waterfalls and three chutes are located in Reach 2 of Rainy Creek (1991 Rainy Creek Report); Snowy Creek has five waterfalls (1991 Snowy Creek Report); Fall Creek has 77 falls and chutes within its two reaches (1995 Fall Creek Report); Lake Creek has a ten-foot barrier falls approximately 900 feet upstream of its mouth (1992 Lake Creek Report); and Cady Creek has a six foot barrier falls 200 feet upstream from its confluence with the Little Wenatchee River (1995 Cady Creek Report).

No anthropogenic barriers are present in the Little Wenatchee watershed and therefore it is considered to be properly functioning**.**

Little Wenatchee-White River Wenatchee HUC 10 summary: functioning at risk (White River and Lake Wenatchee); **functioning properly** (Little Wenatchee).

Habitat Elements

Substrate Embeddedness

Addressed with Water Quality; Sediment.

Large Woody Debris

White River: Historic use of White River included log drives, which necessitated log and log jam removal during the early 1900's. Currently, wood that accumulates upstream of the Little Wenatchee Road Bridge is removed and taken offsite to protect the bridge from damage. As part of a reach survey of the lower 5.5 miles of White River, it was noted that there were indications of new wood recruitment of small pieces but the sizes observed were generally too small in terms of individual piece size and overall volume were insufficient to establish persistent log jams or to re-engage the floodplain (Herrera 2014)

Additionally past timber removal in the floodplain over the last 30 years has severely limited LWD that would be available for recruitment into the channel; existing adjacent forests are comprised of younger trees. When compounded with the regular removal of upstream sourced LWD above the White River bridge, few large logs are available to recolonize the lower section of White River. Projects specifically designed to add LWD back into the White River include the addition of 28 instream structures over 1.6 miles in 2014 and in 2011 a section of White River eroding bank was improved by armoring with three engineered log jams, located along a 320-foot long segment of FS 6400.

The White-Little Wenatchee watershed analysis (1998) showed that LWD abundance was a function of geomorphic subsection, channel type, climax vegetation zone, and size class of riparian overstory. The analysis indicates that White River channels may be comparable to Little Wenatchee, Chiwawa, Nason, and Icicle channels in terms of processes and range of natural condition. Analyses of these Wenatchee Highlands streams indicate the typical range is 70-160 in alluvial channels, 15-200 in bedrock channels, and 20-200 in other channels (categorized by vegetation; TSME/TSHE or ABAM).

Several reaches in lower White River (see Table 30) had relatively low amounts of LWD, as did Napeequa River below the falls. White River below Panther Creek and Napeequa River below the falls may be below their historic condition for LWD abundance due to historic cedar logging, and private development in the valley bottoms.

Table 30. LWD summary from USFS Stream Surveys

Stream	Reach	Year	Channel Type	LWD >12" diam/mile	Includes Potential LWD
Lower White River	3	1992	alluvial	35	yes
White River	1	1997	alluvial	56	no
Lower White River	2	1992	alluvial	65	yes
Lowest White River	1	1992	alluvial	70	yes
Indian Creek	2	1993	alluvial	74	55% potential
Lower White River	1	1992	alluvial	96	yes
Napeequa River	Subreach C1	1996	Alluvial	22	No
Napeequa River	Subreach C2	1996	Alluvial	68	No
Panther Creek	1	1990	bedrock	96	yes
Indian Creek	1	1993	TSME/TSHE*	25	60% potential
Indian Creek	3	1993	TSME/TSHE	31	53% potential

Upper White River	2	1992	TSME/TSHE	81	yes
Upper White River	1	1992	TSME/TSHE	113	yes
White River	2	1997	ABAM	27	no
Napeequa River	Subreach B1	1996	ABAM	27	no
* Personal knowledge of this stream places it in the bedrock category.					

Differences between these channel types are clearly linked to geomorphic processes. Alluvial channels have the greatest LWD abundance which may be linked both to high input rates from banks through lateral migration and to high capacity for LWD storage in the wider floodplains. Low LWD abundance in bedrock channels is likely due to both low retention and low recruitment from the banks. LWD abundance is intermediate in the "other" channel categories (Rosgen B channels ranging between plane-bed and step-pool morphologies). Wood recruitment is typically through pulsed events, wood is delivered via mass wasting, wind throw, or tree mortality, this can be from the nearby bank or transported from upstream.

When channel type and vegetative zone is considered, all other reaches in the White River watershed may be within their natural condition for LWD abundance. Bedrock channels range from 16-98 LWD >12"/mile, suggesting they may be within the natural condition. White River channels in the hemlock zone (TSME/TSHE) range between 31 and 113 pieces/mile. When potential wood estimates are considered, upper White River instream LWD values appear to fall within the natural range of values for Wenatchee Highlands streams, Indian Creek reach 1 and 3 however, fall short of these values. Personal knowledge of Indian Creek would place Indian Creek Reach 1 in the bedrock category and Reach 3 transitions in and out of bedrock canyon. With potential wood estimates removed, Indian Creek reach 1 falls short of the range of values for bedrock channels and this may be due to reduced input from the banks as a result of historic cedar logging and wilderness practices (grazing, trail building, guard station construction).

The range of values for the White River channels in the pacific silver fir zone (ABAM) is 26-110 pieces per mile. All channels seemingly are within the natural range for Wenatchee Highlands streams.

Herrera (2014) surveyed lower White River for LWD (>1 ft. diameter and > 35 ft. length), tallying numbers from aerial photos followed by field verification in 2013. The results are shown in Table 31.

Table 31. LWD Summary on White River (Herrera 2014)

Subreach	1 (RM1-1.7)	2 (RM 1.7-3.5)	3 (RM 3.5-5.7)
LWD/mile	29.4	65.9	88.7

While not meeting Forest Plan standards, the existing LWD density does satisfy Matrix requirements for functioning properly although, LWD recruitment may be inadequate for future requirements. As such the White River has been rated as **functioning at risk** for this indicator.

Recent wildfires (Sears Creek- 2012 and Saul- 2016) affected 1,118 acres in this subwatershed and added large wood into White River during peak flow events within a year or two after the fire and potentially reduced large wood recruitment from the 1.5 miles of riparian adjacent to Indian Creek that was within the Saul fire perimeter. Given the size of this subwatershed and the amount of perennial and intermittent streams that were not affected, long term wildfire impacts are not expected to significantly affect this indicator. Based on available information, White River is considered functioning properly.

Lake Wenatchee: No quantitative information is available for Lake Wenatchee or its smaller tributaries. There has been some large tree removal in riparian reserves associated with the development of 177 homesites along both the north and south shores, and the State Park on the eastern shore. The vegetative condition in the riparian reserve associated with Lake Wenatchee is judged to be functioning at risk for LWD.

Little Wenatchee: The White-Little Wenatchee watershed analysis (1998) showed that LWD abundance was a function of geomorphic subsection, channel type, climax vegetation zone, and size class of riparian overstory. The analysis indicates that White and Little Wenatchee channels may be comparable to Chiwawa, Nason, and Icicle channels in terms of processes and range of natural condition. Analysis of these streams indicate the typical range is 70-160 in alluvial channels, 15-200 in bedrock channels, and 20-200 in other channels (categorized by vegetation; TSME/TSHE or ABAM).

Differences between these channel types are clearly linked to processes. Alluvial channels have the greatest LWD abundance which may be linked both to high input rates from banks through lateral migration and to high capacity for LWD storage in the wider floodplains. Low LWD abundance in bedrock channels is likely due to both low retention and low recruitment from the banks. LWD abundance is intermediate in the "other" channel categories (Rosgen B channels ranging between plane-bed and step-pool morphologies). The 1997 Little Wenatchee stream survey observed low retention of wood in these reaches based on the amount of bark remaining on the pieces (recently input, no observations of "old" wood). Wood recruitment is typically through pulsed events, wood is delivered via mass wasting, windthrow, or simply tree mortality, this can be from the bank or transported from upstream.

LWD abundance appears to be low in Little Wenatchee River below the falls (Table 32). Low LWD levels below the falls in Little Wenatchee River is likely related to management practices but may also be a product of stream survey methodology (1990 and 1991 surveys did not record wood in side channels and did not count wood in two large wood jams, one approximately three acres in size, the other six acres).

Table 32. In-Channel Large wood data for Little Wenatchee River (USDA 2000)

STREAM	REACH	LOCATION	YEAR	LWD PIECES/MILE (≥ 12” diameter & 35’ long)
Little Wenatchee River	1	(RM 1-3.1)	2000	118
	2	(RM 3.1- 5.7)	2000	120
	3	(RM 5.7- 6.8)	2000	38
	4	(RM 6.8-7.2)	2000	52

Surveys conducted in 2000 indicated that the LWD component for reaches 1-4 averages 90 pieces per mile; thus, the Little Wenatchee River is properly functioning for LWD.

Based on survey data, existing LWD is meeting matrix standards for functioning properly but future large wood delivery mechanisms have been altered from natural conditions by the current landscape. Residential development and associated roading in these areas have the potential to alter hillslope hydrology. This can promote negative ecological impacts of windstorms by increasing the susceptibility to mass erosion or wind throw events; thereby altering natural ecological processes for wood delivery and distribution (Everest et al. 2006). Bridges and culverts associated with roads negatively impact how LWD is distributed in lotic systems, especially in larger drainages (i.e. White and Little Wenatchee River systems). Overall, the process of large woody debris recruitment and delivery is impaired; this indicator is judged to be functioning at risk in the White River- Little Wenatchee watershed.

Little Wenatchee-White River Wenatchee HUC 10 summary: functioning at risk.

Pool Frequency/Quality/Large Pools

White River: The White-Little Wenatchee Watershed Analysis (1998) indicates that percent pool area is a function of landtype and channel type. In geomorphically comparable watersheds (White, Little Wenatchee, Nason, Chiwawa, and Icicle), gravel or sand dominated low gradient pool-riffle (Rosgen C5, C6, and E6) channels, have roughly equal areas of pool and riffle with typical values ranging from 24% riffle (Chiwawa River 1996 reach 1) to 58-60% riffle (Chiwawa River 1996 reach 2 and Little Wenatchee 1997 depositional reaches). The White River between Napeequa and Panther, at 69% riffle, represents the extreme value in this distribution and may not be within the natural range of condition. Historic log drives and a large sediment pulse (observed in aerial photography series 1948-92) may have contributed to this condition. However, quality pool habitat exists in this White River segment and compared with the other reaches this is a short segment. If the reach were longer, data may have averaged out more similar to the other reaches.

Within plane-bed (Rosgen B) channels under 2% gradient, all White River reaches have no more than 48% riffle; and are comparable with reference reaches in this category including Icicle and French Creeks and Chiwawa River (47-67% riffle). Similarly, bedrock channels, and higher gradient channels in the White River watershed appear to be within the range of natural conditions (57-95% riffle for bedrock channels, 19-90% riffle for 2-4% channels, 72-95% riffle for 4-8% channels, 73-90% riffle for 8-12%

channels, and 68-95% riffle for >12% channels) (see aquatic module Appendix 2, White - Little Wenatchee watershed analysis 1999).

The majority of the pools in the White River, upper White River, Napeequa River, Panther Creek and Indian Creek have pool depths of greater than 3 feet and adequate cover in the form of turbulence, substrate and/or LWD and are therefore functioning appropriately (1997 White River Report, 1992 Upper White River Report, 1996 Napeequa River Report, 1992 Panther Creek Report and 1993 Indian Creek Report).

The White - Little Wenatchee Watershed Analysis indicated that White River between Napeequa and Panther might be low in pool frequency for its channel type (69% riffle habitat). This may be related to low LWD values, high width:depth values, and altered riparian condition in this portion of the White River, thus White River between Napeequa River and Panther Creek is judged functioning at risk for pool habitat. All other streams/reaches in the White River watershed appear to be within the natural condition for pools (White - Little Wenatchee Watershed Analysis 1999) and are judged to be properly functioning.

Recent wildfires (2012 and 2016) affected 1,118 acres, and elevated sediment loading over the short term. Pool quality was also likely impacted in the first few years after the events but no long-term impacts to pools occurred from sediment loading. Based on available information, White River is considered functioning properly.

Lake Wenatchee: Pool data is limited for the smaller tributaries to Lake Wenatchee; although given that many tributaries to Lake Wenatchee contain high gradient reaches where pool habitat is expected to be limited naturally or contain intermittent flows. The four primary tributary streams to Lake Wenatchee (Falls, Hidden, Plainview, Barnard) were surveyed in 2019 on federal lands (Hall et al. 2019). Barnard and Plainview were confirmed as intermittent while Fall and Hidden Creeks contain perennial flows. Fall Creek's lower reaches are on non-USFS property and therefore were not surveyed. In the upper section of Fall Creek on USFS property, the reach is high gradient (44.79%) with relatively few pools and little human disturbance. Lower gradient Hidden Creek consisted of 97.5% riffle and 2.5% pool unit area. Pool spacing was moderately low at 26 pools per mile with an average residual pool depth of 0.8 feet and average maximum pool depth was 1.2 feet.

Of the lower gradient channels in the watershed, there are two small unnamed perennial streams on the Camp Zanika Lache Special Use Permit site, located on the south shore of Lake Wenatchee. Results indicate that the channel does not meet large wood standards for quantity, likely due to past removal of pieces in and near camp common areas or along the access road. The channel is therefore likely to also be deficient in pool habitat. If this channel is representative of other stream reaches on non-federal lands where development often occurs, it can be argued that pool habitat is lower in those areas as well for similar reasons. There has been some large tree removal in riparian reserves associated with the development of 177 homesites along both the north and south shores, and the State Park on the southeastern shore and has likely reduced available pool habitat. Overall, Lake Wenatchee subwatershed is considered as functioning at risk for pool habitat.

Little Wenatchee: The White-Little Wenatchee Watershed Analysis (1998) indicates that percent pool area in these streams is a function of landtype and channel type. In geomorphically comparable watersheds (White, Little Wenatchee, Nason, Chiwawa, and Icicle), gravel or sand dominated low gradient pool-riffle (Rosgen C5, C6, and E6) channels, have roughly equal areas of pool and riffle with typical values ranging from 24% riffle (Chiwawa River 1996 reach 1) to 58-60% riffle (Chiwawa River 1996 reach 2 and Little Wenatchee 1997 depositional reaches).

Within plane-bed (Rosgen B) channels under 2% gradient, all Little Wenatchee reaches have no more than 48% riffle; and are comparable with reference reaches in this category including Icicle and French Creeks and Chiwawa River (47-67% riffle).

Similarly, bedrock channels, and higher gradient channels in Little Wenatchee appear to be within the range of natural conditions (57-95% riffle for bedrock channels, 19-90% riffle for 2-4% channels, 72-95% riffle for 4-8% channels, 73-90% riffle for 8-12% channels, and 68-95% riffle for >12% channels) (see Aquatic Module Appendix 2, White - Little Wenatchee Watershed Analysis 1999).

Streams/reaches in the Little Wenatchee watershed appear to be within the natural condition for pools (White - Little Wenatchee Watershed Analysis 1999).

Matrix standards require nine pools per mile for wetted widths between 40-65 ft. Pool quality is assessed on maximum depth, cover, temperature, and the extent of pool volume reduction resulting from fines. Stream surveys conducted in 2000 indicated that reaches 1-4 yielded 16 pools per mile, meeting the standard for pool frequency. A total of 81 large pools (≥3 ft. deep) were identified for reaches 1-4. Cover, as provided by two or more countable pieces of LWD was present at all pools with additional cover provided by undercut stream banks, overhanging vegetation and pool depths. Pool indicators are deemed to be functioning appropriately in Little Wenatchee River.

All pools in the Little Wenatchee River had depths of greater than 3 feet. The average maximum pool depths in Rainy Creek were 3.4 feet in reach 1 and 2.5 feet in reach 2 (1997 Little Wenatchee River Report and 1991 Rainy Creek Report).

Fall Creek, Cady Creek, Lake Creek, and Snowy Creek, do not meet USFWS matrix suggested values; however these headwater streams would not naturally have large numbers of 3 feet deep pools, nor are they expected to have naturally supported the anadromous fish that would require 3 ft deep pools. They are considered to be functioning appropriately**;** surveyors saw no indications that pool depth and/or quality were outside the natural range of variability**.** Fall Creek had only 16% of the pools in reach 1 and 9% of the pools in reach 2 being greater than 3 feet deep (1996 Fall Creek Report). Cady Creek had 53% of the pools in reach 1, 31% in reach 2 and 13% in reach 3 being greater than 3 feet deep (1996 Cady Creek Report). Snowy Creek had only 11% of the surveyed pools being 1 meter deep (1991 Snowy Creek Report). Maximum pool depth averaged 3.3 feet in Lake Creek reach 1; 2.8 feet in reach 2; and 3.0 feet in reach 3 (1992 Lake Creek Report).

Little Wenatchee-White River Wenatchee HUC 10 summary: properly functioning (White River, Little Wenatchee); **functioning at risk** (Lake Wenatchee).

Off-Channel Habitat

White River: The upper White River has only 0.3% and 0.6% of its available habitat as side channels but has multiple perennial and intermittent tributaries creating off-channel habitat along with several beaver ponds and marshes found. The Napeequa River and Panther Creek are also functioning appropriately with District records indicating that 1.4% and 6% of their available habitat found as side channels (1996 Napeequa River Report and 1991 Panther Creek Report).
From 2005-2014 private land purchases and conservation easements by Chelan-Douglas Land Trust and Chelan County on property adjacent to over 6 miles of stream on the White River and 0.1 miles on Napeequa River should facilitate maintenance of existing off channel habitats as future development of those properties is not allowed.

The White River is considered properly functioning with side channel habitat being abundant and of good quality and also excellent oxbow habitat (1997 White River Report).

Little Wenatchee: The Little Wenatchee River has abundant side channel habitat in most of its reaches along with several tributaries that provide off channel habitat and is functioning appropriately (1997 Little Wenatchee River Report). The hanging valley in Lake Creek provides the only off-channel area in this otherwise deeply entrenched and confined channel. Lake Creek reach 2 is comprised of 7.6% side channels and 3.6 percent of reach 3 is side channel habitat (1992 Lake Creek Report). Although Fall Creek, and Cady Creek have almost no side channels they are naturally confined bedrock stream channels (1995 Cady Creek Report and 1995 Fall Creek Report) and are functioning appropriately. During the 1991 Stream Survey, Rainy Creek had 13% of its available habitat in Reach 1 found as side channels and 4.5% of the available habitat in Reach 2 being found as side channels (1991 Rainy Creek Report). Snowy Creek had nine side channels with 4% of its available habitat as side channels (1991 Snowy Creek Report). Both of streams are confined Rosgen A or B channel types so are rated as properly functioning regarding off-channel habitat.

Little Wenatchee-White River Wenatchee HUC 10 summary: properly functioning.

Refugia

White River/ Lake Wenatchee/Little Wenatchee: Refugia in the White/Little Wenatchee watershed is functioning appropriately with adequate rearing habitat found in tributaries to the White River and the Little Wenatchee River and the littoral zone of Lake Wenatchee. Off channel habitat, tributary mouths, and riparian wetlands (flow refugia), and deep pools (thermal refugia) remain in those channels where they historically occurred.

Little Wenatchee-White River Wenatchee HUC 10 summary: properly functioning .

Channel Condition and Dynamics

Width:Depth Ratio

White River: Reach A of White River has width:depth (W:D) ratios into the range of braided channels (Rosgen 1996, White River Report 1997) and therefore may be functioning at risk. Maximum W:D reported in the White River 1997 stream survey was 57.1 (Table 33). Analysis of aerial photographs from past to present indicates that a large pulse of sediment has slowly been migrating down the White River since the 1940's. The pulse may have originated in Panther Creek and is now downstream of the confluence with Sears Creek. This sediment deposit may be contributing to the high W:D ratios within the reach.

Table 33. BFW/BFD summary for White River Stream Reaches.

Stream	Reach	Year	Channel Type	BFW:BFD Ratio
White River	A (Napeequa to appx. RM 13.0)	1997	C4	57.1
White River	B (RM 13.0 to RM 13.7, just upstream of Panther Creek)	1997	C2b	21.6
White River (hydro survey)	above Indian	1996	C3	21.4
White River (hydro survey)	above Panther	1997	B2	15.1
Napeequa	1	1996	C4	41.2
Napeequa 1(hydro survey)	1 (1996 survey)	1997	C4	30.0
Napeequa 2 (hydro survey)	1 (1996 survey)	1997	C4	31.9
Panther	1	1990	B3/A2	10.3
Panther 1 (hydro survey)	1 (1990 survey)	1997	B3	15.8
Panther 2 (hydro survey)	1 (1990 survey)	1997	B3	19.9
Indian Creek	1	1993	B2a	17.7
Indian Creek	2	1993	C4	31.1
Indian Creek	3	1993	B3a	21.2

Herrera (2014) noted that based on estimates of channel width from georeferenced aerial images taken in 1938 and 2011, the section of river between RM 3.5 and 5.7 has been experiencing widening from an average of 110 feet in 1938 to 135 feet in 2011. When considered with bank erosion observations described under Streambank Condition, one interpretation could be that that the widening process is still ongoing in this subreach. It appears that the historical floodplain is disconnected hydraulically from the river to some degree and that current channel evolution has the channel geomorphically widening and potentially still incising slowly. More data is needed to confirm this supposition.

Within the bedrock canyon, Panther Creek's channel type is not susceptible to W:D alterations (Rosgen 1996) and is likely functioning appropriately. Panther Creek on the alluvial fan at the mouth may experience extreme W:D alterations due to deposits across the fan. This could create a passage barrier with possible impacts to bull trout. Most of the Panther Creek drainage is within wilderness. The stream is flashy and has created a fan at the confluence with the White River. Periodically the channel moves across this fan.

All other channels reported above have W:D ratios in the expected range for these Rosgen channel types (Rosgen 1996), and these streams are judged to be properly functioning.

Lake Wenatchee: This indicator is not applicable to Lake Wenatchee and quantitative information is not available for tributaries to Lake Wenatchee. In adjacent watersheds (White and Little Wenatchee Rivers) extreme width:depth ratios appear to be linked to disturbance events that pulse large amounts of sediment into the system (White and Little Wenatchee Rivers Watershed Assessment 1999). The link between hillslope processes (watershed inputs such as wood, coarse and fine sediments, and water) and stream channel processes (delivery of the watershed inputs) appears to function properly in this subwatershed. Most of the stream channels in this subwatershed are first order, high gradient, and deeply entrenched due to the debris flow disturbance regime. There are very few segments of stream channels in this subwatershed that are low gradient and subject to channel migration and width:depth alterations. These conditions may occur on private land, particularly on the north shore of Lake Wenatchee where some lands were converted to pasture and homesteading near the turn of the century. These areas represent such a small portion of the subwatershed however, and professional observation determines that this indicator is properly functioning at the subwatershed scale.

Little Wenatchee: Mean bankfull W:D ratios are perhaps the most sensitive indicators of potential channel instability and erosion. The mean bankfull W:D ratio measured for Little Wenatchee River Reaches 1-4, was 41.95 (USFS 2000), which falls within the expected range for bankfull W:D (between 12 and 40 ±2) in a properly functioning C type channel (Rosgen 1996). Lower Little Wenatchee River Erosion (11%) was not a significant issue along the survey reaches and the W:D ratio, which is on the high end of the acceptable range, suggests that the channel may still be adjusting to the influx of sediments that coincided with intensive logging of riparian zones over a 50 year span.

The overall W:D ratios in the White River- Little Wenatchee River appear to be properly functioning as their ratings fall within acceptable ranges for their stream types.

Little Wenatchee-White River Wenatchee HUC 10 summary: properly functioning.

Streambank Condition

White River: The White River naturally experiences high rates of lateral migration at depositional Rosgen C channels. Barry (1996) determined the average historic (1979-1992) lateral migration to be 1.3 feet per year on the White River near the Indian Creek confluence; the total historic migration across the floodplain was 22.7 feet over the period.

Both the White River and lower Napeequa River have sections of riprap and/or bank erosion associated with roads, bridges, dispersed recreation, or other development. Two notable locations include the streambanks located on private land adjacent to the White River Bridge (Little Wenatchee Road) and riprap sections between Napeequa Campground and the Napeequa River. During two record flood events (1990 and 1995/96) two sections of FS 6400 below Panther Creek confluence were washed out and subsequently reconstructed. One segment was relocated further from the river, the other (county road portion) was reconstructed in place with riprap on the banks.

In 2011, a section of White River streambank in the vicinity of Tall Timbers Ranch was armored and planted with native vegetation as part of the White River Log Jam project. The eroding bank were improved by armoring with three engineered log jams, located along a 320-foot segment of FS 6400.

Herrera (2014) surveyed lower White River from RM 1 to RM 5.7, noting active bank erosion as part of the reach assessment. The results are shown in Table 34.

Table 34. Streambank Condition Summary on White River (Herrera 2014)

Subreach	1 (RM1-1.7)	2 (RM 1.7-3.5)	3 (RM 3.5-5.7)
Active Bank Erosion	Both banks - Some outside bends and on both banks in few of the straightaways	Both banks - All outside bends and on both banks in some of the straightaways	Both banks - All outside bends and on both banks in many of the straightaways
Percent Eroded Banks	5-30%	30-60%	60-100%

Modest bank erosion was observed on 5 to 30 percent of banks in sub reach 1, where impacts were concentrated on some outside meander bends and intermittently on both banks between meanders. In sub reach 2, where erosion was observed on 30 to 60 percent of banks, impacts were concentrated on all the outside meander bends and on both banks in between meander bends. Bank erosion was observed on 60 to 100 percent of bank in sub reach 3, where impacts were concentrated on all the outside meander bends and on both banks in many of the straight sections. The outer meander bend at RM 4.1exposed an area with evidence of a small debris flow, abutting an adjacent talus slope.

Overall with the level of disturbance noted on the mainstem White River affects approximately 5 miles of the total 29 miles of stream. This level of disturbance equates to 17% of the total length, with most of that occurring in the lowest 5.7 miles.   Because these locations could be considered functioning at risk or not properly functioning, the watershed is judged to be functioning at risk.

More recently, restoration efforts by the Chelan-Douglas Land Trust and Chelan County from 2005-2014 have protected streambanks through private land purchases and conservation easements ion over 6 miles of stream on the White River and 0.1 miles on Napeequa River. These combined efforts should facilitate degraded streambank recovery.

Lake Wenatchee: Little quantitative information is available for Lake Wenatchee or its smaller tributaries. Shoreline development has increased in past years along Lake Wenatchee and continues to be of concern regarding impacts to shoreline conditions; however, these concerns are generally related to littoral conditions with fewer impacts to streambanks, although homestead clearing and the conversion of forested lands to pasture may contribute to unstable streambanks located on the lower slopes of Dirty Face Mountain. Other tributaries, particularly those on the south shore of Lake Wenatchee, are judged to be functioning appropriately based on 2019 stream surveys which noted that the upstream extent of Barnard Creek is relatively undisturbed; most of Plainview Creek is relatively undisturbed; and that no erosion was observed on Hidden Creek (Hall. et al. 2019.) Individual sites on private lands may be functioning at risk, however they comprise a low proportion of the total stream habitat. Overall, Lake Wenatchee is estimated to be properly functioning for streambank condition.

Little Wenatchee: The Little Wenatchee River naturally experiences high rates of lateral migration at depositional Rosgen C channels. Barry (1996) determined the average historic (1986-1992) lateral migration to be 6.5 feet per year for the Little Wenatchee River above Rainy Creek.

The Little Wenatchee mainstem has sections of rip-rap and/or bank erosion associated with roads, bridges, dispersed recreation, or other development. These individual sites could be considered functioning at risk; however, they comprise a low proportion of the entire streambank.

During the 2000 stream survey bank erosion was generally not a serious problem for reaches 1-4, averaging 11% for the total survey segment. Somewhat higher erosion was present in reaches 1 and 2, while 8% and 9% of the banks were eroded in reaches 3 and 4, respectfully. Riffles in reach 1 showed the highest amount of erosion with 17% of the banks eroding. Consequently, Little Wenatchee River is rated as functioning at risk.

Based on available data that indicate high erosion in specific reaches, bank stability for the White River and Little Wenatchee River is rated as functioning at risk; Lake Wenatchee is properly functioning.

Little Wenatchee-White River Wenatchee HUC 10 summary: functioning at risk for White River, Little Wenatchee and **properly functioning** for Lake Wenatchee**.**

Floodplain Connectivity:

White River: The White River below Panther Creek is functioning at risk due to floodplain development, drainage, and isolation of the channel from oxbows and other wetlands. The remaining watershed

except Rainy Creek largely remains hydrologically connected to its historic floodplain. There is evidence of oxbow isolation in the lower watershed (below Panther Creek) however; restoration projects (White River Oxbow Restoration 2002) have restored floodplain connectivity on Forest lands. Floodplain connectivity on private land in the watershed may be negatively affected due to development and drainage features (ditches associated with old homesteads). The isolation of old oxbows may be natural but the risk of floodplain development is substantial. Efforts (2002 and 2003) by the WDFW to protect the White River floodplain resulted in the purchase of 416 acres (22% of the privately owned land in the watershed) of floodplain properties from private landowners in the lower White River. Efforts by the Chelan-Douglas Land Trust from 2005-2014 have protected floodplains and wetland habitats through private land purchases and conservation easements ion over 6 miles of stream on the White River and 0.1 miles on Napeequa River. These combined efforts will improve White River floodplain connectivity. This indicator is considered functioning at risk, though improved.
Lake Wenatchee: There is no evidence of loss of floodplain connectivity reported in Lake Wenatchee subwatershed.

Little Wenatchee: There is no reported loss of floodplain connectivity documented in Little Wenatchee (1997), Fall Creek (1995), or Cady Creek (1995) stream survey reports, and air photo analysis supports this. An exception occurs on Rainey Creek where Forest Road 6700 parallels the creek for most of the length of the stream and crosses the stream twice. Since Rainy Creek is confined by Road 6700, it is restricted from using its floodplain in some areas, it is rated as functioning at risk (1991 Rainy Creek Report). More recent survey data is not available for this drainage; this subwatershed is still estimated to be functioning at risk.

Little Wenatchee-White River Wenatchee HUC 10 summary: functioning at risk (White River, Little Wenatchee); **properly functioning** (Lake Wenatchee)**.**

Flow/ Hydrology

Peak/Base Flow
White River: A gaging station exists on White River and records are available from 1955 to 1983, the station is located below the Napeequa River. The streamflow data below includes the discharge from the Napeequa River, which we estimate to contribute 40% of the streamflow at its confluence with the White River.

Bankfull flow discharge = 4320 cfs (60% = 2592)
Peak flow return intervals:
2 yr. = 4755 cfs (60% = 2853)
5 yr. = 5430 cfs (60% = 3528)
10 yr. = 5745 cfs (60% = 3447)
25 yr. = 6045 cfs (60% = 3627)
50 yr. = 6225 cfs (60% = 3745)
100 yr. = 6360 cfs (60% = 3816)

Other gaged systems in the Wenatchee Highlands Landtype include Icicle Creek and Chiwawa River. An analysis of streamflow data from selected gaging stations within the Wenatchee River subbasin was conducted to characterize hydrologic processes for dryer subwatersheds (Robison 1995). Included in the analysis were wetter subwatersheds, including Icicle Creek, Chiwawa River, White River and Little Wenatchee River. In these geomorphologically similar watersheds bankfull flow values (CSM, cfs per square mile of drainage area) ranged 16.1 (Chiwawa) to 28.8 (White). A comparison of peak flow events with return intervals from two to 100 years showed a range of base flow/peak flow ratios of 1.3 (White) to 2.6 (Icicle). The analysis concluded that the average wet site 100 year peak flow is only 3.5 times greater than that for dry sites in the subbasin indicating that dry systems tend to be flashier yielding greater water in major peak events or conversely that wetter sites are better regulated. Road and vegetative impacts have been relatively minor in the upper watershed, with 440 acres burned in Indian Creek subwatershed and 24 acres burned in Upper White River subwatershed during the 2016 Saul Fire. No other fires have occurred in the upper watershed since at least 2012. The Saul Fire should have only a slight effect on the snowmelt dominated system, allowing the White River watershed to continue to function properly. Over one-half of the watershed is contained within wilderness.

Lake Wenatchee: Lake Wenatchee is within the rain shadow of the Cascade Mountains and the climate is characterized by substantial precipitation primarily occurring as snow during the winter. Average annual precipitation is nearly 150 inches (Andonaegui 2001) with tributary stream flows dominated by snowmelt and the highest flows occurring in May. Low flows usually occur from July to late September or October.

Private development along the lake combined with roading contributes to an altered hydrograph with flashier runoff due to an increase in impervious surfaces. Based on residential and state park development adjacent to the lake, there are likely some changes in peak flows from historic levels. This indicator is estimated to be functioning at risk.

Little Wenatchee: There is no historic annual flow record in the Little Wenatchee watershed. While the upper reaches of the watershed are within wilderness, much of the non-wilderness portion has been roaded (see roads). Because of substantial road network and timber harvest combined with apparent pool filling and a wide width:depth ratio in lower depositional reaches, Little Wenatchee flows should be considered functioning at risk.

Little Wenatchee-White River Wenatchee HUC 10 summary: functioning at risk (Little Wenatchee, Lake Wenatchee); **properly functioning** (White River).

Drainage Network Increase

White River/Lake Wenatchee/Little Wenatchee: Road density is often used to measure overall watershed condition, and some studies have found that when road densities are between 1.7 and 4.7 miles/square mile, conditions that negatively affect fish are present (Quigley and Arbelbide 1997). Another measure of the effects of roads on the drainage network is the extent of road/stream intersections and the extent of roads in riparian reserves, as these metrics can be an indicator of hydrologic connectivity. An increase of the drainage network occurs primarily road surface runoff are conveyed to a stream channel and road-produced sediment and runoff are delivered directly to the channel network. Road densities, road densities within 300 ft. of perennial streams, Lakes and wetlands, and 150 ft. of intermittent channels by subwatershed are shown in Table 35.

Table 35. Road densities White River-Little Wenatchee River subwatersheds

Subwatershed	Riparian Area Roads (miles)	Riparian Area Road Density (miles/miles^2)	Total Roads (miles)	Total Road Density (miles/miles^2)
Lake Wenatchee	17.4	2.3	43.7	2.5
Lower White River	7.7	1.4	47.1	2.4
Lower Little Wenatchee	5.7	1.9	39	1.5

Little Wenatchee-White River Wenatchee HUC 10 summary: Functioning at Risk

Watershed Conditions

Road Density and Location

White River/Lake Wenatchee/Little Wenatchee:

Based on the Table 35, the lower subwatersheds are functioning at risk with 1.4-1.9 miles/miles^2 of riparian area road density and between 1.5-2.5 mile/mile^2 of total road density. Roads iproximate to stream channels are potentially impacting riparian structure and floodplain function. A subwatershed is considered properly functioning if it contains no valley bottom roads and road densities are <1 mi per mi^2.

Relative to miles of road per square mile it is of note that the existing road densities are for non-wilderness portions of the White River and Little Wenatchee subwatersheds only in the lower extent of each subwatershed. The wilderness portions of these subwatersheds are roadless and are considered properly functioning.

Little Wenatchee-White River Wenatchee HUC 10 summary: Funtioning at Risk

Disturbance History

White River/Lake Wenatchee/Little Wenatchee: The White River- Little Wenatchee River Watershed area includes lands managed by the USFS, Washington Department of Natural Resources, and numerous individual private landowners. For the period 2004 to present, anthropogenic disturbance on NFS lands in the watershed have included: vegetation management projects primarily focused on reducing wildfire risk and moving dry site forest ecotypes towards historic range of variation, human caused wildfires, and on-going maintenance/management of roads and developed and dispersed recreation.

White River: In Lower White River, it is mainly historic logging and land clearing which puts this subwatershed in the functioning at risk category. The White River valley experienced increased settlement in association with the cedar logging days at the turn of the century. Over 2,000 floodplain acres (predominantly private ownership) were cleared of old growth cedar and converted to pastureland. Second growth black cottonwood and mixed coniferous species are now intermingled with the pastureland. This second growth component has been decreased as development on private land has increased.

Lake Wenatchee: This historically a pristine lake has transitioned over time from having vacation cabins scattered along the shores to a rapidly developing year round residential community along the shoreline and in the surrounding hills. Lake Wenatchee State Park also occurs at the southern end of the lake and includes paved parking areas, structures, cleared campsites, boat dock and trails. Water quality samples show that the lake is still a clean oligotrophic lake; however, there is high sediment loading maintained by landowner property improvement actions and development in the watershed. Continued development in the watershed is changing the watershed hydrology resulting in increased sediment loads into the lake. Visual surveys of the shoreline located several areas where high stormwater flows transport sediment into the lake and spots where landslides caused heavy sediment loads to the lake. Some landslide's loadings appear to be associated with clearing of land for development (CCNRD 2011).

Little Wenatchee River: In Little Wenatchee watershed, debris torrents are localized events within the watershed, especially Rainy Creek and the mainstem which may have been accelerated by management impacts, especially roads and timber harvest (Driscoll 1996). The watershed is primarily forested and the USFS owns 97% of the land, with 61% of the watershed designated as wilderness (Hindes 1994). Past logging has occurred on 7% of the watershed, mostly in the lower elevations (Hindes 1994) and a gravel/sand mine is in the vicinity of the gravel-sand transition region of the current stream, which indicates the upstream most extent of inundation-related effects from Lake Wenatchee. In response to past and current impacts, depositional reaches of mainstem Little Wenatchee above the falls appear to be recovering in terms of LWD abundance but evidence of pool filling and fine sediment accumulations are also observed in these depositional areas.

This rating of current condition combined with nonfederal impacts such as gravel mining supports a functional at risk rating for the subwatershed.

Little Wenatchee-White River Wenatchee HUC 10 summary: functioning at risk.

Riparian Reserves

White River: White River drainage has had relatively little riparian harvest impact on federal land; however, turn of the century settlement and land clearing has impacted the riparian reserve network up to Napeequa confluence. Sixty-three percent of the Lower White River's riparian acres and 23% of the Upper White River's riparian acres have been altered, specifically a conversion from old growth cedar to pasture and second growth cottonwood (WNF 1998).

Since the 1998 Watershed Assessment, the Forest Service implemented several restoration projects to improve riparian, wetland, and floodplain function on National Forest managed lands below Panther Creek (Oxbow Restoration, Spur Roads Decommissioning and the White River Road Relocation and Bank Stabilization Project in concert these projects will positively affect riparian conditions along 1.5 miles of the 14.3 mile long segment of the White River below Panther Creek; insignificant on the watershed scale but significant to the public lands in the Upper White River 6th field watershed. Additionally, efforts by the Chelan-Douglas Land Trust to protect floodplain and wetland features in the lower watershed through conservation easements and purchases from willing landowners has the potential to move this indicator close to functioning appropriately for the lower White River. From 2005-2014 private land purchases and conservation easements were gained on over 6 miles of stream on the White River and 0.1 miles on Napeequa River. These combined efforts should facilitate substantial Riparian Reserve recovery, although the extent of improvement has not been documented. Surveys of the land acquisition's Riparian Reserves would document their condition and assist with verification of the level of improvements made to this indicator, thus far. In the upper portion of the subwatershed, woody debris recruitment, shade, aquatic habitat connectivity, and riparian vegetation are similar to the natural condition (White-Little Wenatchee Watershed Analysis 1999).
Recent wildfires (Sears Creek 2012 and Saul 2016) affected 1,118 acres in this subwatershed of which approximately 54 acres were Riparian Reserve habitat adjacent to Indian Creek. Given the size of this watershed, long term wildfire impacts are not expected to significantly affect this indicator. White River subwatershed will retain its functioning at risk rating.

Lake Wenatchee: There has been few acres impacted by fire and very little riparian harvest in this subwatershed (on federal lands) but development associated with private lands continues to occur as the Lake Wenatchee community continues to grow. Around the perimeter of Lake Wenatchee, shoreline development has increased in past years and continues to be a concern regarding loss of functioning riparian habitat and as a result this indicator is rated functioning at risk.

Little Wenatchee River: Historically, most of the older (pre-1985) timber harvest units left no riparian buffer, particularly in the Upper Little Wenatchee, Lower Little Wenatchee and Rainy Creek subwatersheds (USFS 1998). Each of these subwatersheds have had roughly 14% of their riparian acres harvested. In the remainder of the watershed, woody debris recruitment, shade, aquatic habitat connectivity, and riparian vegetation appeared to be similar to the natural condition (White-Little Wenatchee Watershed Analysis 1999).
Little Wenatchee-White River Wenatchee HUC 10 summary: functioning at risk.

Disturbance Regime
White River/Lake Wenatchee/Little Wenatchee: Environmental disturbances can originate from both natural and management actions. Disturbances that may influence habitat conditions at the watershed-scale include wildfire, mass wasting, and flooding, although the primary disturbance processes that impact watersheds are fire and debris slides.

Most of the watershed falls within an intermittent to infrequent (30 to 150 years or more) fire regime and compared to drier forest environments on the eastern edge of the forest the annual fire risk is extremely light (White - Little Wenatchee W.A.). Management activities in the watershed such as fire suppression and vegetative conversion through past logging practices have influenced natural disturbance regimes. Recent wildfires in the watershed have been small and there has been very limited vegetation management and the potential for uncharacteristic fire still exists in much of the watershed.

How an uncharacteristic fire in the White River- Little Wenatchee watershed would behave is not known; short term negative effects are likely but long term effects to aquatic habitat and species may not be negative because habitat connectivity remains high in the watershed and populations are not isolated. Furthermore, fire has the potential to deliver LWD in deficient reaches.

Mass wasting processes (landslides, debris flows, and collapsed till deposits) have shaped many parts of the watershed. Presently, mass wasting events continue to occur as debris slides originating in historic debris paths and avalanche chutes regulating channel form and providing wood and substrate to channels. Management related mass wasting is primarily associated with roads and undersized culverts (improper road drainage and plugged culverts).

Natural riparian and stream channel processes are negatively affected by floodplain development and roads in the White River- Little Wenatchee watershed. Furthermore, mass wasting and debris flow events are likely intensified due to road networks increasing the frequency and magnitude of debris slides and floodplain development limiting the capacity to absorb effects.

Moderate to severe flood events occurred in the White River watershed in 1948/9, 1977, 1990 and 1995/6. These were storm generated peak flows from fall and winter rain on snow events. Flood flows in the White River appear to temporarily overload the system with sediments beyond its transport capacity (White-Little Wenatchee W.A.). Recently (2016), road related failures in both White River and Little Wenatchee subwatersheds occurred where roads were located within the floodplain and hillslope riparian reserves, either by culvert failure or road fill scour and failure.

The White River-Little Wenatchee watershed still maintains high quality, complex habitat with refuge and rearing habitat for multiple life stages and life histories. The watershed is also well connected to adjacent high-quality habitats that provide refuge during disturbance events (Lake Wenatchee, Chiwawa River).

Little Wenatchee-White River Wenatchee HUC 10 summary: functioning at risk.

Integration

Spring chinook are not properly functioning for every subpopulation indicator; steelhead are not properly functioning for every subpopulation indicator except growth/survival; and bull trout are functioning at risk for growth/survival, subpopulation size and persistence and genetic integrity.

White River: The mainstem of White River, below the wilderness boundary, has experienced the brunt of land management and consequently results in many habitat indicators "at risk". The most impacted area is in the lower watershed below Panther Creek. The mainstem White River below White River Falls is a key spawning and migration corridor for spring Chinook salmon, bull trout and possibly steelhead. The mainstem of the White River contains all the known spawning habitat in the watershed for chinook and likely steelhead, as well as mainstem spawning and migration for bull trout.

In the assessment, *Physical Barriers, LWD, Streambank Condition, Floodplain Connectivity, Riparian Reserves,* road related indicators are functioning at risk; all other indicators assessed are properly functioning at the 6th field subwatershed scale.

Most adverse impacts appear to be linked to floodplain development and disturbance to riparian areas from current actions on non-federal lands. The White River, despite historic floodplain conversion and development still contains high quality habitat and connectivity among White River, Panther and Napeequa populations. Increasing floodplain development in the privately owned lower valley continues to be of concern for off-channel habitat, refugia, streambank condition, floodplain connectivity, riparian reserves, LWD, and road density/location. White River is considered functioning at risk.

Lake Wenatchee: Currently, little information has been collected on fish habitat conditions in the Lake Wenatchee subwatershed. Lake Wenatchee is the primary nursery lake for sockeye salmon in the Wenatchee subbasin. The lake also supports bull trout, spring Chinook, steelhead and cutthroat trout. Lake Wenatchee is a vital component of the Wenatchee River subbasin and its connectivity to adjacent watersheds in the upper Wenatchee is key to providing habitat and food supply for a variety of species covering all life stages.

In the assessment, *Off Channel Habitat, Refugia and W:D Ratio, Streambank Condition, Floodplain Connectivity,* Lake Wenatchee are properly functioning; all other indicators assessed are functioning at risk; with the exception of *Chemical Contamination/Nutrients* and *Temperature*, which is not properly functioning at the 6th field subwatershed scale. There is concern in the Lake Wenatchee subwatershed relative to the shoreline development that has occurred along the lake including bank hardening and dock construction. The MCMCP states, “such activities disrupt sediment dynamics and decrease the productivity of littoral zones” and concludes “the construction of bulkheads, removal of riparian vegetation, and shoreline clearing on Lake Wenatchee is a departure from natural condition”. These statements ring particularly true for the sockeye salmon population, which may spawn on shoals and in shallow water areas in their nursery lakes (Burger 1991, in MCMCP); lakeshore development in terms of bulkhead construction likely does not have direct effects on spring Chinook, steelhead, bull trout or westslope cutthroat trout because they are not lake spawners. Regardless, shoreline conditions are altered from the natural condition as well as the lower reaches of adjoining watersheds (White, Little Wenatchee, Nason and Chiwawa). Lake Wenatchee subwatershed is considered functioning at risk.

Little Wenatchee River:

Not surprisingly, the mainstem river below the wilderness boundary has experienced elevated land management and consequently results in many habitat indicators "at risk". The most impacted areas are below the natural barrier falls on the mainstem river. In the Little Wenatchee River, management and above the falls and into Rainy Creek and Lake Creek tributaries. The mainstem Little Wenatchee River below the falls is key spawning and migration corridor for spring chinook salmon, steelhead trout, and migratory bull trout. The mainstems contain all the known spawning habitat in the watershed for chinook and likely steelhead; as well as mainstem spawning and migration corridors for bull trout.

In Little Wenatchee River, above the falls, at risk indicators are pronounced in the depositional reaches of the mainstem river, throughout Rainy Creek, and in the lower portions of Lake Creek. The Little Wenatchee River above Cady Creek (wilderness) is functioning appropriately for all indicators except temperature due to a State 303d listing for temperature from the mouth to the headwaters.

Most impacts appear to be linked to floodplain development, and disturbance to riparian and upslope areas from timber harvest and roading. In Little Wenatchee watershed these impacts are not expected to recover within five years and since population size appears to be extremely reduced in at least some parts of the watershed (e.g., Rainy Creek), the Little Wenatchee watershed is rated as functioning at risk.

Little Wenatchee-White River Wenatchee HUC 10 summary: functioning at risk.

Chiwawa River Watershed (HUC 1702001103)

Although impacts were identified for multiple matrix indicators, the magnitude or intensity of impacts is not expected to shift indicator trends at the HUC5 scale. Table 37 considers the effects of these actions that have occurred since 2010 for a contemporary snapshot of conditions in the Wenatchee River watershed.

Since the *Chiwawa Environmental Baseline Update (2010)* and the *2019 Emergency (Wildlfire) Consultation* which updated the baseline relative to wildfire suppression actions, the following actions and events have occurred within the Chiwawa River Watershed on both federal and non-federal lands:

Table 36. Federal actions in the Chiwawa River Watershed since 2019 Emergency Consultation.

Project Type	Location(s) Subwatershed (HUC12)	Description(s)	Dates Implemented	Impacts to Matrix Indicators
Hazard Trees	Upper Chiwawa Lower Chiwawa Big Meadow	**Campground & Trailhead Hazard Trees-** In developed recreation settings (campgrounds and trailheads), trees are surveyed annually for hazards using the protocol in the Field Guide for Hazard Tree Identification (USDA Forest Service 2012). Corrective action includes removing a portion of the tree or felling the whole tree with a chainsaw.	2019-2021	Insignificant/Discountable
Instream Habitat Improvement	Upper Chiwawa River	**Chiwawa River Nutrient Enhancement-** In-channel nutrient enhancement 5-year study evaluating the impacts of applying salmon carcass analogs 2x each fall in Chiwawa River. Approx. 40k lbs. salmon	2017-2021	Short term positive impacts to: *Water Quality- Nutrients* *Growth & Survival*

		carcass analogs applied in the fall. Water quality monitored. Increases available nutrients for use by juvenile salmonids in a naturally oligotrophic stream.		*(BT, SCH. S)*
Fish Passage Improvement	Upper Chiwawa	**Minnow Creek AOP** Removal of 2 culverts and one upgrade to a bridge to allow for fish passage in Minnow Creek	2020-2021	Long term positive impacts to *Physical Barriers*.

Table 37. Overview of the Environmental Baseline Conditions in Chiwawa River watershed.

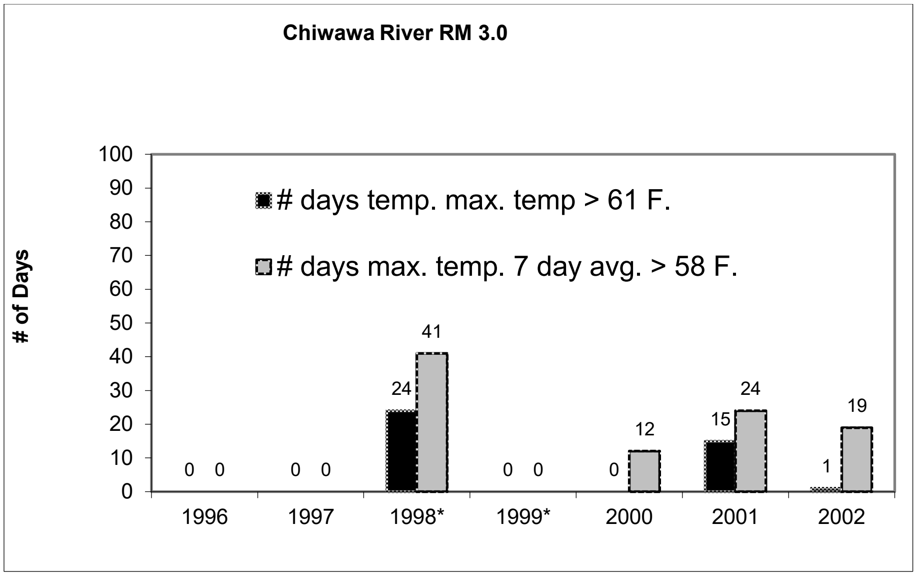
INDICATORS	Chiwawa River HUC 10		
	PF	FAR	NPF
Water Quality			
Temperature	X		
Sediment		X	
Chemical Contaminants/Nutrients	X		
Habitat Access			
Physical Barriers		X	
Habitat Elements			
Substrate Embeddedness		X	
Large Woody Debris		X (upper)	X (lower)
Pool Frequency/Quality		X	
Off-Channel Habitat	X		
Refugia	X		
Channel Condition and Dynamics			
Width/Depth Ratio		X	
Streambank Condition	X		
Floodplain Connectivity	X		
Flow/Hydrology			
Change in Peak/Base Flows	X		
Drainage Network/Roads		X	
Watershed Conditions			
Road Density and Location		X	
Disturbance History		X	
Riparian Reserves		X	
Disturbance Regime	X		
Integration of Species/Habitat Conditions	X (upper)	X (lower)	

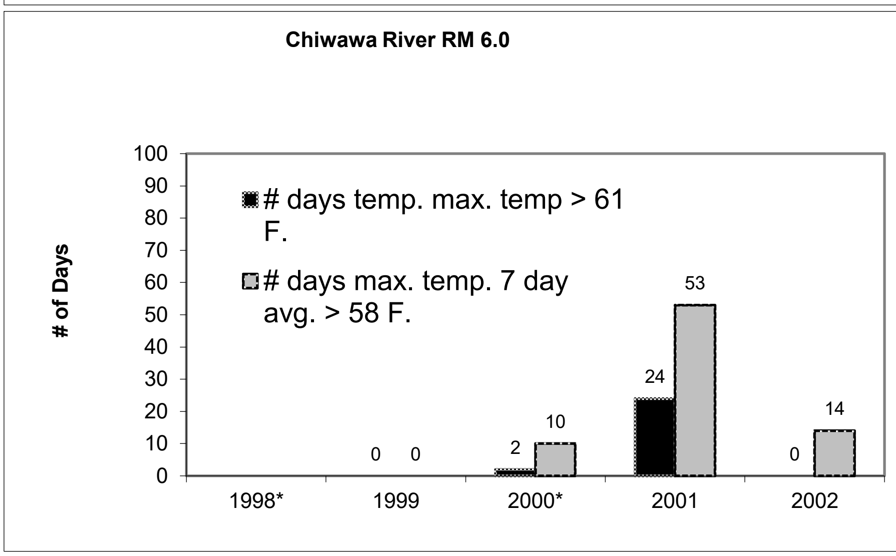
Water Quality

Temperature: The Chiwawa River is not listed for temperature concerns on the Washington State Department of Ecology's 303(d) list for Impaired and Threatened Waterbodies.

A plethora of stream temperature data exists for the Chiwawa River including continuous thermograph data and handheld thermometer data collected by the US Forest Service, U.S. Fish and Wildlife Service, PUD, and Chelan County. Because the Forest Service has collected most of the data over a long time period (1989-present), that data is presented below.

The Forest Service thermograph data set show water temperatures exceed Wenatchee Forest Plan and Washington State water quality standards (daily temperature >61°F; 7-day average maximum temperature >58°F) in the mainstem Chiwawa below river mile 18.0 (see figures below). Thermograph locations above RM 18 on the mainstem Chiwawa and in tributaries to the mainstem (Chikamin, Rock, and Phelps) typically do not exceed water temperature standards however Rock Creek and Chikamin did exceed standards in 2001 with maximum daily temperatures of 60.5° and 61.1° F respectively, and 7-day maximum temperatures of 60.4° and 60.1° F respectively; maximum temperatures were recorded in mid-August.





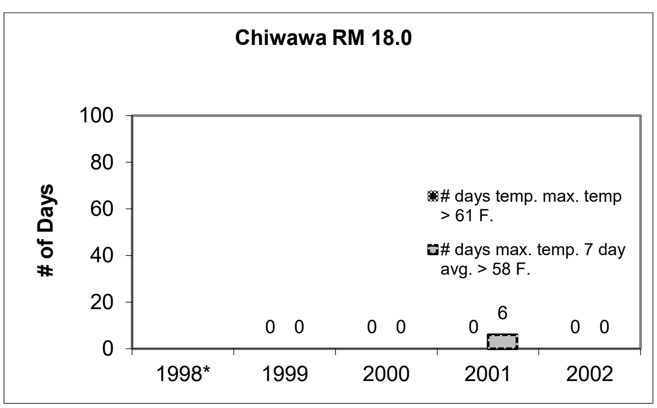


Figure 15. Water Temperature Exceedance at various locations in Chiwawa Mainstem.

Table 38. Summary of Temperatures measured w/ handheld thermometers in Chiwawa watershed.

Stream	Max. Water Temperature	Dates Surveyed
Chiwawa below Grouse Creek	68	Aug – Sep 1992
Chiwawa RM 13.8-30.2	62	Aug – Sep 1992
Chiwawa RM 13.8-30.2	<55	Sep – Oct 1996
Meadow Creek	64	August 1993
Brush Creek	60	July 1998
Gate Creek	48	August 1989
Grouse Creek	51	August 1989
Chikamin Creek	59	Aug – Sep 1998
Minnow Creek	54	July 1989
Marble Creek	56	Aug - Sep 2001
Schaefer	61	July 1995
Buck Creek	45	Aug 1992

Source: USFS Stream Surveys

A maximum temperature of 58 F was recorded in reach one of Phelps Creek during August 1992. Since this recording with a handheld thermometer, further temperature data was collected with continuous thermographs for the period 1999-2002. During this time, Phelps Creek did not exceed temperature standards, including the low flow year of 2001. Because the thermographs are tested and calibrated more rigorously than handheld thermometers, the thermograph data will represent the temperature baseline for Phelps Creek.

A Forward Looking InfraRed (FLIR) aerial flight of the Chiwawa River was flown on the hottest (air temperature) day of the year in 2001 resulting in the longitudinal profile displayed in Figure 16. It should also be noted that 2001 marked the lowest flow record for the Wenatchee River at Plain in eighty years. In the lower 10 miles of Chiwawa River on this date temperatures ranged from 64-69°F. This profile indicates that higher temperatures in the lower Chiwawa (below RM 10) likely result from the lack of cold-water inputs from tributaries and hyporheic exchange in side channels and the broad floodplain that are present in the upper Chiwawa.

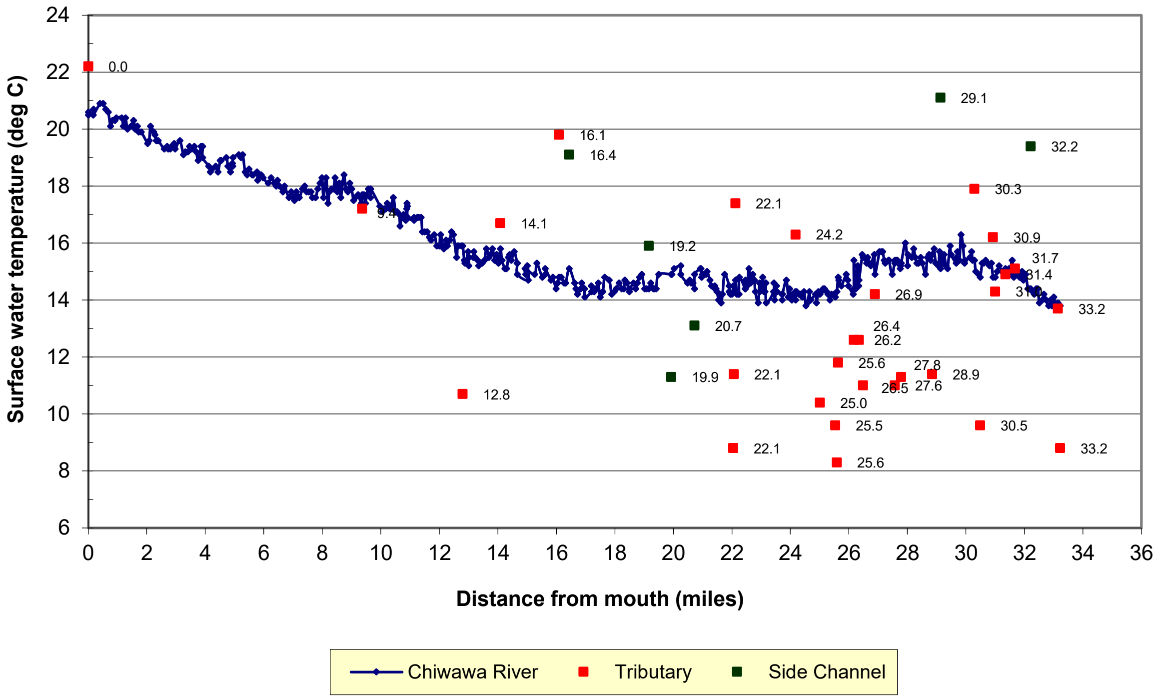


Figure 16. Chiwawa River Longitudinal Temperature Profile, FLIR flight (8/12/01)

In 2015, data were recovered from temperature data loggers that were deployed in the Chiwawa watershed. Data were continuously recorded at 30-minute intervals during the monitoring period with Optic StowAway and HOBO Temperature data loggers. The monitoring period (July 1 – October 1) was selective to capture the low flow period and highest air temperatures for the watershed.

In May 2015, a statewide drought emergency was declared due to snowpack being 16% of normal and 78% of the streams in the state running below normal. May and June are usually the peak run-off periods in the Wenatchee subbasin from snowmelt; however, runoff in 2015 began in March. Early runoff was met with early summer, with air temperatures already in the 90's in June and into triple digits in early July. Instream temperatures in monitored streams responded with recording their maximum temperatures in the first week of July (Table 39).

Table 39. Chiwawa Watershed Temperature Monitoring Results 2015.

	Clear	Goose	Alder	Big Meadow	Twin	Grouse	Minnow
2015 Data Record	7/1-9/30	7/1-9/30	7/1-9/30	7/1-9/30	7/1-9/30	7/1-9/30	7/1-9/30
Days Maximum Temperature Standard Exceed (61°F):	0	0	0	26	0	0	0
Times 7 day avg. Max. Temp. Standard Exceeded (58°F):	0	0	4	49	0	0	0

Maximum recorded Temperature:	55.5°F (7/3/15)	49.9°F (7/20/15)	59.2°F (7/3/15)	66.6°F (7/3/15)	58.4°F (8/13/15)	57.1°F (7/9/15)	57.2°F (7/4/15)
7-Day Average Maximum Temperature:	54.9°F (7/6/15)	49.3°F (7/3/2015)	58.5°F (7/6/15)	65.6°F (7/4/15)	57.9°F (7/6/15)	56.3°F (7/6/15)	56.7°F (7/6/15)

All streams maintained surface water flow throughout the summer however, channel width on Big Meadow Creek receded substantially at the monitoring site resulting in the HOBO being observed out of water in early September, and a few temperature exceedances were recorded. Big Meadow Creek merits further temperature investigation due to HOBO displacement and its proximity to bull trout occupation.

The previous temperature profile had established annual (1998-2003) temperature exceedances in the lower Chiwawa River (at least up to RM 6.0, Goose Creek); there were very few, if any, exceedances above Finner Creek, aproximately RM 18.0). The 2001 FLIR (Forward-Looking Infrared) study mapped the change to cooler temperatures (those that do not exceed State and WNFLMP standards) at Chikamin Creek (RM 14.1). The FLIR study also showed inputs from Big Meadow Creek and Chikamin Creek to be lower than the Chiwawa at their confluences.

Possible explanations for the Chiwawa site exceedances include change in fluvial geomorphological indexes in the lower reaches (higher width/depth ratios), geomorphic land type differences from upper reaches, and a relative reduction in the quantity of cold-water inputs from tributaries when compared to upper reaches and possible influences from floodplain development.

Incubation temperatures: we have one year of data for Chikamin Creek for the period November 1, 1997 to June 9, 1998. The seven-day average temperature dipped below 36° F (2° C) beginning November 11 and continued through March 21; the lowest average recorded in this period was 32.4 F on January 12. Winter temperatures never exceeded 41° F (5° C) during this period.

Rearing temperatures:

<u>Chinook</u>: Based on the hand-held thermometer data, chinook rearing in Chiwawa River between Chikamin (RM 13.8) and Phelps Creeks (RM 30.2) may experience water temperatures as high as 62° F (16.7° C). Chinook rearing on Rock and Chikamin alluvial fans may experience early August temperatures as high as 55° F (12.8° C) and 59° F (15° C) respectively.

<u>Bull trout</u>: Bull trout rearing in Rock and Chikamin Creeks may experience August temperatures as high as 55° F (12.8° C), and 59° F (15° C), respectively. Temperatures in Rock and Chikamin probably represent the natural condition of these streams, as there has been little riparian alteration in these watersheds however, temperatures fall within the functioning at risk category (>12° C; >54° F) of the USFWS bull trout matrix.

<u>Steelhead:</u> Steelhead rear in all the above locations, and rear in Buck, Big Meadow, Chiwawa above Phelps, and Chiwawa below Grouse. Steelhead may experience August temperatures as high as 45° F in

Buck Creek, 64-66° F in Big Meadow Creek, 55° F in Chiwawa above Phelps, and 68° F in lower Chiwawa mainstem.

Westslope cutthroat rear in essentially all surveyed streams in the watershed, and so experience the above temperatures as well as Minnow Creek (max temp 57° F), Grouse Creek (max temp 57° F), Gate Creek (max temp 48° F), Schaefer Creek (max temp 61° F), Brush Creek (max temp 60° F), and Marble Creek (max temp 55° F).

Spawning temperatures:

Chinook: Most of the migration of chinook and bull trout into the Chiwawa occurs during June and July (Chuck Peven, pers. comm.). Chinook spawn in the Chiwawa River in late August, largely between Chikamin and Phelps. Chiwawa mainstem temperatures between Chikamin and Phelps, recorded during stream surveys (1992 and 1996), report a range of 42-55° F September 10 - October 11, 1996; and the maximum recorded in 1992 was 62° F for a period beginning in mid August and ending in early October. The 1992 survey also reports mainstem temperature as high as 68 F below Grouse Creek in early to mid August. Daily temperatures recorded at river mile 3.0 during the 1998 low flow year exceeded the 56 F upstream migration temperature criteria (Dauble and Mueller, 1993) beginning July 16 and continuing into the spawning period with seven day average temperatures above of 57° F through September 30. Seven day maximum averages exceeded 70° F August 12-16 and September 19-30.

Bull trout: Bull trout migrating up the Chiwawa may encounter temperatures in excess of 59° F (15° C) in mid July (1998 data). Water temperatures taken during spawning surveys in Rock, Chikamin, and Phelps Creek are below 10° C (50° F) (Lake Wenatchee bull trout spawning survey data sheets). A thermograph in lower Chikamin Creek in 1997 indicated that water temperatures fell below 10° C around September 10, and remained below for the rest of the season. In 1998, temperatures recorded at the Chikamin thermograph station, never dipped below 53.2 F for the period August 19 to September 30.

Steelhead: Murdock and Viola (2003) report observing steelhead spawning in water temperatures between 5 and 8 °C (late March through early June) and concluded that steelhead likely use the lower seven miles of Chiwawa because low temperatures (<5° C) in the upper watershed may be a limiting factor and prevent steelhead from utilizing high quality spawning habitat. Seven-day average maximum temperatures recorded in lower Chikamin 1998 ranged 34-37° F in March, 36-40° F in April, and 40-43° F in May.

Summary: Throughout the Wenatchee subbasin temperatures can vary depending on flow and air temperatures as seen in 1998 and 2001 (Temperature Monitoring Reports, 1998 and 2001). We believe that temperature exceedances in lower Chiwawa are within the natural range for the following reasons: a change in geomorphological indexes (high width/depth ratios); geomorphic land type differences from upper reaches; a relative reduction in the quantity of cold-water inputs from tributaries when compared to upper reaches. We believe these factors override the possible influence roads and development (2001 Stream Temperature Monitoring Report) may have on lower Chiwawa River temperatures. More data is needed to determine whether temperatures above 61 F are the natural condition in Big Meadow Creek or are management-related. In winter 1997 through fall 1998 temperatures exceeded the matrix standard for incubation, migration and spawning in lower Chikamin. A joint EPA/USFS study of temperatures in eastside Cascade streams is currently underway. At this time, Chikamin Creek and Big Meadow Creek will be considered functioning at risk for water temperature; the Chiwawa River and its remaining tributaries are considered properly functioning at this time.

Chiwawa Ruver HUC 10 summary: properly functioning

Sediment: McNeil core sediment samples have been collected in accordance with the Wenatchee National Forest standard protocol annually for the period 1994-2002 in the Chiwawa River watershed (data also exists for 1991 and 1993). Various standards have been established in order to evaluate stream condition for fish habitat and substrate characteristics. The goal stated in the Wenatchee National Forest Plan is to 'maintain <20% fines (≤1.00 mm) as the area weighted average in spawning habitat (pool tail-outs and glides). The U.S. Fish and Wildlife Services' matrix of pathways and indicators for use in ESA determinations of effects for proposed actions considers <12% fines (<0.85 mm) 'properly functioning', 12-17% fines 'at risk', and >17% fines 'not properly functioning'. Of these two sets of guidelines the Forest Plan is more conservative (the volume of fines <1.00 mm includes the volume of fines <0.85 mm so it will always be equal to or greater than the volume <0.85 mm) and will be evaluated here.

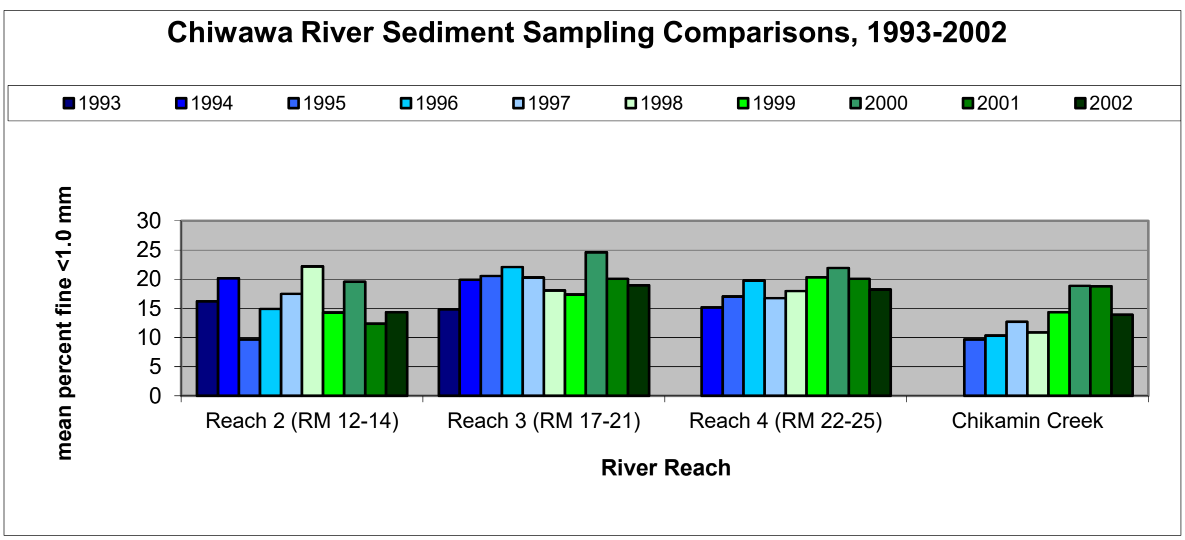


Figure 17. Chiwawa River Sediment Sampling Results

Mainstem Chiwawa River

Fines < 1 mm average 16.3% (range 9.66-22.22) in Chiwawa mainstem between Grouse and Chikamin Creeks (1993-2002), 19.4% (range 14.83-24.62) between Chikamin and Rock Creeks (1991, 1993-2002), and 18.6% (range 15.14-21.91) above Rock Creek (1994-2002). Percent fines in all three reaches are close to, or have exceeded, the forest plan standard of 20% at some point in the 10-year monitoring period. Fine levels during 2002 decreased in Reaches 3 and 4, and increased slightly in Reach 2.

All three sampled reaches occur in the upper watershed, with no known large, management-related source of fine sediment input, so it is possible that the data represent the natural condition of these depositional reaches. High natural rates of lateral channel migration (Robison and Barry 1996), two recent floods of record (1990 and 1995), high ash content of the soils, and glaciers and snowfields in the headwaters may contribute to naturally high levels of fine sediment. All McNeil-sampled reaches of mainstem Chiwawa have exceeded Forest Plan standards for fine sediment at least once during the monitoring period. Many activities have been identified as sources of local sediment input (primarily recreation sites). Since campground restoration activities have been implemented (1999 and 2000) fine sediment levels in Reaches 3 and 4 have decreased and remained below 20% in Reach 2. However, the contribution of these activities on a watershed scale have not been considered within the context of natural condition therefore the Chiwawa River is judged to be functioning at risk for sediment.

Chikamin Creek

McNeil core samples have been collected from a moderate-gradient, cobble-dominated reach of Chikamin Creek (bull trout spawning habitat) from 1995-2000. In 2001 the sampling location was moved below FS Road 6200 bridge on the alluvial fan of Chikamin Creek because if fine sediment input to Chikamin Creek were to increase above background levels due to management activities, we would expect any increase to appear first in “response'' or depositional areas (e.g. the alluvial fan below 6200 road crossing, which is key chinook and steelhead rearing habitat), rather than in the transport-stream-type and bull trout spawning habitat where sampling has occurred. Percent fines averaged 13.6% over the sampling period (range 9.66-18.79). For the period 1995-99, the volume of fine sediment has been consistently low in Chikamin Creek however, 2000 and 2001 highlights a significant increase in percent fines, which may be the result of sampling in a depositional zone. In 2002, fine sediment levels decreased significantly from 18.8% to 13.9%.

A pumice mine in Chikamin headwaters that has created several acres of exposed soil may be a source of fine sediment to Chikamin Creek. Visual observations (for example 1997 photos, Lake Wenatchee R.D.) indicate that sediment is likely routed from the mine site into perennial headwaters of Chikamin Creek. Mine operation ceased prior to 1997. In summer of 1997, the operator re-contoured and re-graded the site, installed five cross drains, seeded and fertilized the area, and subsoiled the road spurs in the mine area. The operator has been released from further obligation to the site. The volume of fine sediments has been consistently below the standard of 20% in Chikamin Creek for the 8 years of samples. Management activities in the watershed have included mining exploration and extraction, roading, timber harvest, and mountain bike/motorcycle trail development. With the exception of mining activities in the headwaters, most of these activities are sufficiently buffered from riparian areas. Presently, the extent natural conditions in the watershed (e.g. erodible sandstone rocks of the Chumstick Formation) contribute to the sediment production of the subwatershed is not known. Chikamin Creek is considered to be properly functioning for fine sediment at this time.

Deep Creek

Fine sediment appears to be a problem in the lower reaches of Deep Creek (Chiwawa Watershed Analysis 1997). Burgess and Morrow Meadows are in low gradient sections of the Deep Creek valley with Rosgen C and E channel types. Downstream of the meadows the stream is dominated by Rosgen E channels with stable banks and a healthy floodplain. Substrate in Deep Creek consists of gravels and sands. Livestock grazing has contributed to stream bank instability and erosion in the areas of the meadows.

Below the meadows, percent fines (<6.3 mm) measured 35% (1995 Wolman pebble count), while the D50 was 11 millimeters. Fine sediments were dominant in the surface areas due to the influence of low-gradient meadows that stops the transport of large substrates to the lower reaches. Also of note would be the grazing within the meadows. Deep Creek above the meadows (high gradient source and transport reaches, 10-20% gradients) is much lower in fine sediment, is dominated by gravels and cobbles and appears to have stable banks (Goose-Maverick ORV Tie Trail Biological Evaluation, 1997). Overall Deep Creek appears to be functioning appropriately relative to sediment but is considered functioning at risk due to the grazing activity in the meadows.

More recently the US Forest Service conducted stream surveys from 2015-2018 which included looking at sediment in the major streams in the lower portion of the Chiwawa watershed Surveys used the United States Forest Service (USFS) Region 6 Level I & II Stream Survey Protocol Version 2.16 for eastside streams (USFS 2013).

In the Lower Chiwawa subwatershed, substrate in reaches based on pebble counts performed in fast water units was generally dominated by gravel (63%) but included sand/fines < 2mm (29%) with smaller amounts of cobbles (7%) and boulders (1%). Ocular substrate composition estimates in riffles showed substrates that were dominated by gravel (52%) with sand/fines < 2mm (38%), cobble (8%), boulder (2%), and bedrock (0.05%) components.

Most of the reaches surveyed had few, if any, signs of disturbance. For all streams, the reaches most impacted by disturbances were the most downstream reaches that confluence with the mainstem Chiwawa River. Across all Chiwawa tributary streams, the most downstream reach was intersected by the Chiwawa Loop Road and had the most disturbance from roads, camp sites, and other residential development. The Lower Chiwawa River subwatershed has high density of roads within the riparian corridor. Reaches located further upstream from the Chiwawa Loop Road were impacted by forestry practices, USFS roads, and other small-scale disturbances. Of the surveyed reaches only 1% of channel length had bank erosion. Riffle units had the most erosion (658 feet of 42,495 feet total length) while pool units had the highest percent of total length overall eroding (2.7%).

Although the sand/fine sediment measurements collected as part of stream surveys include larger particles aside from those < 1 mm, those measurements indicating fines at 29% and 38% <2mm are well above 20% , which is indicative of elevated substrate embeddedness and high levels of fine sediment. When considered in combination with the other sediment data discussed a functioning at risk rating for the watershed is reasonable.

Chiwawa Ruver HUC 10 summary: functioning at risk

Chemical Contaminants / Nutrients: Consistently low pH readings have been measured in the headwaters of Chikamin Creek at an audit associated with the Gold Ring/Silver Dome mine exploration activities. Late summer to early fall measurements have ranged between 4.05 and 6.79 (avg. 5.06) at this site for the period 1997-2001. It should be noted however that low pH was also recorded at ground seeps in the Chikamin watershed for the same period; the sampled seeps were located throughout the watershed including above the mining claim boundary, tributaries within the claim boundary, and tributaries outside of the claim boundary. The 1997-2001 range of averages for the seeps was 6.44-6.96.

Historic mining occurred in much of Chiwawa headwaters; however no known chemical contamination occurred. Some mine tailings in the Red Mountain and Trinity area remain unvegetated. They have been tested for leachate / water quality concerns, and no problems were detected (Dan Rife, pers. comm.). The tailings are on private land. In some cases they may be within 300 ft of streams (for example Trinity tailings may be within 300 ft of Phelps Creek). The tailings are crushed rock size. There is no obvious contribution of fines from the tailing to streams.

No streams in Chiwawa watershed are on the CWA 303(d) list. The current condition of the watershed appears to be functioning appropriately.

Chiwawa Ruver HUC 10 summary: properly functioning

Habitat Access

Physical Barriers: A supplementation hatchery run by the CCPUD at the mouth of the Chiwawa River controls fish passage with a weir; fish are able to migrate past it however, USFWS and WDFW believe (as a result of telemetry data) that the weir interferes with upstream migration.

Two culverts in the headwaters of Chikamin Creek (crossing of FS road 6210) are impassable to fish but are believed to be upstream of all fish-bearing waters (1989 Chikamin stream survey). The lower culvert across Brush Creek may be a passage barrier (Dan Rife, personal communication) but may currently be an effective barrier to brook trout colonization of Brush Creek above the culvert (1998 Brush Creek Report). A culvert inventory in 2000 found passage barriers on Deep Creek, Elder Creek, Goose Creek, Grouse Creek, Gate Creek, Minnow Creek, Elder Creek, Alder Creek, Twin Creek and Finner Creek (2001 Culvert Database). Of these culverts, Deep Creek, Minnow Creek, and Gate Creek barriers occur in potential anadromous habitat. Passage problems are primarily associated with velocity through the culvert, the distance through the culvert, and jump height into the culvert affecting juvenile passage. The remaining barriers are upstream of anadromous habitat where water quantity and gradient are the upstream limitations.

A surface water diversion from Phelps Creek in T30N, R16E, SEC14 provides power to the private development at Trinity. The Trinity diversion is located within fish-bearing waters where westslope cutthroat are abundant. The diversion is above natural passage barriers to bull trout, steelhead, and spring chinook. The diversion does not block upstream fish passage, and may not capture significant amounts of downstream migration because water is taken from a backwater above a naturally occurring 8+ ft waterfall; however the diversion is unscreened so there may be potential impacts to westslope cutthroat trout. The diversion is currently up for relicensing under FERC and screening is being addressed.

An irrigation diversion from the Chiwawa River about ¼ mile below the mouth of Deep Creek provides up to 4725 acre-ft/yr to the irrigation district. The diversion is screened and the screen was redesigned 3 years ago to protect fry.

Although passage through Chiwawa watershed is good overall, we rate this element functioning at risk since culverts on tributary streams may be barriers to juvenile fish and the weir bay pose a migration barrier to bull trout.

Chiwawa Ruver HUC 10 summary: functioning at risk.

Habitat Elements

Substrate Embeddedness: Addressed with Sediment.
Large Woody Debris: The White-Little Wenatchee watershed analysis (1998) analyzed LWD abundance reported in stream surveys at the Wenatchee subbasin scale. The goal of this analysis was the creation of categories, with reduced variation in LWD within each category. For LWD >12" these categories are: pool-riffle channels (alluvial), bedrock channels, channels <10 ft. wide (low order) and other channels (climax vegetation zone). Analyses of Wenatchee Highlands streams indicate the typical[4] range is 70-160 in alluvial channels, 15-200 in bedrock channels, 5-100 in low order channels, and 20-200 in other channels (categorized by vegetation/ TSME/TSHE or ABAM).

Table 40. LWD abundance in surveyed reaches of Chiwawa watershed.

Stream	Reach	Year	Channel Type	LWD >12" diam/mile	Includes Potential LWD
Chiwawa River	1	1996	alluvial	134	no
Chiwawa River	2	1996	alluvial	126	no
Chiwawa River	3	1996	alluvial	112	no
Big Meadow Creek	2	1993	alluvial	3	yes

[4] These figures do not include stream data where potential wood was inventoried or alpine meadows. We also dis not include data which we determined to be altered from management practices.

Chikamin Creek	1	1998	alluvial	39	no
Schaefer Creek	1	1995	bedrock	10	no
Gate Creek	1	1989	low order	502	yes
Grouse Creek	1	1989	low order	639	yes
E. Fork Chikamin	1	1989	low order	768	yes
Rock Creek	1	1990	ABAM	60	yes
Rock Creek	2	1990	ABAM	133	yes
Rock Creek	3	1990	ABAM	145	yes
Big Meadow Creek	1	1993	ABAM	115	yes
Big Meadow Creek	3	1993	ABAM	118	yes
Chikamin Creek	2	1998	ABAM	100	no
Chikamin Creek	3	1998	ABAM	76	no
Chikamin Creek	4	1998	ABAM	141	no
Chikamin Creek	5	1998	ABAM	53	no
Chikamin Creek	6	1998	ABAM	60	no
Chikamin Creek	7	1998	ABAM	54	no
Minnow Creek	1	1989	ABAM	285	yes
Minnow Creek	2	1989	ABAM	513	yes
Minnow Creek	3	1989	ABAM	616	yes
Minnow Creek	4	1989	ABAM	557	yes
Upper Chiwawa	1	1993	TSME/TSHE	21	yes
Upper Chiwawa	3	1993	TSME/TSHE	22	yes
Phelps Creek	1	1992	TSME/TSHE	38	yes

Phelps Creek	2	1992	TSME/TSHE	50	yes
Phelps Creek	3	1992	TSME/TSHE	7	yes
Buck Creek	1	1992	TSME/TSHE	26	yes
Buck Creek	2	1992	TSME/TSHE	60	yes

Most surveyed reaches in Chiwawa watershed fall within the range of values for LWD categorized by channel types. The Chiwawa mainstem below Chikamin Creek (not reported in table above) has 92 LWD/mile (1992 Stream Survey Report), which is near Forest Plan standards of 100 pieces/mile. However, this difference is not significant relative to wood counting errors that occur during a stream survey.

From 2015-2018, surveys for LWD were conducted in Lower Chiwawa and Big Meadow Creek subwatersheds. Reach-Based Ecosystem Indicators (REI) were developed to provide a consistent framework for evaluating the condition of LWD and other indicators within the context of regional standards that consider the habitat requirements of key aquatic species. In general, the REI process evaluates the quality of stream habitat conditions with respect to watershed condition, habitat access, habitat quality, channel dynamics, and riparian condition. These pathways include a suite of indicators that are yield ratings of **Adequate**, **At Risk**, or **Poor** based on a combination of qualitative and quantitative evaluations of conditions at watershed and reach scales.

Table 41. Lower Chiwawa River and Big Meadow Creek LWD

Reach	LWD piece/mile	LWD X2 piece/mile	Total LWD/mile	% Overstory Large and Mature Trees	LWD/mile REI rating	Overstory Recruitment rating	Overall rating
Chiwawa from Wenatchee to Clear 1-36	3	-	3	-	Poor	-	Poor
Chiwawa from Clear to Alder 37-115	2	-	2	-	Poor	-	Poor
Chiwawa from Alder to Big Meadow 116-152	6	-	6	-	Poor	-	Poor
Chiwawa from Big Meadow to Twin 153-159	2	-	2	-	Poor	-	Poor
Chiwawa from Twin to Grouse 160-192	5	-	5	-	Poor	-	Poor

Chiwawa River Reach 2 2015	4	-	4	-	Poor	-	Poor
Chiwawa R50	1	0	1	0	Poor	Poor	Poor
Gate R49	6	13	19	38	Poor	Poor	Poor
Gate R23	1	6	7	43	Poor	Poor	Poor
Grouse R18	21	25	47	64	Adequate	At Risk	Adequate
Grouse R41	44	29	74	60	Adequate	At Risk	Adequate
Grouse R5	9	9	18	25	Poor	Poor	Poor
Twin R40	7	14	21	37	Adequate	Poor	At Risk
Alder R52	10	-	10	-	Poor	-	Poor
Alder R19	4	-	4	0	Poor	Poor	Poor
Alder R26	-	-	-	-	-	-	-
Alder R28	-	-	-	-	-	-	-
Alder R37	-	-	-	-	-	-	-
Alder R55	-	-	-	-	-	-	-
Goose R2	1	2	4	18	Poor	Poor	Poor
Deep R53	2	12	14	38	Poor	Poor	Poor
Deep R6	0	0	0	0	Poor	Poor	Poor
Deep R47	7	10	17	25	Poor	Poor	Poor
Clear Creek Reach 1 2015	6	-	6	-	Poor	-	Poor
Clear R21	2	4	6	0	Poor	Poor	Poor
Clear R33	11	11	22	80	Adequate	Adequate	Adequate
Clear R8	5	13	18	43	Poor	Poor	Poor
Clear R17	2	9	11	25	Poor	Poor	Poor
Big Meadow Cr R1	12	-	12	17	Poor	Poor	Poor
Big Meadow Cr R2	6	-	6	11	Poor	Poor	Poor

Alluvial Channels:

LWD levels in Big Meadow Creek and Chikamin Creek Reach 1 are below the range of values for these channel types with Big Meadow also not meeting the REI indicator metric for properly functioning habitat. Large accumulations of wood in the meadow reach (Reach 2) of Big Meadow Creek are not expected in the narrow and deep channel of this reach (Rosgen E channel type) due to the bridging effect of fallen wood and the vegetative characteristics of the meadow (shrubs/grasses/forbs) therefore, Big Meadow Creek (Reach 2) may be considered properly functioning for its channel type and vegetative character.

The alluvial fan of Chikamin Creek has been altered from its natural condition. As a result of channel straightening and LWD removal in the 1940's, much of Chikamin Creek's alluvial fan is abandoned floodplain. Presently, Chikamin Creek is entrenched on the upper fan area with reduced LWD recruitment from the elevated terrace and from historic timber harvest. Current LWD values on

Chikamin fan are below the range of values for alluvial channel types however, long-term woody debris recruitment through downstream delivery and from the banks is functioning properly, resulting in a functioning at risk determination.

Bedrock Channels:

Schaefer Creek falls slightly below the range of vales for bedrock channels however; this is judged to be the natural condition for this channel with very little management influence (one hiking trail bridge near the upper reach).

Low Order Channels:

Very high LWD abundance in these channels is suspect. Recent surveys of LWD in some of the low order channels in the lower watershed indicate far fewer pieces of instream LWD to the extent that most are not properly functioning. A re-survey of Chikamin Creek in 1998 (also initially surveyed the same year as these streams with the same methodology) supports our theory that early methodology overestimated large wood counts particularly related to potential LWD.

Other Channels:

Phelps Creek Reach 3 falls below the range of values however, this is a high alpine meadow reach (Spider Meadow) and like Big Meadow Creek above due to channel type and natural vegetative characteristics it is considered functioning appropriately. LWD values in Buck Creek Reach 1 and Upper Chiwawa Reach 1 fall near the lower end of the range and this is likely due to a substantial bedrock component in these reaches, there has not been vegetation removal in these systems (wilderness streams).

Like Chikamin Creek on its alluvial fan, Rock Creek was artificially channelized on its alluvial fan in the 1940's, which appears to have reduced LWD abundance on the fan. However, potential LWD along Rock Creek fan and in the upper section of the reach is good. The Forest Service has attempted to reduce recreational impacts on the alluvial fan of Rock Creek by blocking vehicle access and disassembling fire rings.

Chikamin Creek Reach 1 is considered functioning at risk as outlined above.

Chiwawa Ruver HUC 10 summary: not properly functioning *(Lower Chiwawa subwatershed);* ***functioning at risk*** *(remaining subwatersheds).*

Pool Frequency/Quality/Large Pools: An analysis of pool abundance occurred in 1998 (White - Little Wenatchee watershed analysis), this analysis classified reaches according to geomorphic processes using characteristics of landtype, valley width, gradient and substrate. The 1998 analysis considered only channel-spanning pools that are eligible in the USFS Region 6 Stream Survey Protocol; in the survey years prior to 1995, pools were required to be longer than wide to be counted. Thus pocket pools, side pools, and many step pools and plunge pools that are important to fish, particularly in steeper channels, were not included. All surveyed reaches in Chiwawa watershed were included in the 1998 analysis, since they share geomorphic characteristics.

The analysis indicated that unconfined, low gradient (<2%); gravel or sand dominated pool-riffle channels in this landtype are typically 40-75% surface area channel-spanning pools. All surveyed Chiwawa reaches in this category have 42% or more percent pool[5] with exception of Chikamin Creek on its alluvial fan, which is 35% pool. Reduced channel sinuosity and LWD inputs as a result of timber management and channel straightening (see LWD discussion above) have likely attributed to reduced pool frequency in this segment to Chikamin Creek.

In another category, low gradient larger substrate plane-bed channels in this landtype that have been lightly managed (including Icicle Creek, French Creek, and White River above White River Falls) are typically 30-65% pool. More heavily managed channels in this grouping (including lower Nason Creek and lower Little Wenatchee River) may have as little as 11% pool. Chiwawa River below Goose Creek has 6% pool, and cover is limited to depth (all pools greater than five feet deep) and large boulders. All other surveyed Chiwawa reaches in this category have at least 46% pool. Chiwawa River below Goose Creek is judged functioning at risk for pool frequency.

Higher gradient channel types appear to have lower percentage surface area of channel-spanning pool as the natural condition. Lightly managed 2-4% gradient streams in this landtype (including Leland, Jack, Cady, and White River above White River Falls) had 9-30% pool. Rock Creek on its alluvial fan currently falls in this category, and its 11% pool is not outside the typical range. However Rock Creek's channel type may have been altered when the channel was straightened. Chikamin Creek above its alluvial fan and below its confluence with East Fork Chikamin ranges between 23 and 40% pool area (1998 survey of Reaches 2-5), this area of Chikamin Creek is very lightly managed with tremendous amounts of LWD input which "force" many pools in a Rosgen B channel type.

Lightly managed 4-8% gradient channels in this landtype (including Trout, Indian, Doughgod, and Jack Creeks) typically have 5-30% pool. Rock Creek above its alluvial fan has 13% pool, with good cover and good pool quality. Rock Creek above its alluvial fan has experienced little management appears in its natural condition. Chikamin Creek Reach 6 (1998 survey) has 17% pool, some timber harvest has occurred adjacent to the channel in this reach possibly affecting pool development. All other Chiwawa reaches in this category are within the wilderness and are believed to be within their natural condition for pool frequency and quality.

In the highest gradient streams in this landtype (>12% gradient), very low percentages of channel-spanning pool may be within the natural condition. Reach 7 (1998 survey) of Chikamin Creek has 14%

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[5] Throughout this document, ``percent pool'' will mean percent surface area of channel-spanning pools unless otherwise specified. This is an underestimate of total pool habitat because it does not include side pools, pocket pools, and other pools that do not span the entire wetted channel.

pool, but this is a higher percentage than a wilderness stream (Chatter Creek) in this category. No sign of pool filling was noted in 1998 surveyed streams with cover and pool quality rated high in surveyed streams Rock Creek and Chikamin Creek. Both streams are rated functioning at risk for pool habitat.

Recent surveys in Lower Chiwawa and Big Meadow subwatersheds classified Goose Creek, Deep Creek and Clear Creek as not properly functioning. Pool data for many of the small tributaries in the lower watershed (Clear, Deep, Goose), where significant roading and timber management have occurred indicate they are not properly functioning for pools; while Alder, Twin, Grouse and Gate appear to be properly functioning (Table 42).

Table 42. Lower Chiwawa River and Big Meadow Pool Habitat

Reach	Pools/mile	Max D3 pools/mile	Pool Frequency REI	D3 Pool Frequency REI
Wenatchee-Clear 1-36	5.3	5.3	Adequate	At Risk
Clear-Alder 37-115	4.8	4.6	Adequate	At Risk
Alder-Big Meadow 116-152	4.2	4.2	Poor	At Risk
Big Meadow-Twin 153-159	1.5	1.5	At Risk	Poor
Twin-Grouse 160-192	2.3	2.3	At Risk	Poor
Chiwawa River Reach 2 2015	9.5	13.5	Adequate	Adequate
Chiwawa R50	5.2	2.6	Adequate	Poor
Gate R49	95.1	0	Adequate	Poor
Gate R23	96.5	0	Adequate	Poor
Grouse R18	93.1	0	Adequate	Poor
Grouse R41	71.7	0	Adequate	Poor
Grouse R5	46.3	0	Adequate	Poor
Twin R40	60.9	0	Adequate	Poor
Alder R52	54.0	0	At Risk	Poor
Alder R19	75.0	0	Adequate	Poor
Alder R26	-	-	-	-
Alder R28	-	-	-	-
Alder R37	-	-	-	-
Alder R55	-	-	-	-
Goose R2	23.1	0	Poor	Poor
Deep R53	33.6	0	Poor	Poor
Deep R6	13.2	13.2	Poor	Adequate
Deep R47	3.3	0	Poor	Poor
Clear Creek Reach 1 2015	28	0	Poor	Poor
Clear R33	43.6	0	Poor	Poor
Clear R21	29.5	0	Poor	Poor
Clear R8	6.5	0	Poor	Poor
Clear R17	22.1	0	Poor	Poor
Big Meadow Cr R1	47	0.8	Adequate	Poor
Big Meadow Cr R2	41	0.7	Adequate	Poor

Chiwawa River between Alder and Grouse Creek is mainly functioning at risk (Table 42). The remainder of the upper watershed is rated properly functioning for pool habitat. Overall rating for watershed is functioning at risk.

Chiwawa Ruver HUC 10 summary: functioning at risk.

Off-Channel Habitat: Chiwawa River valley floor has an extensive high quality network of ponds, beaver canals, side channels, abandoned oxbows and other wetlands. Abundance, diversity, connectivity and quality of these wetlands are extremely high (Chiwawa Watershed Analysis 1997).

Brush, Big Meadow, Minnow and Marble Creeks also have extensive riparian wetlands, which appear to be healthy and to have retained their original extent. Some wetlands in the lower watershed on private land (for example Burgess and Morrow Meadows) and some on Forest Service land near recreation

Wetland and off-channel habitat overall in the watershed is in excellent condition and is rated properly functioning.

Chiwawa Ruver HUC 10 summary: properly functioning.

Refugia: The Chiwawa River is considered a Category 1 watershed under the Upper Columbia River Strategy To Protect And Restore Salmonid Habitat In The Upper Columbia Region (July 2001). Category 1 watersheds represent systems that most closely resemble natural, fully functional aquatic ecosystems. In general they support large, often continuous blocks of high-quality habitat and subwatersheds supporting classifications for multiple populations. Connectivity among subwatersheds and through the mainstem river corridor is good, and more than two species of federally listed fish are known to occur. Exotic species may be present but are not dominant.

Third order drainages (Rock, Chikamin, Phelps, Buck, James, etc.) in Chiwawa watershed provide well-connected, but semi-autonomous habitat for bull trout, westslope cutthroat and juvenile steelhead, and function as a connected network of refugia, so that a disturbance event in one watershed is mitigated by access to neighboring watersheds. The same process on a larger scale provides refugia to chinook, steelhead and bull trout through good connectivity to White, Little Wenatchee, Nason, and mainstem Wenatchee.

However not all life stages of all species have refugia. Outmigrating steelhead and spring chinook depend on the lower Wenatchee River where riparian development threatens instream quality (especially when coupled with natural disturbance such as flooding) and refugia are lacking. Refugia for steelhead and chinook that outmigrate from the Chiwawa into the mainstem Wenatchee may be at risk in the mainstem Wenatchee, however habitat refugia in the ***Chiwawa watershed is properly functioning*** for all life stages and species.

Channel Condition and Dynamics

Width:Depth ratio: Width:depth ratios in Chiwawa River below Phelps Creek range 32-41feet, which is typical for an unconstrained Rosgen C channel in this landtype (Robison and Barry 1996). Rosgen C3 channels average 33 for width:depth (Rosgen 1996).

Rosgen B channels in the watershed, including upper Chiwawa, Buck Creek, Rock Creek, Chikamin, and portions of Phelps Creek, ranged 9-24. The typical range for Rosgen B4 channel width:depths is 12-20; less common values of 28 and 36 are also reported (Rosgen 1996).

Lower Phelps Creek, a Rosgen A channel type, had a width:depth ratio of 10; A channel width:depths are typically less than 12 (Rosgen 1996).

Surveys for W:D were included in stream survey data collected for Lower Chiwawa and Big Meadow Creek subwatersheds in 2015-2018. Chiwawa tributary reaches were largely rated as functioning properly, except for Alder Creek and Big Meadow Creek reaches where BFW:BFD ratios were rated functioning at risk. Chiwawa mainstem reaches were largely rated not functioning properly and functioning at risk.

Chiwawa River HUC 10 summary: functioning at risk.

Streambank Condition

The Chiwawa River naturally experiences high rates of lateral migration (Barry 1996). High levels of bank erosion (10-30%) were observed following two floods of record in a five-year period. Only a small fraction of the bank erosion was management-related (adjacent to roads/campgrounds); nearly all of the erosion was in unconfined, low-development areas and appeared to be associated with natural channel migration (Chiwawa River stream survey 1996). This degree of bank erosion appears to be the natural condition of the channel (1996 flood report), and bank erosion in this landtype appears to be positively correlated with LWD input (White - Little Wenatchee Watershed Analysis 1998).

Areas of bank erosion do occur adjacent to several campgrounds along Chiwawa mainstem (Chiwawa watershed analysis 1997). In 1999 and 2000 rehabilitation efforts including site designation with surfaced roads and sites; boulder, log, and vegetation barriers; access trail development; and minor site relocations occurred at Atkinson Flat, Schaefer Creek, Riverbend, Swallow Caves, and East and West Chiwawa Bridge dispersed sites; bank erosion attributable to recreation use has improved at these locations. An effort to locate and inventory all recreation sites (dispersed and developed) in the Chiwawa watershed began in 2002 and will continue in 2003; this effort will allow the District to quantify recreation use and identify sensitive areas that may require restoration and education (a la Respect the River Program) to reduce impacts that may occur from recreation use including bank erosion. Presently, the extent of the streambank damage due to recreation appears to be small in scale but, individual locations that have not been hardened or designated are a concern based on the time of recreation use and the type of use (access to sensitive spawning areas is the primary concern).

Grazing in Morrow and Burgess meadows appears to have altered the streambank vegetation over time (Chiwawa Watershed Analysis 1997).

Local areas of bank damage, usually occurring in campgrounds, do occur as was noted in 2015-2018 stream surveys, but overall the Chiwawa watershed is rated properly functioning for streambank condition.

Chiwawa Ruver HUC 10 summary: properly functioning.

Floodplain Connectivity: Along Chiwawa River above Goose Creek, excellent connectivity exists between Chiwawa River and its floodplain (see off-channel habitat above). Below Goose Creek the channel is naturally confined and downcut into a glacial moraine (Chiwawa watershed analysis 1997).

In some areas of Burgess and Morrow Meadows (Deep Creek), the floodplain is not properly linked to wetlands due to many years of grazing and is considered at risk in these localized areas.

At the watershed scale however, floodplain connectivity is ***functioning appropriately*** *in Chiwawa watershed*.

Flow/Hydrology

Peak/Base Flows: Thirty-five percent by area of Meadow-Brush Creek watershed has been harvested, and 25% of Lower Chiwawa has been harvested. Only 2% of the remainder of the watershed has been harvested (Chiwawa watershed analysis 1997). Road densities in Meadow-Brush and Lower Chiwawa are 3.7-3.8 miles per square mile. Road density in the remaining watershed is less than 1 mile per square mile. Harvesting and associated road-building in these areas was completed in the 1980's; the harvest units are determined to be hydrologically mature after 20 years of growth in this high precipitation zone (40-78 inches annually) (M. Karrer, personal communication 2003).

A USGS continuous recording gaging station located on Chiwawa River near Goose Creek has operated (with interruptions) since 1911. This location is downstream of Meadow and Brush Creeks, but upstream of much of the private development in the watershed. An analysis of streamflow data from selected gaging stations within the Wenatchee River subbasin was conducted to characterize hydrologic processes for dryer subwatersheds (Robison 1995). Included in the analysis were wetter subwatersheds, including the Chiwawa, Icicle, Little Wenatchee, and White River. In these geomorphologically similar watersheds bankfull flow values ranged 16.1 (Chiwawa) to 28.8 (White). A comparison of peak flow events with return intervals from two to 100 years showed a range of base flow (2 year flow)/peak flow (100 year flow) ratios of 1.3 (White) to 2.6 (Icicle), the Chiwawa ratio was 2.2. The analysis concluded that the average wet site 100 year peak flow is only 3.5 times greater than that for dry sites however, the average two year peak for a wet site is over ten times greater than that for the dry sites thus, dry systems tend to be flashier yielding greater water in major peak events or conversely wetter sites are better regulated.

Karrer (personal communication, 2003) states that ECA modeling of smaller (6th field watersheds) show that at least 25-30% of the watershed must be in a clear-cut or non-vegetated condition to show changes in peak and base flows. Lower watershed alterations may (have) alter(ed) peak and base flows at the smaller subwatershed level however, the Chiwawa River watershed as a whole is considered **functioning appropriately** since the lower watershed has little effect on the snow-melt dominated system.

Increase in Drainage Network: The road network may contribute to increased drainage network density in portions of the watershed (see road density below).

Trail density in Rock watershed is 2.33 mi/mi^2. Trail density in Chikamin, Upper Chiwawa, and Headwaters Chiwawa is 1-1.6 mi/mi^2. Trail density in the remainder of the watershed is less than 0.5 mi/mi2. Erosion problems have been documented on several system and non-system trails in Headwaters Chiwawa (Chiwawa Watershed Analysis 1997).

Although sections of several trails in headwaters Chiwawa have erosion problems, the percentage of the trail system with erosion problems is low. These are narrow, non-motorized trails on high elevation ridges and meadows, in many cases distant from perennially flowing lotic water feature. Trails could be a potential source of drainage network increase if the trails are capturing ground water or collecting and routing surface runoff. Due to the depth of glacial till in the watershed and the very shallow excavation required to construct a trail there should be little if any capture of ground water. We do not believe the trails significantly increase drainage network density. The *Chiwawa watershed is rated **functioning appropriately*** for non-road-related increases in drainage density.

Watershed Conditions

Road Density and Location:

6th field watershed	road density (mi/mi2)
Rock Creek	0.1
Headwaters Chiwawa	0.1
Upper Chiwawa	0.4
Chikamin Creek	0.7
Middle Chiwawa	1.5
Meadow - Brush	3.7
Lower Chiwawa	3.8

Rock, Chikamin, and Chiwawa above Rock Creek are considered functioning appropriately because of road densities less than 1 mi/mi^2. Chiwawa between Brush and Rock has a road density of 1.5. This includes the main travel route up Chiwawa (6200 road) and some logging roads on the ridge between Brush Creek and Chiwawa River, far from any riparian impact. This 6th field watershed is also considered to be functioning appropriately.

In the Chiwawa watershed below Brush Creek, including Brush and Big Meadow Creeks, road density exceeds 3.7 mi/mi^2. The entire watershed is rated ***functioning at risk*** *for road density.*

Disturbance History: The watershed from Brush Creek downstream, including Brush and Big Meadow, has > 3.7 mi/mi2 of roads. Although the area harvested (> 25%) is considered hydrologically recovered, much of the harvest and roading occurred in areas of moderate or high debris failure hazard and in riparian areas with inadequate buffers (Chiwawa Watershed Analysis 1997). The amount of late successional habitat in the watershed is not known at this time. The watershed is rated ***functioning at risk*** for disturbance history due to miles of roads and harvest activity.

Riparian Reserves: The riparian condition of Big Meadow, Brush, Clear, Deep, Goose, Elder, Alder, and Twin Creeks, and of Chiwawa River below Goose Creek, is fair to poor (see LWD discussion, page 29) due to riparian roads and timber harvest with inadequate riparian buffers (Chiwawa Watershed Analysis 1997). Riparian function in these portions of the watershed is reduced, but greater than 25% of the riparian vegetation is in a natural condition. The lower Chiwawa is rated **functioning at risk** for riparian condition. The upper Chiwawa has excellent riparian condition (Chiwawa Watershed Analysis 1997) that is well connected; however, recreation use within riparian areas may not adequately buffer refugia for sensitive species. The middle portion of the Chiwawa (Chikamin Creek to Phelps Creek) is a favorite destination for many recreationists, and most of the developed and dispersed campsites in the Chiwawa watershed are located within the middle Chiwawa's riparian reserves. The Chiwawa Watershed Analysis highlighted several recreation sites that are at risk from natural channel processes (lateral migration and debris flows), consequently the location of these sites also interrupts natural riparian reserve processes (sediment filtering, LWD recruitment). The extent of the riparian disturbance on a watershed scale is currently being evaluated; there are known localized areas of riparian degradation and user-related effects to at risk fish that are currently being addressed in the Respect the River program. Overall, the watershed is considered ***functioning at risk*** at this time for riparian condition.

Integration: Habitat in the upper watershed (above Chikamin Creek) is largely pristine. This portion of the watershed provides 90% of the chinook spawning, the majority of the bull trout spawning, a substantial portion of the chinook rearing, steelhead rearing, and bull trout rearing, and also contains the most genetically pure and possibly the strongest cutthroat populations.

All current management activities in the upper watershed revolve around recreation. Identified management concerns include several campgrounds beside Chiwawa River. The concerns, described in Chiwawa Watershed Analysis (1997), and further elucidated through monitoring (2002) mainly revolve around bank erosion, habitat alteration, and possible harassment to spawning spring chinook and bull trout adjacent to the campgrounds. Several recreation restoration projects were implemented in 1998 and 1999 (Riverbend C.G., Schaeffer Creek C.G., Swallow Caves dispersed sites, East side and West side Bridge dispersed sites, and Atkinson Flat C.G.). The overall restoration goal is to improve streambank condition, floodplain function, and riparian condition for the benefit of recreationists and fisheries by limiting and defining access (vehicular and foot) into riparian reserves, gravelling, and providing drainage on roads, closing and rehabilitating dispersed sites, revegetating riverbanks, improving sanitation, and educating the recreation public. Erosion problems on high elevation trail routes probably have little relevance to the four fish species considered here. Apart from this, recreation use may have little impact beyond user-related effects that are currently being addressed in the Respect the River program.

One of the greatest threats to the upper watershed is from brook trout, which could damage existing healthy bull trout and westslope cutthroat populations through genetic introgression and competitive displacement. Hillman and Miller (2002) reported finding brook trout in the Chiwawa River, Chikamin Creek, and Big Meadow Creek during their 1992-2001 sampling. Brook trout were found during 2001 in the upper reaches of the Chiwawa and they concluded that brook trout now occur throughout most of the Chiwawa River.

The situation in the lower watershed (Brush Creek and below) is strikingly different. Numerous habitat concerns exist. Road density and disturbance history are rated functioning at unacceptable risk. Pool frequency in lower mainstem and on Rock Creek and Chikamin Creek alluvial fans are rated functioning at risk, due to historic channel straightening and log drives. Temperature, sediment, embeddedness, pools, potential large woody debris, riparian reserves, and disturbance regime are rated functioning at risk in all or parts of the lower watershed. These concerns relate to past roading and harvesting in the watershed. Riparian condition impacts from these activities are clear from aerial photos (Chiwawa Watershed Analysis 1997). Some roads have been closed, but monitoring is needed to determine the hydrologic effectiveness of the closures. Additional candidates for closure have been identified, but there are no immediate plans to do the work.

The lower watershed is a crucial migration corridor for the migratory life histories/stages of all four species addressed in this document. Although impacts have occurred, passage is not yet thought to be hindered: bull trout spawning populations are among the highest in the mid-Columbia basin; observed declines in spring chinook spawning in the 1990's seems linked to a larger spatial phenomenon, mirroring patterns throughout the Wenatchee basin. Brook trout may displace rearing steelhead in the lower watershed.

The lower watershed (below Brush Creek) is judged to be **functioning at risk**, and the upper watershed is considered **functioning appropriately.**

Potential Effects on Listed Fish and Critical Habitat

The format from the Analytical Process for Developing Biological Assessments for Federal Actions Affecting Fish Within the Northwest Forest Plan Area (USDA et al. 2004) was used in preparing the project effects section. The analysis procedure involves looking at the following eight factors when considering effects: proximity, probability, magnitude, distribution, frequency, duration, timing, and nature. These were derived from the ESA consultation handbook (USDI and USDC 1998).

Summary statements for each indicator use the terms positive; negative; or neutral to describe the effect of the project elements on the direction of the baseline indicator over time. A positive effect would improve the direction of the baseline indicator. Conversely, a negative effect would cause a decline in the direction of the baseline indicator. A neutral effect would not change the baseline indicator nor affect the direction of the baseline indicator, either positively or negatively. For the purposes of this specific assessment, a discountable effect (either positive or negative) is a qualitative statement indicating that there is an extremely unlikely probability of something occurring. An immeasurable effect (either positive or negative) is a qualitative statement indicating a potential effect but lacks sufficient magnitude to be meaningfully measured or affect resources.

The first three factors allow for a quick evaluation of project effects with insignificant, discountable, or no effects without further factor analysis. When assessing the Probability factor for an element, if the outcome is entirely discountable (extremely unlikely to occur), no further factor analysis is required for that element. If the outcome of the Probability analysis is not discountable, assess for Magnitude. Should the outcome for Magnitude result in insignificant effects, no further factor analysis is required for that project element. When the outcome to magnitude is significant or results in take, we analyzed the remaining five factors. Where some of the indicators needed little discussion to discount effects, we did not follow the above method.

Some project activities will have mechanisms for effects to indicators, but they would not reasonably be affected due to proximity or to a lack of probability or would require effects to other indicators that are insignificant. For example, effects to pool habitat would occur from changes in wood levels, sediment loads, and alterations of streambanks. If each of the effects to each of these individual indicators would be insignificant, it's logical their additive effects to pool habitat would be insignificant as well. In these cases, indicator effects were analyzed but in a condensed manner.

Project Elements

To be consistent with the 2004 Analytical Process for Developing Biological Assessments for Federal Actions Affecting Fish With-in the Northwest Forest Plan Area (USDA et al. 2004), the non-ARBO II Mission Project activities were divided into the following Project Elements:

- All Vegetation Treatments including commercial and non-commercial thinning, burning, and construction of fuel breaks
- Transportation System Management (TSM)/Log Hauling/Temp Roads

Direct Effects

Vegetation treatments: No direct effects to listed fish would occur from the vegetation treatments proposed. No mechanical treatment or active ignition will occur within 100 feet of any fish bearing stream and hand thinning will not occur within 25 feet of stream or within the edge of riparian vegetation, whichever is greater (Table 3). These "no treatment" buffers provide an adequate barrier between vegetation treatments and active stream channels and will prevent any direct effects to ESA-listed fish.

Transportation System Management: Transportation system management includes building temporary roads and opening closed roads for vegetation management (including installing necessary culverts, removing culverts, and road reconstruction), decommissioning or hydrologically closing roads, removing stream crossings, and using roads for hauling timber (this includes any potential improvement or maintenance for haul purposes). Table 43 lists all roads identified for decommissioning, closure, or opening, in Riparian Reserves within 1000 ft of ESA listed fish and associated Critical Habitat. The comments describe the location of the roads action and estimated distance to streams that are occupied by ESA-listed fish or CH.

Table 43. Roads located in Riparian Reserves within 1000 ft of ESA listed fish and associated Critical Habitat.

NFS Road Number	Length (miles)	Action Recommendation	Species	Subwatershed	Comments
6102230	0.17	Decommission Closed Road	BLT; STH	Lower Chiwawa	outside edge of Elder Cr RR; 1000 ft upstream of BLT and STH CH (unoccupied)
6105130	0.44	Decommission Closed Road	STH	Lower Chiwawa	no crossings, adjacent to unnamed Clear Cr Trib, less than 50 ft from potential STH
6105140	0.79	Decommission Open Road	STH	Lower Chiwawa	no crossings, adjacent to Clear Cr, less than 50 ft from occupied and CH for STH
6121120	0.21	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	Outer edge of Chiwawa River RR, 250 ft from ESA fish and CH
6121120	1.13	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	Outer edge of Chiwawa River RR, only 300 ft of road in RR, 200 ft from ESA fish and CH
6121120	0.09	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, 150 ft from ESA fish and CH
6121125	0.20	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, 100 ft from ESA fish and CH
6121127	0.57	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, only 250 ft of road located in RR, 100 ft from ESA fish and CH
6121917	0.25	Decommission Open Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR, 200 ft from ESA fish and CH
6122674	0.09	Decommission Closed Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR, 200 ft from ESA fish and CH
6122912	1.35	Decommission Closed Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR, minimum of 100 ft from ESA fish and CH
6122918	0.31	Decommission Closed Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR, only 100 ft of road in RR, 200 ft from ESA fish and CH
6200202	0.11	Decommission Open Road	STH; BLT	Lower Chiwawa	Outer edge of Alder Cr RR, 300 ft from STH CH
6200310	0.19	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, 200 ft from ESA fish and CH
6200330	0.76	Open for Haul/Decommission Closed Road After Haul	STH	Lower Chiwawa	Crosses fishless Twin Cr intermittent side channel. Greater than 500 ft from STH but potential for STH access during high flows, culvert install/removal will occur during low flow isolation
6200340	0.90	Decommission Open Road	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, 200 ft from ESA fish and CH

6200380	0.04	Open Closed Road	BLT; STH; CHK	Lower Chiwawa	Adjacent to Grouse Cr, in campground. 750 ft from occupied habitat and no change to on-the-ground conditions
6200385	0.29	Close Open Road	BLT; STH; CHK	Lower Chiwawa	Adjacent to Chiwawa River, 150 ft from ESA fish and CH
6300151	0.11	Decommission Closed Road	BLT; STH; CHK	Lower Chiwawa	Adjacent to Chiwawa River, 25 ft from ESA fish and CH
6304114	0.20	Decommission Open Road	BLT; STH	Big Meadow Creek	Adjacent to Big Meadow Cr, 50 ft from STH and BLT
6304115	1.89	Close Open Road	STH	Big Meadow Creek	Only 800 ft located in outer edge of Big Meadow Creek RR (marsh area). Over 700 ft from STH.
6309000	1.97	Decommission Closed Road	STH	Big Meadow Creek	Crosses unnamed tribs to Big Meadow Creek, 750 ft from STH
6309117	0.32	Decommission Closed Road	STH	Big Meadow Creek	Adjacent to unnamed Big Meadow Creek tributary, 500 ft from STH
6606103	0.28	Decommission Open Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR, 150 ft from ESA fish and CH
7906000	0.39	Decommission Closed Road	BLT; STH; CHK	Beaver Creek-Wenatchee River	In Wenatchee River RR; no change on ground
6200125-0.3R-1	0.09	Decommission Unauthorized Route	BLT; STH; CHK	Lower Chiwawa	Adjacent to Chiwawa River, 100 ft from ESA fish and CH
6200130-0.08R-1	0.06	Decommission Unauthorized Route	BLT; STH; CHK	Lower Chiwawa	25 ft from Chiwawa R and 50 ft from Alder Cr. Dispersed campsite along route will be rehabbed using ARBO II.
6200200-2.8L-1	0.18	Decommission Unauthorized Route	STH	Lower Chiwawa	Outer edge of Alder Cr RR, 250 ft from STH and CH
6200310-0.2R-1	0.06	Decommission Unauthorized Route	BLT; STH; CHK	Lower Chiwawa	In Chiwawa River RR, 150 ft from ESA fish and CH
6300000-2.5L-1	0.05	Decommission Unauthorized Route	BLT; STH; CHK	Big Meadow Creek	40 ft from Big Meadow Cr, dispersed campsite at end of the route will be rehabbed using ARBO II.

Direct Effects to Bull Trout:

Proximity: Decommissioning and road closures - 11.39 miles of roads will be decommissioned in RRs within 1000 ft of occupied or critical habitat. 2.18 miles of roads will be closed post-project in RRs within 1000 ft of occupied or critical habitat. Many of the roads are located on the outer edges of RRs and none of the identified roads cross occupied or critical bull trout habitat. See Table 43 for road actions near bull trout occupied or Critical Habitat. There is no proximity to bull trout and so this will not be discussed further.

Temporary roads– No temporary roads will be built in RRs within 1000 ft of occupied or critical bull trout habitat. Only 0.04 miles of currently closed roads will be opened permanently, and this is a short spur road to the Grouse Creek Group Campsite and there will be no change on the ground. Temporary roads will not be discussed further.

Road openings- There are 5.7 miles of potential haul routes in RRs within 1000ft of occupied or critical bull trout habitat with 0.4 miles being currently closed roads that would be opened temporarily for hauling: 0.1 miles in the Wenatchee River Watershed (on the outer edge of an intermittent stream over 600 ft from the Wenatchee River) and 0.2 miles in the Chiwawa River Watershed (across an intermittent tributary to Twin Creek over 0.4 from occupied bull trout habitat in the Chiwawa River, and in the outer edge of the Big Meadow Creek RR, over 600 ft upland from occupied bull trout habitat). With no proximity to bull trout, road openings will not be discussed further.

Haul routes- Potential haul routes on unpaved roads are located at three stream crossings over critical habitat (unoccupied and confirmed with recent eDNA samples; J. Vazquez, 2021) in Alder Creek. Big Meadow Creek is the only tributary in the project area that has known bull trout populations but there are no unpaved roads that will be used for haul. Recent eDNA studies did not find presence of bull trout in Alder, Elder, or Twin Creeks and it is unlikely that bull trout are present in Gate, Brush or Goose Creeks (J. Vazquez, 2021). Based on eDNA surveys, snorkel surveys, and professional opinion, it is extremely unlikely that any of the IP habitat in tributaries in the project area (Brush, Gate, Twin, Alder, Goose, and Elder Creeks) contain any reproducing populations of bull trout. There is the possibility that bull trout may use any of these tributaries for rearing and foraging, in which case, bull trout would be more likely to be found near the confluence (<0.25 mile) with the Chiwawa River.

Table 44. Locations of unpaved road crossings in potential proximity to bull trout. Bold indicates crossing over CH. All these crossing will be repaired prior to log haul use.

Creek	Road Number	Stream Mile	Est Distance to Known Bull Trout (mi)	Project Phase and Years of Use	Max Log Trucks per Year (est)	Comments
Alder	**6208**	**0.8**	**0.4**	**1&2; Years 3-8**	**500**	**Alder Creek drainage is in Phase 1 but some of the roads might continue to be used in Phase 2. Surveys did not find any sediment contribution and road surface is graveled.**
Alder	**6102-200**	**1.3**	**0.9**	**1&2; Years 3-8**	**500**	**Alder Creek drainage is in Phase 1 but some of the roads might continue to be used in Phase 2. Road surface has rilling with minor sediment transport over land but not entering the stream.**
Alder	**6104**	**3.9**	**3.5**	**1&2; Years 3-8**	**500**	**Minor rutting and no evidence of sediment delivery to stream**
Elder	6102	0.3	0.9	2; Years 4-8	360	Graveled road surface and sediment is deposited into ditch, not the stream channel.
Goose	6200	0.4	0.4	2; Years 4-8	360	Rilling present with no evidence of sediment input.
Goose	6102	0.5	0.5	2; Years 4-8	360	Rilling present and delivers minor sediment to the stream.
Gate	6200	0.1	0.1	3; Years 2-5	400	No evidence of sediment input. Crossing is flat and side slopes are vegetated.
Brush	6306	1.0	1.0	3; Years 2-5	400	Road surface is graveled and in good condition but does slope

						towards the stream with the potential for sediment input.

Probability: Haul routes- Unpaved road crossings used for haul routes over critical habitat in Alder Creek will be maintained with gravel to reduce sediment entering the stream channel. Alder Creek is believed to be unoccupied at the unpaved road crossings (0.8 miles are greater from the Chiwawa River), and it is unlikely that log hauling will have any direct effects of bull trout or critical habitat, but not entirely discountable. Bull trout are more likely to be found in the Chiwawa River. The closest unpaved haul route crossing to the Chiwawa River over a tributary is Gate Creek where there is a crossing about 0.1 miles from the mainstem. Other unpaved crossings over tributaries are over 0.5 miles from the Chiwawa and there is a small probability that bull trout would be found that far upstream during this project. Based on the unoccupied status of the tributaries, it is unlikely, but not discountable that haul routes may have a direct affect to bull trout.

Overall, there is a low likelihood that transportation system management activities could cause sedimentation in occupied streams that may directly affect bull trout, but, due to the duration of the project and the abundance of bull trout found in the Chiwawa River, it is possible that bull trout may be present at these locations during the project.

Magnitude: Haul routes- All unpaved road crossings used for haul routes are over unoccupied critical or IP habitat. All crossings will be repaired and monitored during hauling and, at a minimum, crossings will be covered with gravel to reduce potential sediment inputs to the stream. All road maintenance within RRs will follow appropriate BMPs and will follow the design criteria and conservation measures outlined in ARBO II. These measures will ensure that the effects to bull trout will be minor.

There is a total of eight unpaved crossings that will be used for haul are less than 1.0 mile from occupied bull trout habitat or CH (Table 44). All crossings will be repaired and monitored during hauling and, at a minimum, crossings will be covered with gravel prior and during log hauling to reduce potential sediment inputs to the stream. By gravel armoring all fish-bearing clog haul crossings, there is expected to a reduction in sediment by 80% (Ward and Seiger 1983; Buck Forest and Fuels project; M. Karrer, personal communication). Field surveys within the project area found minimal evidence of sediment input at the crossing locations (Table 44) and by repairing then before haul, the magnitude will be minor. Additionally, GRAIP Lite model results (Nelson et al. 2018) indicate that most road segments in the project area contribute minimal, if any, sediment to the stream (Appendix C). Project area streams experience very little sediment input from roads, as calculated using GRAIP Lite.

Summary: While it is unlikely that sediment will enter occupied streams as part of the transportation management of the project, there is a small probability that haul routes over critical and IP habitat may be a source of sediment into the stream channel. Due to the low, but not discountable, probability of fish being present, the extent of sediment effects to a single bull trout or two would be minor. Even if a bull trout is present in the stream, any sediment that enters would be small and not sufficient to result in direct injury or physical stress. There may be isolated minor negative impacts to bull trout or designated critical habitat through the potential for increased sedimentation.

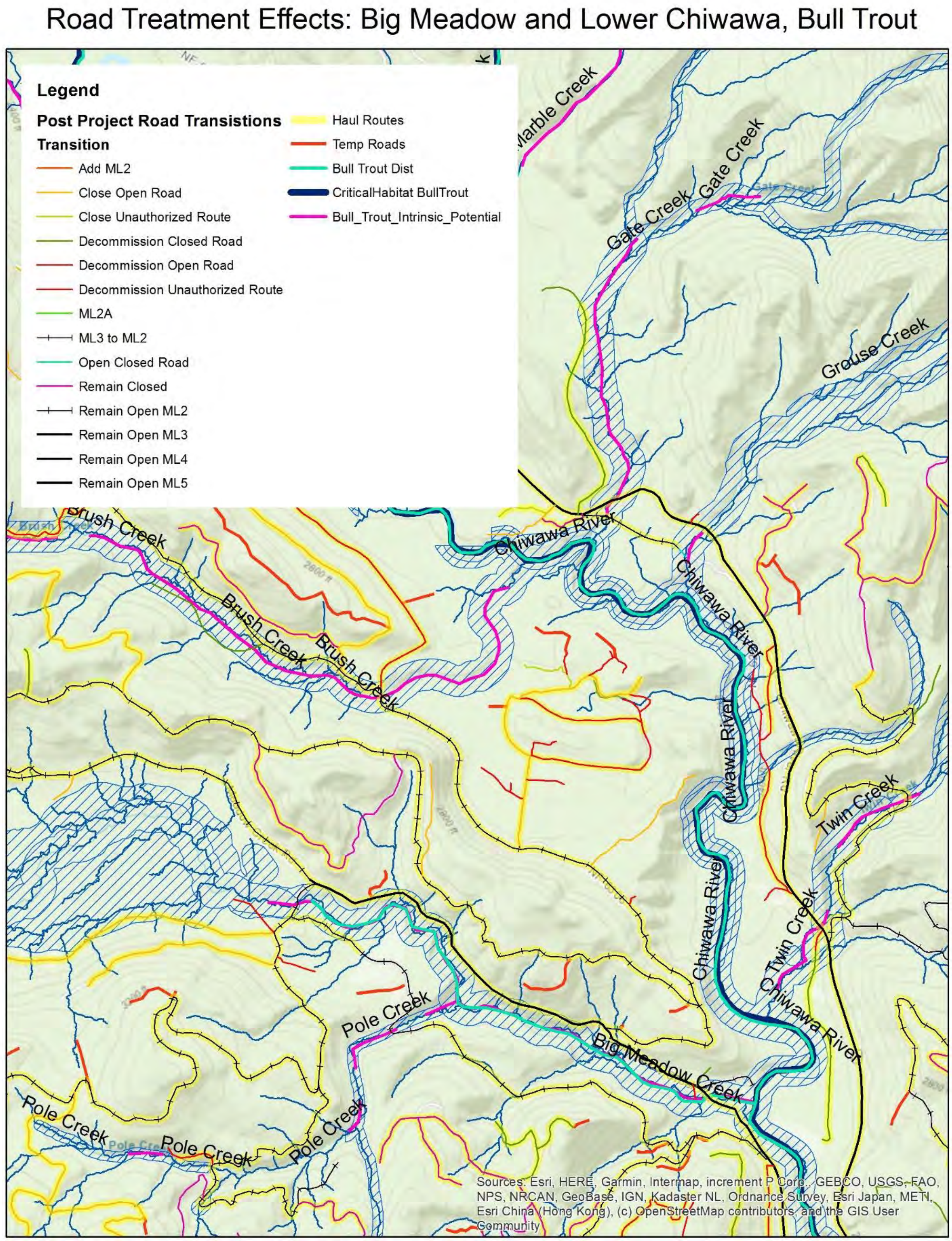

Figure 18. Road treatments and potential effects to bull trout occupied habitat, critical habitat, and intrinsic potential (from UCSRB 2021) in Big Meadow Creek and Lower Chiwawa River Tributaries.

Road Treatment Effects: Alder and Goose Creeks, Bull Trout

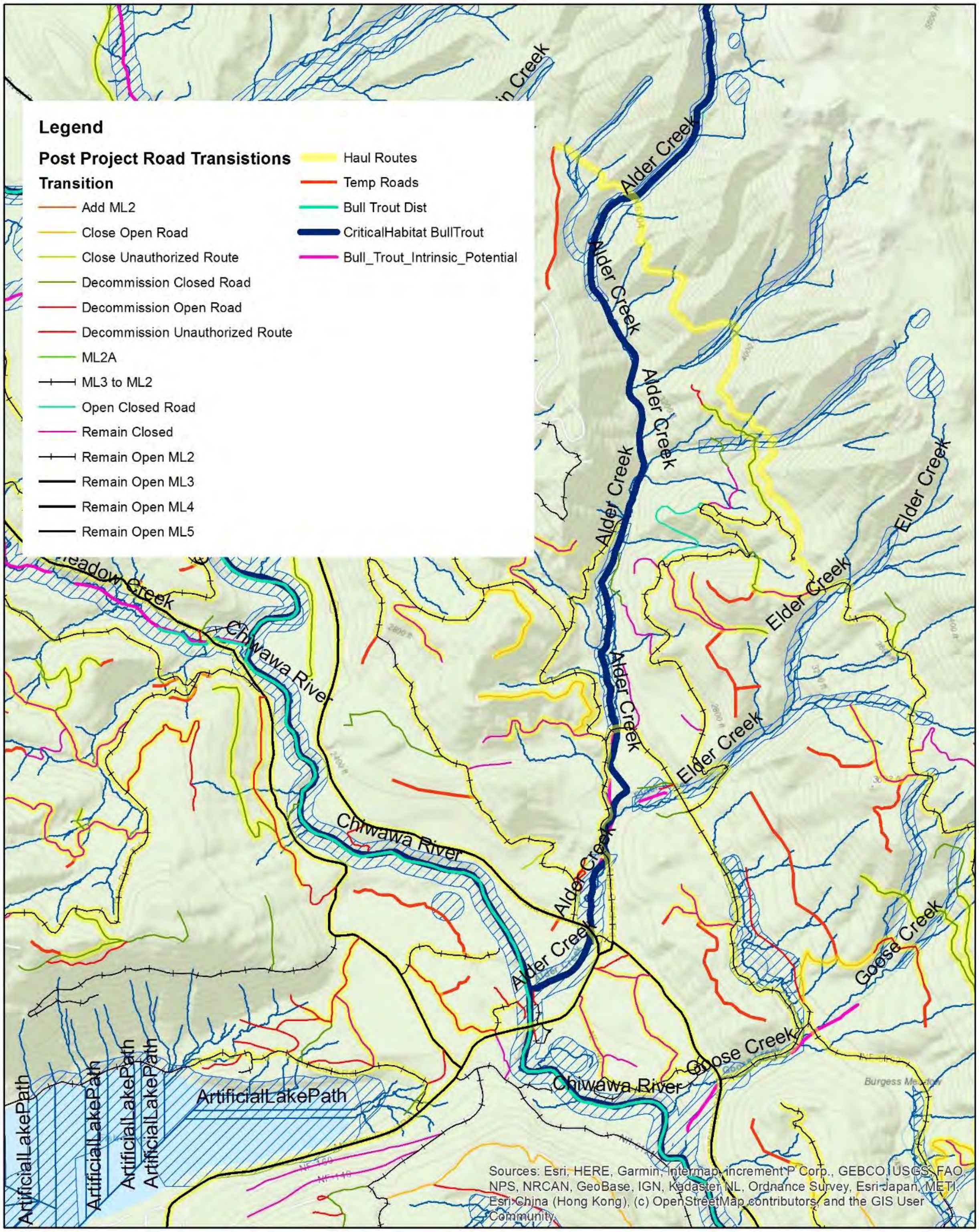

Figure 19. Road treatments and potential effects to bull trout occupied habitat, critical habitat, and intrinsic potential (from UCSRB 2021) in Alder and Goose Creek.

Direct Effects to Spring Chinook:

Proximity: Decommissioning and road closures - 11.39 miles of roads will be decommissioned in RRs within 1000 ft of occupied or critical habitat. 2.18 miles of roads will be closed post-project in RRs within 1000 ft of occupied or critical habitat. Many of the roads are located on the outer edges of RRs and none of the identified roads cross occupied or designated critical habitat for Spring Chinook. See Table 43 for roads actions near Chinook occupied or critical habitat. No direct effects from decommissioning and road closures are expected and will not be discussed further.

Temporary roads– No temporary roads will be built in RRs within 1000 ft of occupied or critical Spring Chinook habitat. Only 0.04 miles of currently closed roads will be opened permanently, and this is a short spur road to the Grouse Creek Group Campsite. That road is already constructed, and no on-the-ground changes will occur. No direct effects from temporary roads are expected and will not be discussed further.

Road openings- There are 3.18 miles of potential haul routes in RRs within 1000ft of occupied or critical Spring Chinook habitat with 0.2 miles being currently closed roads that would be opened temporarily for hauling: 0.1 miles in the Wenatchee River Watershed (on the outer edge of an intermittent stream over 600 ft from the Wenatchee River) and 0.1 miles in the Chiwawa River Watershed. None of the roads that may be temporarily opened cross occupied, critical, or Spring Chinook IP habitat. Road openings for haul will not be discussed further.

Haul routes- No unpaved haul routes cross streams that are either occupied or IP habitat for Chinook. The unpaved crossing over Goose Creek is located 0.5 miles upstream from occupied habitat and is at the upper end of unoccupied critical habitat. Hauling may also occur on 0.86 miles of ML2 (unpaved high clearance roads) within 1000 ft of critical or occupied Spring Chinook habitat (Figure 20, IP data from UCSRB 2021, fish distribution data from USFS and WDFW). ML2 may require maintenance and repair prior to using for haul.

Table 45. Locations of unpaved road crossings in potential proximity to spring Chinook. Bold indicates crossings over CH. All crossings will be repaired prior to use for log haul.

Creek	Road Number	Stream Mile	Est Distance to Known Sprin Chinook (mi)	Project Phase and Years of Use	Max Log Trucks per Year (est)	Comments
Alder	6208	0.8	0.8	1&2; Years 3-8	500	Alder Creek drainage is in Phase 1 but some of the roads might continue to be used in Phase 2. Surveys did not find any sediment contribution and road surface is graveled.
Goose	**6200**	**0.4**	**0.4**	**2; Years 4-8**	**360**	**Rilling present with no evidence of sediment input.**
Goose	6102	0.5	0.5	2; Years 4-8	360	Rilling present and delivers minor sediment to the stream.
Gate	6200	0.1	0.1	3; Years 2-5	400	No evidence of sediment input. Crossing is flat and side slopes are vegetated.

Probability: Haul routes- Based on USFS stream surveys, fish distribution studies, and ongoing WDFW monitoring, it is extremely unlikely that any of the tributaries, except Big Meadow Creek, contain Chinook. Big Meadow Creek does not have any unpaved haul route crossings. The two tributaries that are most likely to have Chinook present are Alder and Goose Creeks and the proposed unpaved haul route crossings are over 0.5 miles from occupied habitat. Additionally, the Goose Creek crossing is located at the upper end of critical habitat. Gate Creek is unlikely to have spring Chinook but is about 0.1 miles from the Chiwawa River so there may still be impacts from log hauling. Based on known and potential fish use in the tributaries, it is unlikely, but not discountable that haul routes may directly affect Spring Chinook.

Magnitude: Haul Routes- All crossings will be repaired and monitored during hauling and, at a minimum, crossings will be covered with gravel to reduce potential sediment inputs to the stream. All road maintenance within RRs will follow appropriate BMPs and will follow the design criteria and conservation measures outlined in ARBO II. These measures will ensure that the effects to Spring Chinook will be insignificant.

There is a total of four unpaved crossings that will be used for haul are less than 1.0 mile from occupied spring Chinook habitat or CH (Table 45). All crossings will be repaired and monitored during hauling and, at a minimum, crossings will be covered with gravel prior and during log hauling to reduce potential sediment inputs to the stream. By gravel armoring all fish-bearing clog haul crossings, there is expected to a reduction in sediment by 80% (Ward and Seiger 1983; Buck Forest and Fuels project; M. Karrer, personal communication). By graveling and conducting necessary road repairs, we can expect a reduction to 20 kg/yr to 200 kg/yr. Field surveys within the project area found minimal evidence of sediment input at the crossing locations (Table 45) and by repairing then before haul, the magnitude will be insignificant. See Appendix C for results from GRAIP Lite (Nelson et al. 2018).

Summary: While it is unlikely that sediment will enter occupied streams as part of the transportation management of the project, there is a small probability that haul routes over critical and IP habitat may be a source of sediment into the stream channel. Even if a Spring Chinook is present in the stream, any sediment that enters would be small and not sufficient to result in direct injury, physical stress, or altering behavior like moving out of hiding cover. There may be isolated insignificant negative impacts to Spring Chinook or designated critical habitat through the potential for increased sedimentation.

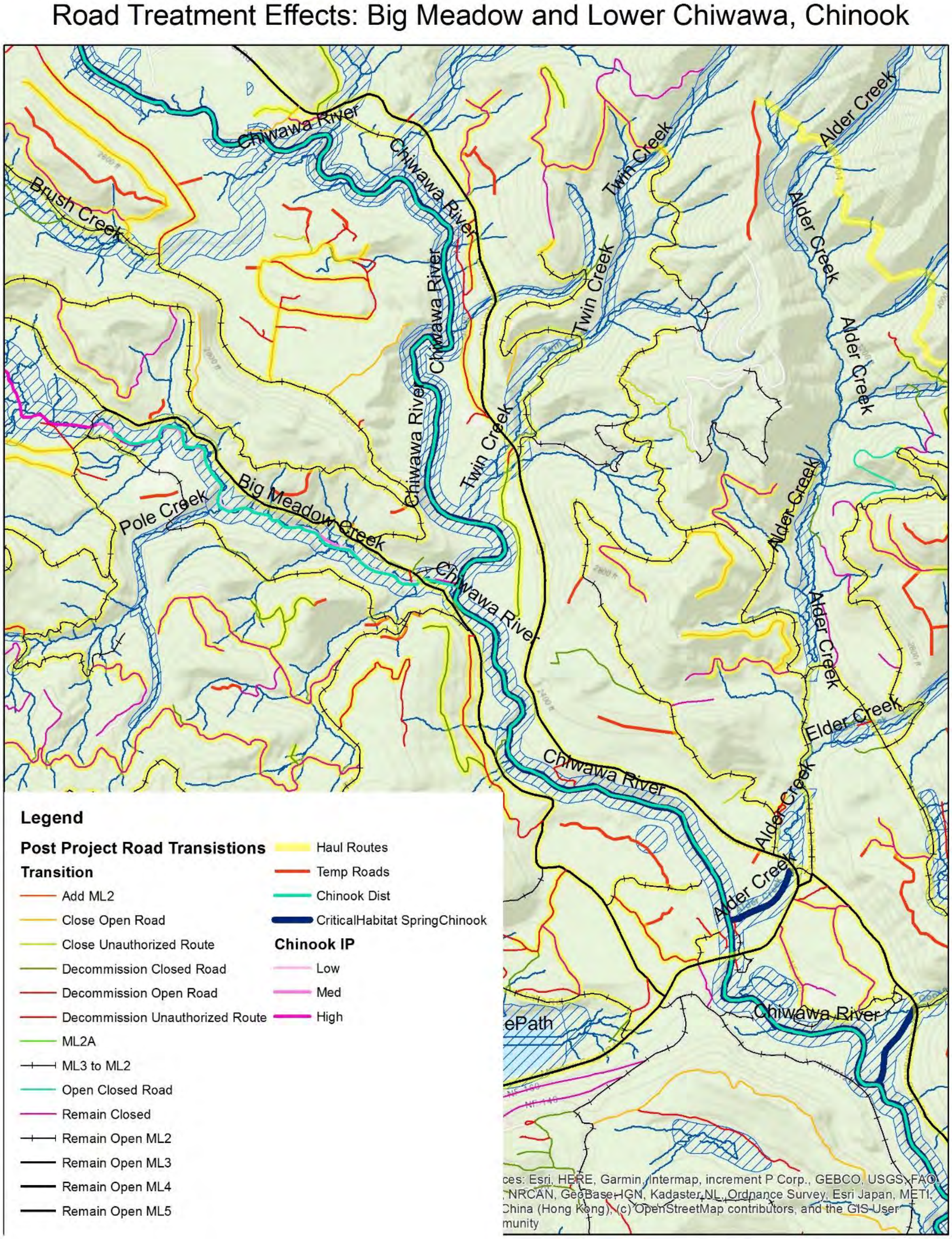

Figure 20. Road treatments and potential effects to Chinook occupied habitat, critical habitat, and intrinsic potential (from UCSRB 2021) in Big Meadow Creek and Lower Chiwawa River Tributaries.

Direct Effects to Steelhead:

Proximity: Decommissioning and road closures - 11.39 miles of roads will be decommissioned in RRs within 1000 ft of occupied or critical habitat. 2.18 miles of roads will be closed post-project in RRs within 1000 ft of occupied or critical habitat. Many of the roads are located on the outer edges of RRs. There is one road that crosses an intermittent tributary of lower Twin Creek (6200-330; about 150 ft to steelhead) that will be decommissioned post-project, but work will be completed in the dry with appropriate BMPs. No direct effects are expected from decommissioning and road closures and will not be discussed further.

Temporary roads– No temporary roads will be built in RRs within 1000 ft of occupied or critical steelhead habitat. Only 0.04 miles of currently closed roads will be opened permanently, and this is a short spur road to the Grouse Creek Group Campsite that is already on-the-ground. No direct effects are expected from temporary roads and will not be discussed further.

Road Openings- There are 5.1 miles of potential haul routes in RRs within 1000ft of occupied or critical steelhead habitat with 0.4 miles being currently closed roads that would be opened temporarily for hauling: 0.1 miles in the Wenatchee River Watershed (on the outer edge of an intermittent stream over 600 ft from the Wenatchee River) and 0.2 miles in the Chiwawa River Watershed (across an intermittent tributary to Twin Creek about 150 ft from occupied steelhead habitat in Twin Creek, and in the outer edge of the Big Meadow Creek RR, over 600 ft upland from occupied steelhead habitat). None of the roads that may be temporarily opened cross occupied or critical steelhead habitat. Road openings will not be discussed further.

Haul Routes- Hauling may also occur on 2.62 miles of ML2 (unpaved high clearance roads) within 1000 ft of critical or occupied steelhead habitat (Figure 21, Figure 22, and Figure 23). ML2 may require maintenance and repair prior to using for haul and there are several places where ML2 roads cross steelhead habitat: Clear Creek (3 crossings; occupied habitat), Alder Creek (1 crossings; occupied and critical habitat), and Twin Creek (2 crossings; 1 on unoccupied habitat but with IP and 1 on intermittent tributary 150 ft from occupied habitat). There are several tributaries that have low Intrinsic Potential for steelhead use that will also have unpaved haul routes: Brush, Gate, Goose, Elder, and upper Alder Creeks (IP data from UCSRB 2021).

Probability: Haul routes- Unpaved road crossings used for haul routes over occupied or critical steelhead habitat will be maintained with gravel to reduce sediment entering the stream channel. Clear Creek has a total of 3 unpaved haul route crossings over occupied steelhead habitat and there is a high probability that steelhead will be present during log hauling. In Twin Creek, the lower crossing on the intermittent tributary is only 150 ft from year-round occupied habitat in the mainstem Twin Creek. Based on the close proximately to occupied habitat, there is a potential that during certain times of the year, steelhead may be present in the side channel while log hauling is occurring. The unpaved crossing on upper Twin Creek is only 0.1 miles upstream of known steelhead distribution and has low IP. There is a potential that steelhead may be present during periods of log hauling.

There is one unpaved crossing over occupied habitat on Alder Creek and it is likely that steelhead will be present during log hauling. The next unpaved crossing on Alder Creek is over mixed rating IP habitat and is 0.5 miles upstream of occupied habitat. It is possible that steelhead may be present during log hauling. Elder Creek (tributary to Alder Creek) has very limited IP and the unpaved crossing is 0.5 miles upstream from occupied habitat. It is unlikely that steelhead would be present in Elder Creek during haul operations.

Brush Creek has low IP but with the presence of resident rainbows, it is likely that steelhead may be present. Beaver Creek has a high IP but the unpaved haul route crossings are over 2.7 miles upstream of any known occupied habitat, so it is extremely unlikely that steelhead are present at those crossings. There is a potential that steelhead may seasonally be present at the Gate Creek crossing. Gate Creek has low IP for steelhead, but the unpaved haul route crossing is only 0.1 miles from occupied habitat in the mainstem Chiwawa River. Goose and Deep Creeks have very limited low IP for steelhead and Deep Creek has a natural cascade near the mouth that is acting as an almost complete barrier to anadromy. It is unlikely that steelhead would be present at either of these crossings during log haul operations.

Magnitude: Haul routes- There is a total of nine unpaved crossings that will be used for haul that are either likely or have the potential to have steelhead in the vicinity during haul operations. All crossings will be repaired and monitored during hauling and, at a minimum, crossings will be covered with gravel prior and during log hauling to reduce potential sediment inputs to the stream. By gravel armoring all fish-bearing clog haul crossings, there is expected to a reduction in sediment by 80% (Ward and Seiger 1983; Buck Forest and Fuels project; M. Karrer, personal communication). Field surveys within the project area found minimal evidence of sediment input at the crossing locations (Table 46) and by repairing then before haul, there will be a very minimal potential for sediment input. Additionally, GRAIP Lite model results (Nelson et al. 2018) indicate that most road segments in the project area contribute minimal, if any, sediment to the stream (Appendix C). Project area streams experience very little sediment input from roads, as calculated using GRAIP Lite.

All road maintenance within RRs will follow appropriate BMPs and will follow the design criteria and conservation measures outlined in ARBO II, such as use of silt screens and water bars, where needed. Additionally, log hauling will not occur during heavy rain events when sedimentation into streams would be most likely. Despite these mitigations and BMPs, based on the number of unpaved crossings with potential steelhead, there may be sediment entering the streams. This sedimentation is expected to be minor and unlikely to cause direct injury to steelhead but may alter behavior or cause minor stress (Newcombe and MacDonald 1991).

Distribution: The effects of potential sedimentation to steelhead will be isolated to nine crossings where steelhead have known or potential distribution. Sediment levels are expected to be minor and the downstream effect will be limited, less than 0.1 miles downstream of the unpaved crossing. See Table 46 for locations.

Table 46. Unpaved crossings used for haul routes with potential adverse effects to steelhead. Bold indicates crossing over Critical Habitat. All crossings will be repaired prior to log haul.

Creek	Road Number	Stream Mile	Est Distance to Known Steelhead (mi)	Project Phase and Years of Use	Max Log Trucks per Year (est)	Comments
Alder	**6208**	**0.8**	**0.0**	**1&2; Years 3-8**	**500**	**Alder Creek drainage is in Phase 1 but some of the roads**

						might continue to be used in Phase 2. Surveys did not find any sediment contribution and road surface is gravelled.
Alder	6102-200	1.3	0.5	1&2; Years 3-8	500	Alder Creek drainage is in Phase 1 but some of the roads might continue to be used in Phase 2. Road surface has rilling with minor sediment transport over land but not entering the stream.
Twin	6209	1.1	0.1	1; Years 3-6	350	In poor condition with evidence of sediment delivery to the stream. Crossing will be repaired prior to haul use.
Trib to Twin	6200-330	0.3	<0.1	1; Years 3-6	350	Intermittent trib, may have seasonal steelhead use. New crossing will be installed while the stream is dry and will follow BMPs.
Gate	6200	0.1	0.1	3; Years 2-5	400	No evidence of sediment input. Crossing is flat and side slopes are vegetated.
Brush	6306	1.0	~0.3	3; Years 2-5	400	Road surface is graveled and in good condition but does slope towards the stream with the potential for sediment input.
Clear	6105	1.5	0.0	2; Years 4-8	450	Rilling present on road, may contribute sediment. Will be repaired prior to haul.
Clear	6105	1.7	0.0	2; Years 4-8	450	Rilling present on road, may contribute sediment. Will be repaired prior to haul.
Clear	6105	1.9	0.0	2; Years 4-8	450	Rilling present on road, may contribute sediment. Will be repaired prior to haul.

Frequency: It is estimated that less than 500 log trucks per year will cross unpaved crossings with the potential highest rate of travel occurring over the Alder Creek crossings.

Duration: Table 46 shows the potential years that log hauling would occur over a specific crossing. The crossings in Alder Creek have longest potential duration of impact because the roads may be used for two separate phases, depending on how the timber sales are scheduled.

Timing: Log hauling has the potential to occur during all times of year. All these tributaries are small and primarily used for steelhead spawning and rearing, although no known spawning. Adult steelhead may be startled or stressed during spawning and juvenile steelhead may alter behavior based on increased sedimentation. The potential sediment input is not expected to reduce egg-to-fry survival but may have a minor effect (Jensen et al. 2009).

Summary: In the short term (during the specific project phase), there may be ***isolated, short-term, minor negative impacts*** to individual steelhead through the potential for increased sedimentation. This potential sedimentation is unlikely to cause direct injury to steelhead but may alter behavior or cause minor stress during spawning and rearing life history stages. The effects to eggs and incubation would be insignificant. The potential sedimentation is expected to be minor and will not alter or degrade designated critical habitat.

Road Treatment Effects: Big Meadow and Lower Chiwawa Tribs, Steelhead

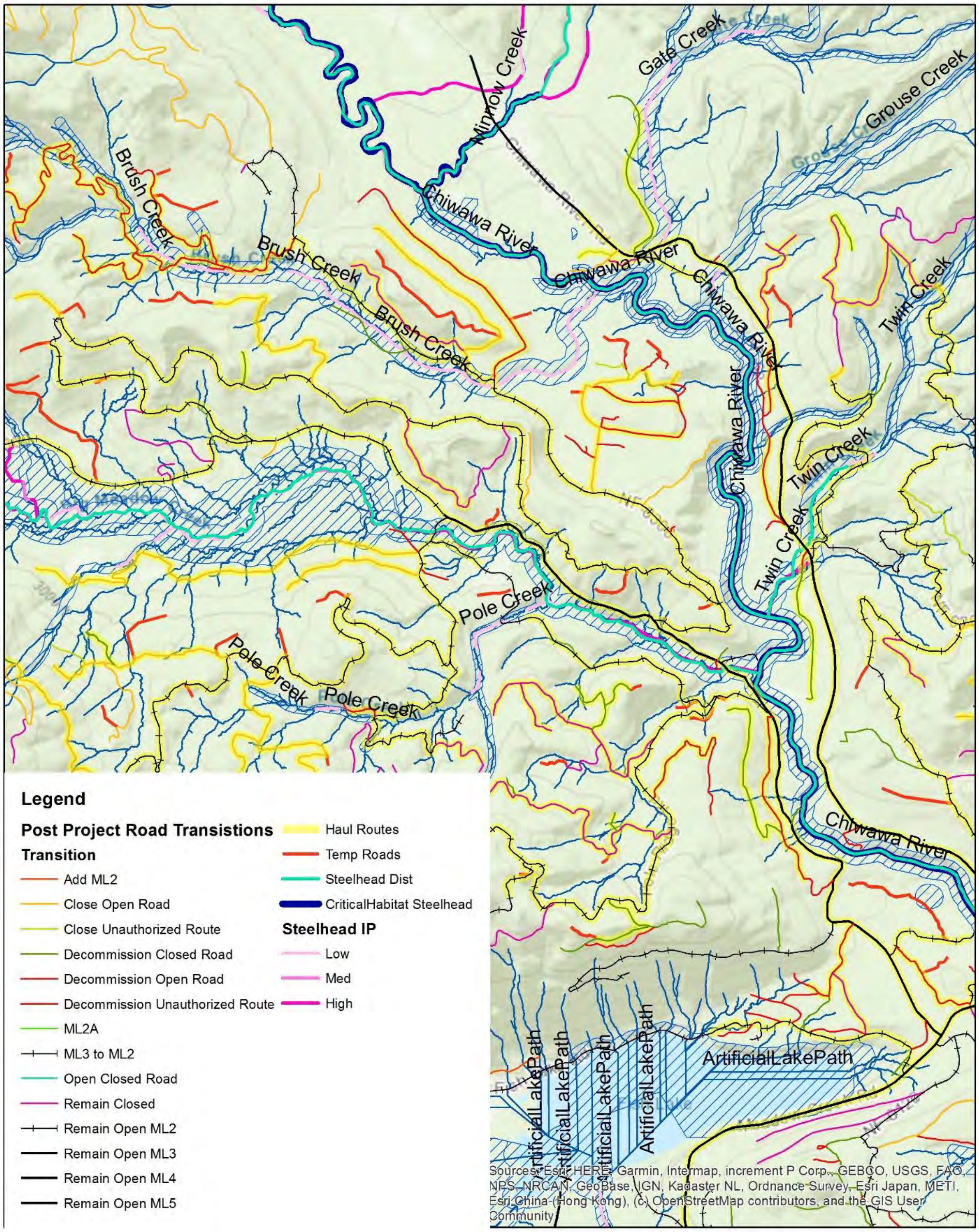

Figure 21. Road treatments and potential effects to steelhead occupied habitat, critical habitat, and intrinsic potential (from UCSRB 2021) in Big Meadow Creek and Lower Chiwawa River Tributaries.

Road Treatment Effects: Lower Chiwawa Tribs, Steelhead

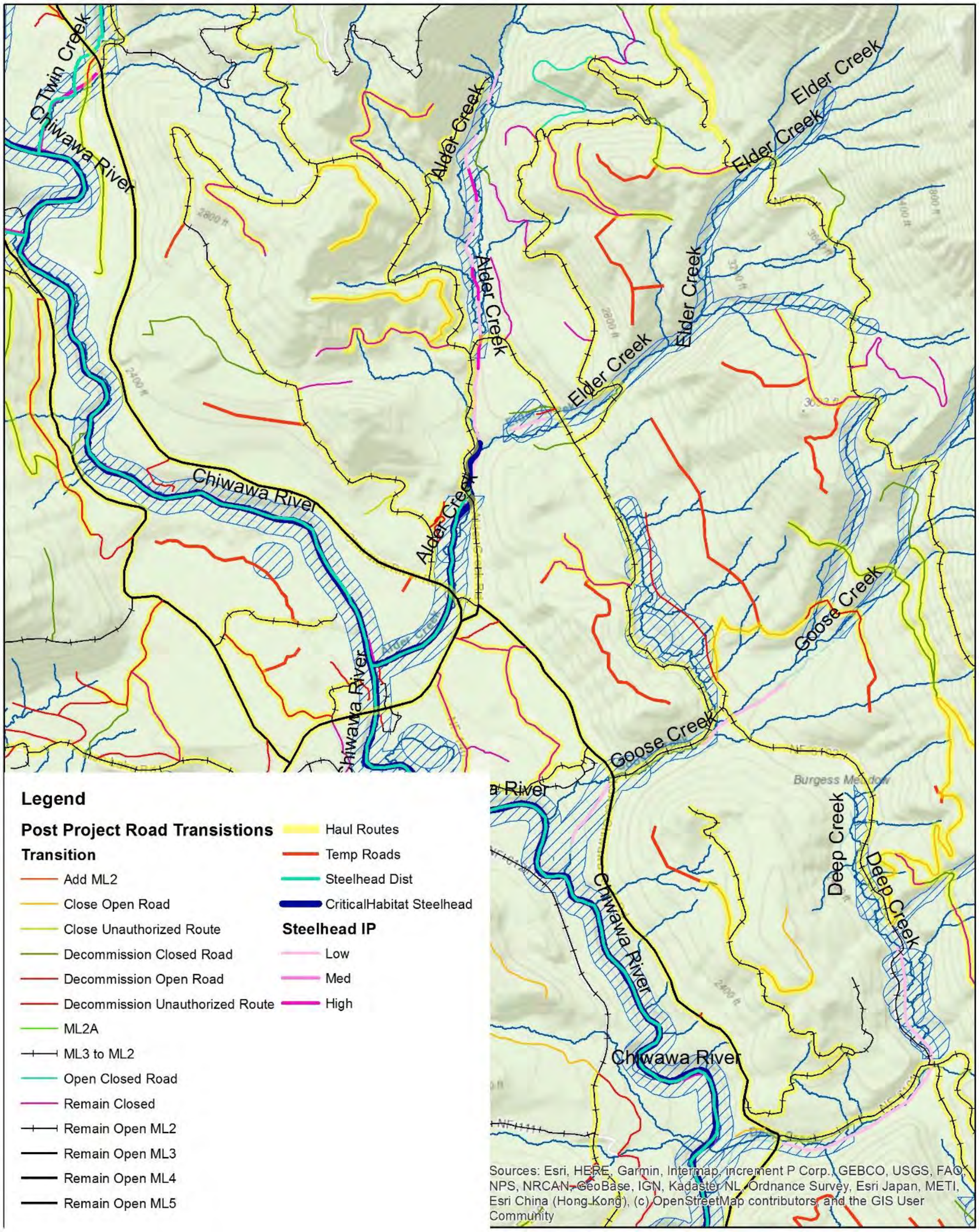

Figure 22. Road treatments and potential effects to steelhead occupied habitat, critical habitat, and intrinsic potential (from UCSRB 2021) in Alder, Goose, and Deep Creeks.

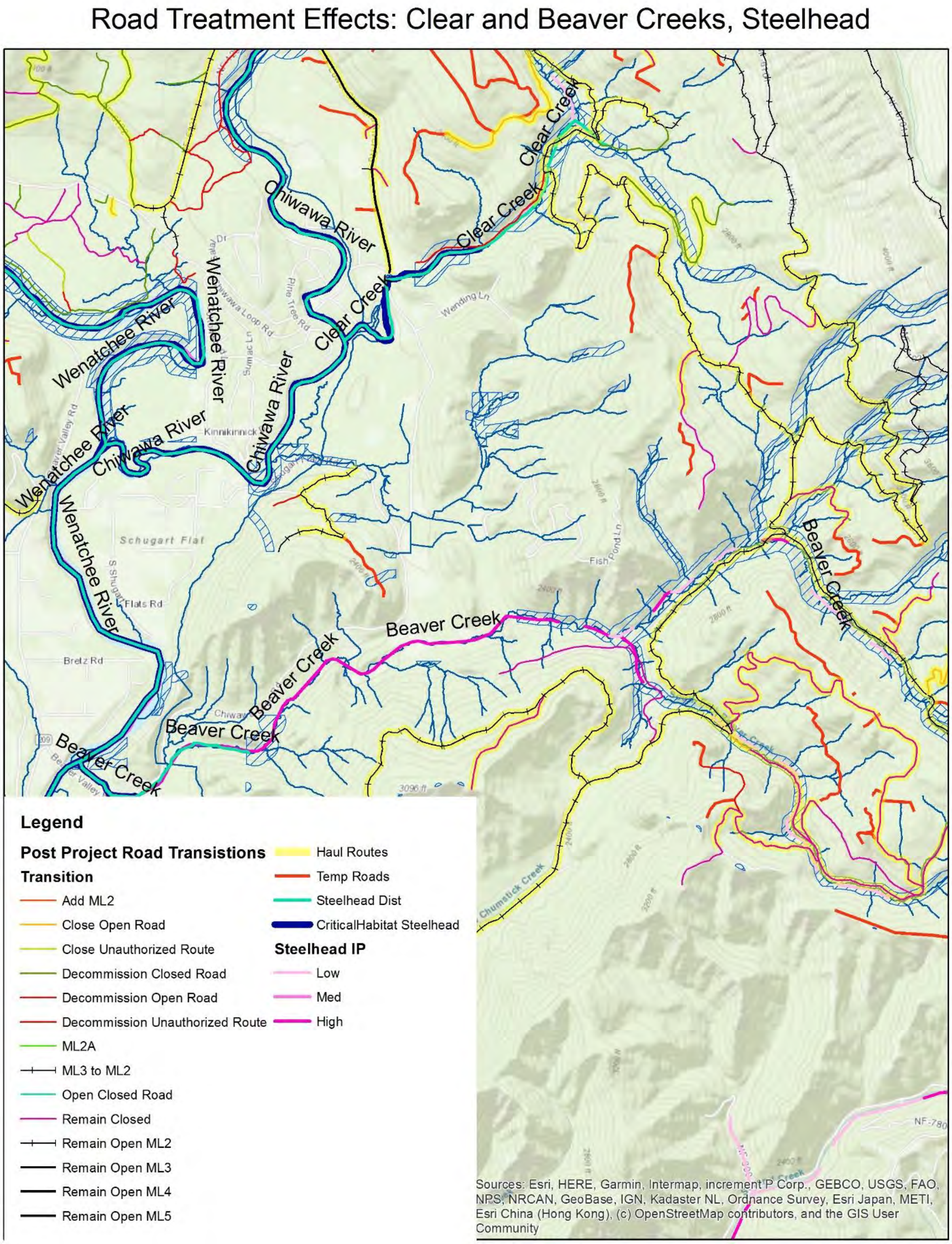

Figure 23. Road treatments and potential effects to steelhead occupied habitat, critical habitat, and intrinsic potential (from UCSRB 2021) in Clear and Beaver Creeks.

Indirect Effects

Project Elements

To be consistent with the 2004 Analytical Process for Developing Biological Assessments for Federal Actions Affecting Fish With-in the Northwest Forest Plan Area (USDA et al. 2004), the non-ARBO II Mission Project activities were divided into the following Project Elements:

- Vegetation Treatments, including commercial and non-commercial thinning, burning, and construction of fuel breaks
- Transportation System Management, including log hauling, temporary roads, opening of closed roads, and post-project closure or decommissioning of roads.

Indicators not affected by the Proposed Action

The following Indicators have no causal mechanisms linking project elements to the respective indicator:

- **Physical Barriers:** Harvest activities, prescribed fire, and related transportation system changes would not create or remove any migration barriers to fish. No harvest or other treatment proposes felling trees in proximity to streams or creating any physical disturbance within the fish-bearing stream network. The restorative road treatments include aquatic organism passage projects and direct effects of AOP and culvert removal will be covered under ARBO II consultation.
- **Off-channel Habitat**: The few areas with off-channel habitat, it is created by backwaters and side-channels. While some work is proposed within the RRs, none of the activities analyzed in this BA would change habitat indicators to affect off channel habitat.
- **Refugia:** For those reasons cited above for barriers and off-channel habitat, activities would not interrupt or disconnect existing refugia habitat. No effects to temperature are expected.
- **Floodplain Connectivity**: No activities are proposed in riparian corridors that would sever the floodplain from the stream channel, particularly in areas adjacent to fish-bearing waters and areas near CH. There may be instances in decommissioned road segments where road-fill removal increases floodplain connectivity at a small scale; however, most of these upland streams are Rosgen A- and B-channels with minimal floodplain development.

Indicators remaining for analysis

The remaining habitat indicators for analysis are shown below. Indicators will be lumped for analysis since similar causal mechanisms link them as listed in the table below. For example: streambank erosion/failures contribute fine sediment to the stream network. Fine sediment that in-fills substrate interstitial spaces is a primary mechanism in which substrates become embedded.

Table 47. Indicator analysis lumping strategy.

Habitat Indicators	Lumped group name	Rationale for lumping

• Temperature • Large Woody Debris	Temperature & Wood	Indicators linked with vegetation/tree cover in relation to stream
• Sediment • Substrate Embeddedness • Pool Freq. / Quality • Large Pool Quantity	Sediment & Pools	Indicators linked with fine sediment delivery to streams and pools
• Avg. Width/Depth Ratio • Streambank Condition	Streambanks & Channel Geometry	Indicators linked to streambank stability/erosion
• Change in peak/base flow • Drainage Network • Road Density/Location	Roads & Drainage Network	Indicators linked to road network
• Disturbance History • RRs • Disturbance Regime	Disturbance & RRs	Indicators linked with clearing and disturbance in RRs

Effects to Wenatchee River Watershed:

A summary of existing baseline condition and effects from the proposed action are below:

Table 48. Effects Summary Table: Wenatchee River Watershed 5th HUC. While there may be isolated, minor changes to watershed indicators, there will be NO CHANGE to the watershed baseline.

DIAGNOSTICS/ PATHWAYS: Wenatchee River Watershed HUC 10		POPULATION AND ENVIRONMENTAL BASELINE[1]			EFFECTS OF THE ACTION(S)		
INDICATORS		PF	FAR	NPF	Restore	Maintain	Degrade
WATER QUALITY	Temperature		X			X	
WATER QUALITY	Sediment/Turbidity		X	X (Chumstick)	X (long term)		X (short term)
WATER QUALITY	Chemical Contamination/ Nutrients		X	X (Chumstick)		X	
HABITAT ACCESS:	Physical Barriers		X	X (Chumstick)		X	
HABITAT ELEMENTS	Substrate Embeddedness			X	X		
HABITAT ELEMENTS	Large Woody Debris		X (Chumstick)	X		X	
HABITAT ELEMENTS	Pool Frequency & Quality		X			X	
HABITAT ELEMENTS	Off-channel Habitat		X	X (Chumstick)		X	
HABITAT ELEMENTS	Refugia		X	X (Chumstick)		X	

CHAN.COND./DYNAMICS: Width/Depth Ratio		X			X	
Streambank Condition		X			X	
Floodplain Connectivity			X		X	
FLOW/HYDROLOGY: Change in Peak/Base Flows		X			X	
Increase in Drainage Network			X	X (long term)		X (short term)
WATERSHED CONDITIONS: Road Density/Location		X (Tumwater, Chiwaukum)	X	X (long term)		X (short term)
Disturbance History			X		X	
Riparian Reserves		X (Chiwaukum)	X	X (long term)		X (short term)
Disturbance Regime:		X		X (long term)		X (short term)

[1] Ratings are broken out by HUC 12 watersheds if one rating does not accurately describe the HUC 10 watershed

Water Quality: Temperature and LWD

Analysis of potential effects to temperature and wood are lumped because the primary mechanisms affecting them are similar – shade loss (temperature) and physical material loss (reducing wood recruitment) via removal of streamside vegetation and trees either by harvesting, thinning, mortality through fire, or other physical means of removal.

Effects to Temperature: Removal of shade producing trees and vegetation is the primary mechanism that affects stream temperature. PEs that could reduce shade along streams include commercial harvest, non-commercial thinning, prescribed fire, and the TSM such as removal of vegetation while opening closed roads, closing roads, and decommissioning roads.

Effects to Instream Large Wood and Future Recruitment Potential: The primary mechanisms by which instream large wood and future wood recruitment are affected is via removal of trees from the core inner zone of riparian reserves where they would otherwise senesce and fall into the channel. No proposed vegetation treatment PEs would remove instream wood, limiting potential wood impacts to altering future wood recruitment and increases in wood loading.

PE: Vegetation Treatments

Proximity: Up to 14,104 acres (280 acres of prescribed fire only) of vegetation treatments are proposed in the Wenatchee River watershed, which is 7% of the total watershed acreage. Of these potential treatments, up to 1,382 acres of treatment are proposed in the outer edges of Riparian Reserves, as described in the design criteria (Table 3). The only treatments that may affect the temperature and large wood indicators would be commercial harvest (all other vegetation treatments will only remove small diameter trees, <7” dbh, and shrubs). In perennial streams and lakes/ponds, no commercial harvest will occur within 100 ft of the channel/waterbody edge. In intermittent streams and wetlands, no commercial harvest will occur within 50 ft of the channel/waterbody edge. For all harvest outside that no-cut buffer but still within the Riparian Reserve, 50% or more canopy cover would be maintained. These buffers are also the same for non-commercial (mechanical thinning) but hand thinning of small diameter trees may occur closer to the waterway. Prescribed fire may occur in the riparian reserves; along intermittent streams, backing fire would be allowed within 25 feet of the channel and along perennial streams, backing fire may occur within 100 feet of non-fish bearing and 300 feet of fish bearing streams.

Probability: The probability of commercial, non-commercial thinning, yarding, or landings affecting stream temperature or wood recruitment in adjacent streams and critical habitat below ranges from zero to discountable. Prescribed fire within the riparian reserve will be minimal, with only backing fire allowed within 100 ft of non-fish bearing perennial streams and 300 ft of fish-bearing streams (no active lighting). The prescription for prescribed fire is retaining 95% of the existing canopy cover in active ignition areas and is expected to be even higher for areas with backing fires (RRs). Arkle and Pilloid (2010) showed that backing fire into riparian reserves had no change on RR and in-stream habitat metrics, such as large wood, as have other studies (Robichaud and Waldrop 1994; Beche et al. 2005; Cawson et al. 2012). Based on observations in the field and previous studies, effects to stream temperature and wood recruitment from prescribed fire is entirely discountable.

Using the prescribed no-treatment buffers would either prevent or minimize impacts to the adjacent channel where critical habitat is located. Studies reported in FEMAT (p. V-28, 29; USDA et al., 1993) as well as more recent work (Moore et al., 2005; Sridhar et al., 2004) indicate that shade approached 100% effectiveness when harvest buffer widths were between 0.5 and 1 Site Potential Tree (SPT; within the Upper Wenatchee Pilot Project area, SPT is generally about 200ft). Another study cited by FEMAT reported buffer widths of at least 100 feet in western Cascade Mountains provide as much shade as similar undisturbed sites. Johnston and others (2011) report that over 90% of wood in similar streams in interior British Columbia was sourced within about 60 feet of stream channels. Benda et al. (2003) also found that there is less than a 5% probability that a tree 100 ft away from the stream will fall and enter the stream channel as large wood. Commercial harvest in the outer areas of the RRs (100ft to 300ft) will retain 50% canopy cover and will work to restore large tree structure. While there may be a short term reduction in number of trees, the resulting condition will allow for large tree growth which is more likely to provide in-stream canopy cover and large wood inputs. Non-commercial thinning will remove overall biomass within the RRs, but, as the focus is on small trees less than 7" dbh, we expect that this thinning will encourage growth in the large trees which will eventually lead to greater volume of large wood in the stream. We expect the proposed buffer widths along perennial streams would maintain existing shade sufficient to not measurably affect water temperatures or wood recruitment levels along perennial streams. Additionally, managing the outer RRs (beyond 100 feet in perennial streams) for larger, more resilient species, is expected to result in slightly larger trees capable of being delivered to the stream from greater distances, in time. Neither commercial nor non-commercial thinning along intermittent streams would affect temperature because they would be dry during the summer/fall periods.

Element Summary: Removing commercial sized trees at least 100ft from the channel would not affect stream shade or wood recruitment. Small diameter thinning along intermittent channels to within 25 feet has potential to affect localized wood recruitment, but the potential for impacts downstream in critical habitat are discountable because these trees are small diameter and not actively contributing to shade or large wood recruitment, especially when the channel is only intermittently flowing. Therefore, the proposed commercial harvest would result in a **neutral (0) effect** to temperature **discountable negative (-) effect** to LWD indicators in critical habitat.

PE: Transportation System Management

The TSM PE includes road treatments and log hauling in association with the vegetation management. Aspects of the TSM PE that could influence shade or LWD are removal of vegetation while opening closed roads (negative), closing roads long-term (positive), and decommissioning roads (positive). The majority of temporary roads will be constructed outside of RRs but a total of 0.5 miles of temporary roads may be constructed in the RRs of intermittent headwater streams within the Wenatchee River watershed.

Proximity: Opening Closed Roads - Up to 1.8 miles of currently closed roads in RRs may be opened for haul routes. Road Decommissioning - A total of 1.91 miles of riparian roads would be decommissioned. Road Closure – a total of 2.74 miles of roads within RRs would be put in long-term storage in the Wenatchee River watershed.

Probability: Opening Closed Roads- reopening of roads require a variety of techniques: some may only require opening a gate or removing a berm while others may need to be thinned and bladed. The closed roads that are vegetated contain primarily small diameter trees. It is highly unlikely that removal of small diameter trees within the road prism would affect stream temperature, shade, or large wood recruitment. Road closures and decommissioning- closing and decommissioning roads will allow for the eventual return of vegetation and, in the very long-term, road decommissioning may include an additional source of shade and large wood recruitment. This would result in a slight increase in riparian function, but a measurable benefit to stream temperature and wood recruitment would be highly unlikely.

Element Summary: Opening and closing roads would have no mechanism to affect shade or wood recruitment in critical habitat. Riparian road decommissioning would result in a small, inconsequential improvements to watershed processes but road openings would result in a short-term degradation of the indicators. Therefore, the roads PE would result in a **discountable negative effect** for opening closed roads and closing roads and a **discountable positive (+) effect** for RR road decommissioning to the temperature and LWD indicators.

Indicator Summary: The proposed treatments within RRs are not expected to measurably affect stream shade or wood recruitment to adjacent streams. Setbacks for harvest or other thinning activities, low severity burning, and the few road activities may result in small, localized reductions in shade, but it is not expected to rise to a measurable impact. Likewise, the benefits of riparian road decommissioning and closure, is not expected to have measurable benefits in the long-term. We expect a **neutral (0) effect** to stream temperature and a **discountable negative (-) short-term** and **positive (+) long-term effects** to LWD indicator.

Water Quality: Chemical Contaminants/Nutrients

Nutrients for all PEs: Clayton and Kennedy (1985) investigated changes in nutrient budgeting and runoff in Idaho streams following timber harvest (primarily clearcuts) and describe significant losses in dissolved nitrogen from disturbed soils. They suggest that use of logging systems that minimize erosion and use adequate buffer strips should not cause unacceptable nutrient loss. Jurgensen et al. (1997) found similar results in investigating Inland Northwest timber harvest operations and noted the importance of carefully planned use of prescribed fire and mechanical site preparation when accomplishing forest management objectives.

PE: Vegetation Treatments

Proximity: All re-fueling and fuel storage must occur outside of RRs. The vegetation treatment PE does not propose to apply chemicals to streams or other water features. Standard mitigating measures include hazardous materials storage in durable containers, use of spill kits, equipment inspection and maintenance, as well as spatial separation of equipment and activities from waterbodies.

Probability: Based on the buffers, mitigations, and lack of chemicals used in vegetation treatments, there is a **zero to discountable** probability of chemical contaminants entering the stream.

PE: Transportation System Management

Proximity: Lignin-based dust abatement may be applied to the road surfaces, as needed. Chemical dust abatements will not be applied within 100 ft of an occupied ESA-list stream and not within 25 ft of other streams.

Probability: Even in areas with relatively high annual rainfall (60-80 inches), there is good evidence that leaching of lignosulfonates from stabilized road soils is minor providing such soils contain 10-20 percent clay to absorb the lignin. Lignonsulfonates have low permeability through soil and pose little, if any, threat to ground water (Heftner 1996). Based on the application rate and buffers, there is a **zero to discountable** probability that chemicals will enter the stream during transportation system management activities.

Element Summary: There will be a **neutral effect** to chemical contaminants/nutrients indicator within the Wenatchee River watershed.

Habitat Element: Sediment and Pools

Analysis of potential effects to sediment and pools are lumped because the primary mechanism affecting pool quality and quantity is sediment (in terms of filling in pools or degrading their quality). LWD also plays a role, but the effects to LWD were assessed above with temperature and determined to be insignificant in the analysis such that risk of wood reduction/pool formation is not a concern.

PE: Vegetation Treatments

Proximity: About 1,382 acres of vegetation treatment is proposed from 100ft to 300 ft of the Riparian Reserves and all commercial harvest and non-commercial mechanical thinning would occur at least 100 feet from an adjacent stream. See description under effects to temperature and LWD for more details on locations. There would be no measurable soil disturbance within the no-cut buffer because there will not be any heavy equipment use, except in winter harvest conditions. Unmeasurable soil disturbance may occur do to non-mechanical thinning (hand crews) or the burning of hand piles. These impacts would be isolated and discountable. Additionally, any treatment that occurs in the outer edges of Riparian Reserves would be required to harvest during winter or meet the Soil Disturbance Guidelines. No new landings would be constructed within Riparian Reserves, unless no other practical location exists, and they are able to meet Soil Disturbance Guidelines. All skid trails would occur in the outer edges, involve no stream crossings, and would also be required to meet Soil Disturbance Guidelines. Non-commercial fuels reduction has a prescribed no-treatment buffer of 50 ft to perennial streams. Prescribed fire activities may occur adjacent to perennial streams, but no active lighting will occur within 300 ft of fish bearing streams or within 100 feet of non-fish bearing perennial streams.

Probability: All treatments in Riparian Reserves would have buffers of at least 100 feet along perennial streams for commercial harvest and the only mechanism for sediment to reach streams is from surface runoff via overland flow. Surface runoff over undisturbed ground generally permeates the soil and moves to stream channels via subsurface flow (Chamberlain et al. 1991). Additionally, Sweeney et al. (2014), who looked at buffer widths to prevent the delivery of suspended sediment to streams suggests 30-meter (98ft) buffers are necessary to prevent ultra-fine sediment from reaching streams. Based on this study, the lack of harvest in steep riparian gradients and the prescribed 100-foot buffers, the project fish biologist expects no fine sediment to reach adjacent streams. None of the proposed yarding would cross any streams. Manual fuel reduction thinning will not create soils disturbance that would create sediment sources to streams. Prescribed fire within Riparian Reserves will attempt to maintain at least 50% ground cover reducing the probability of sediment input. No active lighting will occur adjacent to fish bearing perennial streams and backing fires in RRs will be low impact. Beche et al. (2005) and Arkle and Pilloid (2010) found no change in in-stream habitat metrics following low intensity fire in the RR. With the design criteria and buffers established, there is a discountable probability of any sediment delivery to adjacent streams or affecting the sediment or pool indicators.

Element Summary: With the prescribed buffers and design criteria, high infiltration rates, and no stream crossings, there is limited mechanism to deliver sediment to streams or affect pool habitat. Therefore, vegetation treatments would result in a **discountable negative effect** on the sediment and pool indicators in the Wenatchee River watershed.

PE: Transportation System Management

Proximity: Temporary roads- 0.5 miles of temporary roads are proposed for construction in the Wenatchee River watershed, but all of these road segments are within RRs along unnamed intermittent and ephemeral stream channels. All temporary roads would be constructed following BMPs to reduce potential sedimentation (constructed in the dry, appropriate crossing structures installed, etc.). Opening of Closed Roads for Haul- 1.8 miles of currently closed roads in RRs are proposed for reopening for log haul and the majority of these are along South Fork Beaver Creek (other segments are present in RRs of unnamed intermittent channels). The lower section of the road has been decommissioned and will not be reopened for haul but the other road segments, which are adjacent to South Fork Beaver may be reopened. Other Roads Used for Haul- about 2.5 miles of currently open roads in RRs are proposed for log haul, with 1.8 miles being ML2 roads. These roads may require maintenance, such as resurfacing, grading, and brushing, before, during, and after use. All these actions will follow BMPs to reduce sediment input. Road Closure and Decommissioning- Post-project, 5.4 miles of roads within RRs will have on-the-ground changes (closure or decommissioning). These actions will follow BMPs and all applicable ARBO II design criteria and conservation measures to reduce the potential of sedimentation into streams.

Table 49. Road status, post-project, in the Wenatchee River watershed.

	Riparian Reserve Roads (miles)	All Roads (miles)
Close Open Road	3.2	18
Close Unauthorized Route	0.3	2
Decommission Closed Road	1.3	10.9
Decommission Open Road	0.4	4.7
Decommission Unauthorized Route	0.2	6.1
Remain Closed	4.1	31.1
Remain Open ML2	7.7	65.3
Remain Open ML3	0.1	0.9
Remain Open ML4	0	1.5
Remain Open ML5	0.7	2.1

Table 50. Road actions within the Beaver Creek-Wenatchee River watershed, by project phase, in miles of roads. Values in parentheses indicate miles within RRs.

	Phase					
Road Transition	**1**	**2**	3	**4**	**5**	**6**
Close Open Road	--	0.8 (0.1)	--	3.3	--	11.1 (2.6)
Close Unauthorized Route	--	0.4	--	--	--	1.6 (0.3)
Decommission Closed Road	0.7	7.0 (0.8)	--	--	2.4 (0.5)	0.8
Decommission Open Road	1	0.6 (0.1)	--	--	1.3	1.8 (0.2)
Decommission Unauthorized Route	0.5	1.1	--	0.5	1.9	2.1 (0.2)
Open Closed Road	--	--	--	--	0.2	0.2
Open Closed Rd for Haul	--	2.0	--	10.0 (1.6)	1.0	1.8 (0.1)
Temp Road	0.4	--	--	1.8 (0.2)	1.1	3.6 (0.3)

Probability: Temporary Roads- Since temporary roads do not cross any waterways and would be constructed and removed when the intermittent channels are dry and isolated, it is extremely unlikely that construction would allow for sediment to enter the waterway. Opening of Closed Roads for Haul- Reopening the road along South Fork Beaver may increase sediment levels slightly but, as the road prism is still intact (although currently undrivable) and does not cross a perennial stream, it is unlikely. Other Roads Used for Haul- following all road maintenance for haul purposes would be likely that sediment input into streams will increase. Road Closure and Decommissioning- Decommissioning of roads within RRs will occur on the outer areas of Wenatchee River RR, the outer areas of the Fish Lake RR, and on several unnamed intermittent stream channels, all greater than 100 feet from an active channel. Closures will occur in intermittent stream RRs. Based on the proximity of the road actions to the Wenatchee River, it is unlikely but not entirely discountable that these actions may increase sediment to the Wenatchee River.

Magnitude: Other Roads Used for Haul- Unpaved haul routes may increase sediment into streams (as discussed in the Direct Effects section) but in the Wenatchee River watershed, the only unpaved haul route crossings are located on Beaver Creek (three crossings) and, due to the isolated nature of this potential input, the increase of sediment would be short-term and localized to Beaver Creek and overall insignificant to the watershed indicator. Field observations and monitoring of stream restoration projects show that most of all sediment settles out of streams within 400 ft of the project site and the sediment inputs from open road crossings would be much less than in-stream restoration work. Bilby (1985) also found that there was no statistical difference in fine sediment levels above and below the input point, i.e., the road crossing. Road Closure and Decommissioning- The active decommissioning and closure work will occur on the outer edges of the RR and will not include any in-stream channel work or stream crossings on perennial streams. These projects will follow ARBO II guidelines, and the effect of any actions will be insignificant.

Element Summary: With the BMPs, no decommissioning or closures happening on perennial stream crossings, minimal haul routes crossings, and actions completed in the dry, there is very limited potential to deliver measurable sediment to streams or affect pool habitat. Therefore, transportation treatments would result in a **discountable negative effect** on the sediment and pool indicators in the Wenatchee River watershed.

Channel Condition: Streambanks and Channel Geometry

PE: Vegetation Treatments

Timber felling, yarding, and thinning actions occur spatially distant (100 feet from perennial streams during commercial treatments) and have no causal mechanism to affect the habitat indicators. There may be potential for upland-sourced fine sedimentation to change channel geometry via sedimentation; however, the analysis of the sediment indicators found that that magnitude of short-term increases would be much less than those sufficient to measurably aggrade the channel miles downstream. Prescribed fire treatments generally occur spatially distant from streambanks and will not occur adjacent to critical habitat. All pile burning would occur away from stream channels and little risk of fire creep. Analysis of the sediment delivery from project activities found that sediment would have a slight increase in sediment – but of small magnitude not likely sufficient to measurably aggrade a channel or change its width:depth ratio. This PE would have a **neutral (0) effect** to streambanks and channel geometry.

PE: Transportation System Management

Streambanks are generally only affected where changes to road-stream crossings occur. No other project action would directly affect streambanks, particularly at the watershed scale.

Proximity: Opening of Closed Roads for Haul- There are no roads being opened for haul that have crossings over streams. Road Closures and Decommissioning- There are no changes to road-stream crossings in the Wenatchee River watershed as part of the post-vegetation treatment transportation system management. There may be potential for upland-sourced fine sedimentation to change channel geometry via sedimentation; however, it is unlikely that the magnitude would be sufficient to measurably change channel process/geometry. In the long-term, the proposed road treatments would result in a reduction in fine sediment delivery, though it is expected to be immeasurable as well. Due to the lack of impacts downstream and proximity, this PE would have a **neutral (0) effect** to streambanks and channel geometry.

Element Summary: There is no spatial or temporal overlap between PEs affecting streambanks and actual streambanks associated with critical habitat. There may be potential for upland-sourced fine sedimentation to change channel geometry via sedimentation; however, the analysis of the sediment indicators found that the magnitude would be insufficient to measurably change channel process/geometry. In the long-term, the proposed road treatments would result in a reduction in fine sediment delivery, though it is expected to be immeasurable as well. There will be no direct impact to streambanks with this PE and incorporation of standard BMPs such that downstream changes in the sediment yield would be insignificant and not capable of measurably aggrading or degrading the channel. Based on these findings, we expect that there would be **neutral (0) effect** to the streambank stability and width:depth ratio indicators.

Flows/Hydrology: Roads and Drainage Network

The Increased Drainage Network, Road Density/Location, and Change in Peak/Base Flows were lumped because forest roads are believed the primary anthropogenic agent influencing stream flow relating to water quantity. Forest roads artificially increase the drainage network in a watershed. As an example, Wemple (1996) documented a substantial increase in drainage network from the road network in a forested watershed in western Oregon, which has shown to increase peak flows (Jones et al. 2000). In the Beaver Creek-Wenatchee River subwatershed, there are about 223.9 miles of artificial drainage with a relatively high road density of 5.1 miles/miles^2. Because of the 22% increase in the drainage network, the project fish biologist assumes the road drainage network has altered peak and base flows to some degree. Commercial harvest can affect runoff and is discussed below, but the assessment concludes it would have an insignificant effect to peak and base flows.

PE: Vegetation Management

Vegetation management would not affect water yield in any measurable way from vegetation cover removal. Potential commercial harvest accounts for 8,327 acres of the watershed, or 4.1%. Out of these acres, a total of 525 acres of clear-cut are proposed for disease control and off-site genetic material plantation management. This is less than 1% of the total watershed. When less than 25% of a watershed is harvested, no detectible change in peak flows have been observed (Stednick 1996; NOAA Fisheries Memorandum 2005). The commercial harvest would only result in a negligible impact to peak flows and baseflows. Felling and thinning actions lack causal mechanism to affect road or drainage network indicators. Landings are not proposed within RRs, except in already disturbed areas, such as old landings.

Proximity: All commercial harvest would be at least 100 feet or further from any stream and in the outer edges of RRs, harvest actions would leave 50% canopy cover and any soil disturbance would be isolated and immeasurable.

Probability: With the riparian harvest/treatment buffers, it is unlikely and discountable that there would be a change to flow/hydrology indicators.

Element summary: With existing buffers, BMPs, and soil disturbance standards, it is likely that there will be a **neutral (0) effect** to flow/hydrology indicators in the Wenatchee River watershed.

PE: Transportation System Management

Proximity: <u>Temporary Roads and Opening Closed Roads</u>- During this project, we expect there to 15.8 miles of temporary roads (0.5 within intermittent headwater stream RRs). Temporary roads are required to be removed within one year of construction and, since vegetation treatments will occur in stages, not all the temporary roads will be opened at the same time. Similarly, 14.9 miles (1.8 miles within RRs) of currently closed roads will be opened for vegetation management and will temporarily increase the drainage network and road densities. <u>Road Closure and Decommissioning</u>- During and post-project, we will be closing and decommissioning roads and, as a result, there will be a net decrease from 155.3 miles of open roads to 84.0 miles of open roads in the Wenatchee River watershed, post-project.

Probability: During the project, it is likely that the overall road densities within the watershed will increase. But, based on the locations of the temporary roads and roads that will be opened for use, it is unlikely that there will be any change to flow/hydrology or that the new roads will add significantly to the drainage network. In the long-term, the road closures and decommissioning actions will impact the flow/hydrology by reducing the drainage network, reducing the likelihood of changes to flow regime, and reducing road densities.

Magnitude: With the multi-year implementation, location of new roads, and BMPs, any potential negative effects to flow/hydrology would be insignificant. In the long-term, reduction in the road network may have a minor positive effect on flow/hydrology in the watershed.

Element summary: Based on the slight increases to road density and riparian road drainage, the project would have a short-term minor negative impact to these metrics and to peak and base flows. The road closures and decommissioning would result in a long-term positive (+) effect via reductions in the overall road network. The post-project road decommissioning and closures would all provide further movement towards restoration for the project area drainages, reducing the drainage increase from 22% to 18% within the Beaver Creek subwatershed. These reductions will also allow the roads program to better focus shrinking maintenance budgets on roads that needed, thus reducing their effects. The proposed harvest-related road activities would result in a **short-term minor negative (-)** and **long-term minor positive (+) effect** on the Drainage Network, Road Density, and Changes to Peak/Base Flows.

Indicator summary: The harvest, prescribed fire, and road management PEs would change the drainage network slightly. There will some minor short-term negative for the drainage network, but mitigation measures will effectively decouple this disturbance and potential for rill development from the stream network. Temporary road construction, management, and hauling will have an inconsequential negative short-term on the drainage network. Long term, road management activities associated with this project will minimally reduce the total size of the drainage network associated with roads by reducing open road density from 3.5 to 1.9 mi/mi^2. The magnitude of change resulting from these improvements would be a **short-term insignificant negative (-) effect** and a **long-term minor positive (+) effect** in the long-term for these indicators.

Watershed Indicators

Disturbance History

The project proposes to complete vegetation treatments on 14,104 acres of the Wenatchee River watershed. These treatments will range from strictly prescribed fire to hand thinning, to commercial timber harvest. 1,464 acres of treatments will occur in RRs. The project will have a short-term increase in road densities but, post-project, a long-term reduction in open roads. The objective of the project is to improve conditions in presently overstocked stands with high densities, removing genetically inappropriate trees, reducing disease risk, reducing wildfire risks, and reducing sediment sources. Vegetation and prescribed fire related activities would have insignificant negative and positive effects. The analysis of effects to the peak flow indicator determined the proposed timber harvest would not result in measurable changes in peak and base flow volumes. Consequently, there would be an **insignificant negative (-) effect** and a **long-term insignificant positive (+) effect** in the long-term to the disturbance history.

Riparian Reserves

Harvest and other actions would occur within outer bands of RRs, in areas not described as riparian or wetland, either in soil- or vegetation-type. Setbacks would be sufficient to protect key habitat elements including provision of shade/ maintenance of temperature, recruitment of large woody debris, wildlife connectivity, and buffering capacity for overland transport of fine sediment or other contaminants. Overall, we expect the vegetation management and transportation system management PEs to result in a temporary **minor negative (-) effect** to the Riparian Reserves indicator. In the long-term, the project would have a **long-term minor positive (+) effect** in the long-term to RRs.

Disturbance Regime

The proposed timber harvest, prescribed fire, and road construction activities would result in insignificant effects the disturbance regime. The goal of this project is to help return a natural disturbance regime to the watershed by using appropriate silviculture prescriptions. If all areas proposed are treated, it is less than 10% of the total watershed area and treatment will occur over several years. The prescribed no treatment buffers would protect stream conditions and fish habitat. Temporary road construction, management, and hauling will have an inconsequential negative short-term on the drainage network. Long term, road management activities associated with this project will move the project area towards a more stable condition, albeit the improvements would be negligible. The magnitude of change resulting from these improvements would be a **short-term insignificant negative (-) effect** and a **long-term minor positive (+) effect** for the disturbance regime indicator.

Effects to Chiwawa River Watershed

Summary of indirect effects to the Chiwawa River watershed are summarized below:

Table 25. Effects Summary Table Chiwawa River Watershed 5th HUC. While there may be isolated, minor changes to watershed indicators, there will be NO CHANGE to the watershed baseline.

DIAGNOSTICS/ PATHWAYS: Chiwawa River Watershed HUC 10	INDICATORS	POPULATION AND ENVIRONMENTAL BASELINE			EFFECTS OF THE ACTION(S)		
		PF	FAR	NPF	Restore	Maintain	Degrade
WATER QUALITY	Temperature			X		X	
WATER QUALITY	Sediment/Turbidity		X		X (long term)		X (short term)
WATER QUALITY	Chemical Contamination/ Nutrients		X			X	
HABITAT ACCESS:	Physical Barriers		X			X	
HABITAT ELEMENTS	Substrate Embeddedness		X		X		
HABITAT ELEMENTS	Large Woody Debris		X			X	
HABITAT ELEMENTS	Pool Frequency & Quality		X			X	
HABITAT ELEMENTS	Off-channel Habitat			X		X	
HABITAT ELEMENTS	Refugia			X		X	
CHAN.COND./DYNAMICS:	Width/Depth Ratio			X		X	
	Streambank Condition		X			X	
	Floodplain Connectivity			X		X	
FLOW/HYDROLOGY:	Change in Peak/Base Flows		X			X	
	Increase in Drainage Network		X		X (long term)		X (short term)
WATERSHED CONDITIONS:	Road Density/Location			X	X (long term)		X (short term)
	Disturbance History			X		X	
	Riparian Reserves			X	X (long term)		X (short term)
	Disturbance Regime:			X	X (long term)		X (short term)

Water Quality: Temperature and LWD

Analysis of potential effects to temperature and wood are lumped because the primary mechanisms affecting them are similar – shade loss (temperature) and physical material loss (reducing wood recruitment) via removal of streamside vegetation and trees either by harvesting, thinning, mortality through fire, or other physical means of removal.

Effects to Temperature: Removal of shade producing trees and vegetation is the primary mechanism that affects stream temperature. PEs that could reduce shade along streams include commercial harvest, non-commercial thinning, prescribed fire, and the TSM such as removal of vegetation while opening closed roads, closing roads, and decommissioning roads.

Effects to Instream Large Wood and Future Recruitment Potential: The primary mechanisms by which instream large wood and future wood recruitment are affected is via removal of trees from the core inner zone of streams where they would otherwise senesce and fall into the channel. No proposed vegetation treatment PEs would remove instream wood, limiting potential wood impacts to just altering future wood recruitment and increases in wood loading.

PE: Vegetation Treatments

Proximity: Up to 25,156 acres of vegetation treatments are proposed in the Chiwawa River watershed, which is 20.8% of the total watershed acreage. 707 of these acres are prescribed fire only units and, based on the buffers in place and the expected survival of trees >7" dbh, will not affect large wood and stream temperature. Of these potential vegetation treatments, up to 2,229 acres are proposed in the Riparian Reserves, as described in the design criteria (Table 3). The only treatments that may affect the temperature and large wood indicators would be commercial harvest (all other vegetation treatments will only remove small diameter trees and shrubs, <7" dbh, and shrubs). In perennial streams and lakes/ponds, no commercial harvest will occur within 100 ft of the channel/waterbody edge. In intermittent streams and wetlands, no commercial harvest will occur within 50 ft of the channel/waterbody edge and, for harvest outside that no-cut buffer but still within the Riparian Reserve, 50% or more canopy cover would be maintained. These buffers are also the same for non-commercial (mechanical thinning) but hand thinning of small diameter trees may occur closer to the waterway.

Probability: The probability of commercial, non-commercial thinning, yarding, or landings affecting stream temperature or wood recruitment in adjacent streams and critical habitat is small.

Using the prescribed no-treatment buffers would either prevent or minimize impacts to the adjacent channel enough to result an extremely low probability of impacts to critical habitat. Studies reported in FEMAT (p. V-28, 29; USDA et al., 1993) as well as more recent work (Moore et al., 2005; Sridhar et al., 2004) indicate that shade mostly approached 100% effectiveness when harvest buffer widths were between 0.5 and 1 SPT (within the Upper Wenatchee Pilot Project area, SPT is generally about 200ft). Another study cited by FEMAT reported buffer widths of at least 100 feet in western Cascade Mountains provide as much shade as similar undisturbed sites. Johnston and others (2011) report that over 90% of wood in similar streams in interior British Columbia was sourced within about 60 feet of stream channels. Commercial harvest in the outer areas of the RRs (100ft to 300ft) will retain 50% canopy cover and will work to restore large tree structure. While there may be a short-term reduction in number of trees, the resulting condition will allow for large tree growth which is more likely to provide in-stream canopy cover and large wood inputs. Non-commercial thinning will remove overall biomass within the RRs, but, as the focus is on small trees less than 7” dbh, we expect that this thinning will encourage growth in the large trees which will eventually lead to greater volume of large wood in the stream. We expect the proposed buffer widths along perennial streams would maintain existing shade sufficient to not measurably affect water temperatures or wood recruitment levels along perennial streams. Additionally, managing the outer RRs (beyond 100 feet in perennial streams) for larger, more resilient species, is expected to result in slightly larger trees capable of being delivered to the stream from greater distances, in time. Neither commercial nor non-commercial thinning along intermittent streams would affect temperature because they would be dry during the summer/fall periods. Prescribed fire within the riparian reserve will be minimal, with only backing fire allowed within 100 ft of non-fish bearing perennial streams and 300 ft of fish-bearing streams (no active lighting). The prescription for prescribed fire is retaining 95% of the existing canopy cover in active ignition areas and is expected to be even higher for areas with backing fires (RRs). Arkle and Pilloid (2010) showed that backing fire into riparian reserves had no change on RR and in-stream habitat metrics, such as large wood, as have other studies (Robichaud and Waldrop 1994; Beche et al. 2005; Cawson et al. 2012). Based on observations in the field and previous studies, effects to stream temperature and wood recruitment from prescribed fire is entirely discountable.

Element Summary: Removing commercial sized trees at least 100 ft from would not affect stream shade or wood recruitment in any measurable amount. Small diameter thinning along intermittent channels to within 25 feet has potential to affect localized wood recruitment, but the potential for impacts downstream in critical habitat are discountable because these trees are small diameter and not actively contributing to shade or large wood recruitment, especially when the channel is only intermittently flowing. Therefore, the proposed commercial harvest would result in a **neutral (0) effect** to temperature **insignificant negative (-) effect** to LWD indicators in critical habitat.

PE: Transportation System Management

The TSM PE includes road treatments and log hauling in association with the vegetation management. Aspects of the TSM PE that could influence shade or LWD are removal of vegetation while opening closed roads (negative), closing roads long-term (positive), and decommissioning roads (positive). The majority of temporary roads will be constructed outside of RRs but a total of 0.2 miles of temporary roads may be constructed in the RRs of intermittent headwater streams within the Chiwawa River watershed.

Proximity: Opening Closed Roads - A total of 2.7 miles of closed roads in RRs are proposed for log hauling within the Chiwawa River watershed. Road Decommissioning - A total of 40.6 miles of roads will be decommissioned, but only 7.4 miles are within RRs and may effect stream temperature and LWD. Road Closure – A total of 30.8 miles of roads will be closed post-project with 0.9 miles occurring within RRs.

Table 51. Road Status, post-project, in the Big Meadow and Lower Chiwawa subwatersheds.

	Riparian Reserve Roads (miles)	All Roads (miles)
Close Open Road	0.9	29.2
Close Unauthorized Route	0.0	1.6
Decommission Closed Road	2.7	18.6
Decommission Open Road	4.0	17.9
Decommission Unauthorized Route	0.7	4.1
Open Closed Road	0.0	0.7
Remain Closed	0.7	29.6
Remain Open ML2	9.3	85.1
Remain Open ML3	1.1	5.4
Remain Open ML4	1.4	9.1
ML3 to ML2	0.3	2.7

Table 52. Road actions within the Lower Chiwawa watershed, by project phase, in miles of roads. Values in parentheses indicate miles within RRs.

	Phase					
Road Actions	**1**	**2**	**3**	**4**	**5**	**6**
Close Open Road	12.5 (0.5)	6.1 (0.1)	4.3 (0.2)	--	--	--
Close Unauthorized Route	0.9	0.2	0.4	--	--	--
Decommission Closed Road	6.0 (0.6)	5.8 (0.8)	6.6 (1.2)	--	0.1	--
Decommission Open Road	7.5 (0.5)	5.2 (1.9)	5.2 (1.5)	--	--	--
Decommission Unauthorized Route	1.9 (0.4)	1.7 (0.2)	0.5 (0.1)	--	--	--
Open Closed Road	0.7	--	--	--	--	--
Open Closed Road for Haul	23.2 (0.8)	12.0 (0.7)	8.6 (1.2)	--	0.3	--
Temp Roads	4.8 (<0.1)	4.4 (<0.1)	4.3 (0.1)	0.4	--	--

Probability: Opening Closed Roads- opening of closed roads may require the removal of small diameter trees and shrubs. But all roads will be returned to pre-project status after vegetation treatments are concluded, allowing vegetation to eventually return. The potential effect of road reopening to stream temperature and large woody material is discountable. Road closures and decommissioning- closing and decommissioning roads will allow for the eventual return of vegetation and, in the very long-term, may include an additional source of shade and large wood recruitment. This would result in a slight increase in riparian function, but a measurable benefit to stream temperature and wood recruitment would be extremely unlikely.

Element Summary: Opening and closing roads would have no mechanism to affect shade or wood recruitment in critical habitat. Riparian road decommissioning would result in a small, inconsequential improvements to watershed processes. Therefore, the roads PE would result in a **discountable negative**

effect for opening closed roads and closing roads and a **discountable positive (+) effect** for RR road decommissioning to the temperature and LWD indicators.

Indicator Summary: The proposed treatments within RRs are not expected to measurably affect stream shade or wood recruitment to adjacent streams. Setbacks for harvest or other thinning activities, low severity burning, and the few road activities may result in small, localized reductions in shade, but it is not expected to rise to a measurable impact. Likewise, the benefits of riparian road decommissioning, under harvest funded work, is not expected to have measurable benefits in the long-term. We expect a **neutral (0) effect** to stream temperature and a **discountable negative (-) short-term** and **positive (+) long-term effects** to LWD indicator.

Water Quality: Chemical Contaminants/Nutrients

Nutrients for all PEs: Clayton and Kennedy (1985) investigated changes in nutrient budgeting and runoff in Idaho streams following timber harvest (primarily clearcuts) and describe significant losses in dissolved nitrogen from disturbed soils. They suggest that use of logging systems that minimize erosion and use adequate buffer strips should not cause unacceptable nutrient loss. Jurgensen et al. (1997) found similar results in investigating Inland Northwest timber harvest operations and noted the importance of carefully planned use of prescribed fire and mechanical site preparation when accomplishing forest management objectives.

PE: Vegetation Treatments

Proximity: All re-fueling and fuel storage must occur outside of RRs. The vegetation treatment PE does not propose to apply chemicals to streams or other water features. Standard mitigating measures include hazardous materials storage in durable containers, use of spill kits, equipment inspection and maintenance, as well as spatial separation of equipment and activities from waterbodies.

Probability: Based on the buffers, mitigations, and lack of chemicals used in vegetation treatments, there is a **zero to discountable** probability of chemical contaminants entering the stream.

PE: Transportation System Management

Proximity: Lignin-based dust abatement may be applied to the road surfaces, as needed. Chemical dust abatements will not be applied within 100 ft of an occupied ESA-list stream and not within 25 ft of other streams.

Probability: Even in areas with relatively high annual rainfall (60-80 inches), there is good evidence that leaching of lignosulfonates from stabilized road soils is minor providing such soils contain 10-20 percent clay to absorb the lignin. Lignonsulfonates have low permeability through soil and pose little, if any, threat to ground water (Heftner 1996). Based on the application rate and buffers, there is a **zero to discountable** probability that chemicals will enter the stream during transportation system management activities.

Element Summary: There will be a **neutral effect** to chemical contaminants/nutrients indicator within the Chiwawa River watershed.

Habitat Element: Sediment and Pools

Analysis of potential effects to sediment and pools are lumped because the primary mechanism affecting pool quality and quantity is sediment (in terms of filling in pools or degrading their quality). LWD also plays a role, but the effects to LWD were assessed above with temperature and determined to be insignificant in the analysis such that risk of wood reduction/pool formation is not a concern.

PE: Vegetation Treatments

Proximity: About 2,229 acres of vegetation treatment is proposed in the outer edge of Riparian Reserves and all commercial harvest and non-commercial mechanical thinning would occur at least 100 feet from an adjacent stream. See description under effects to temperature and LWD for more details on locations. There would be no soil disturbance within the no-cut buffer because there will not be any heavy equipment use, except in winter harvest conditions. Unmeasurable soil disturbance may occur do to non-mechanical thinning (hand crews) or the burning of hand piles. These impacts would be isolated and discountable. Additionally, any treatment that occurs in the outer edges of Riparian Reserves would be required to harvest during winter or meet the Soil Disturbance Guidelines. No new landings would be constructed within Riparian Reserves, unless no other practical location exists, and they are able to meet Soil Disturbance Guidelines. All skid trails would occur in the outer edges and involves no stream crossings. Manual fuels reduction has a prescribed no-treatment buffer of 50 ft to perennial streams. Prescribed fire activities may occur adjacent to perennial streams, but it would include backing fires which are expected to be low intensity and will meet 50% ground cover retention guidelines.

Probability: All treatments in Riparian Reserves would have no-cut buffers of at least 100 feet and the only mechanism for sediment to reach streams is from surface runoff via overland flow. Surface runoff over undisturbed ground generally permeates the soil and moves to stream channels via subsurface flow (Chamberlain et al. 1991). Additionally, Sweeney et al. (2014), who looked at buffer widths to prevent the delivery of suspended sediment to streams suggests 30-meter (98ft) buffers are necessary to prevent ultra-fine sediment from reaching streams. Based on this study, the lack of harvest in steep riparian gradients and the prescribed 100-foot buffers, the project fish biologist expects no fine sediment to reach adjacent streams. None of the proposed yarding would cross any streams. Outside of the RRs, commercial and mechanical harvest is limited in steep areas and areas that may be more prone to landslides/erosion (see BMPs in Table 13). Manual fuel reduction thinning will no create soils disturbance that would create sediment sources to streams. Prescribed fire within Riparian Reserves must maintain 50% ground cover reducing the probability of sediment input. Beche et al. (2005) and Arkle and Pilloid (2010) found no change in in-stream habitat metrics following low intensity fire in the RR. With the design criteria and buffers established, it is discountable that any sediment delivery to adjacent streams or affecting the sediment or pool indicators.

Element Summary: With the prescribed 100-foot buffers of undisturbed vegetation, slopes of 0 to 20%, high infiltration rates, and no stream crossing, there is very limited mechanism to deliver sediment to streams or affect pool habitat. Therefore, vegetation treatments would result in a **discountable negative effect** on the sediment and pool indicators in the Chiwawa River watershed.

PE: Transportation System Management

Proximity: Temporary roads- All the 0.2 miles of proposed temporary roads are located on the outer edge of RRs. Short segments are located: 1) along outer edge of Big Meadow Creek RR, 300 ft from stream channel, 2) outer edge of small wetland isolated from any other stream channels, and 3) an unnamed intermittent headwaters stream. All temporary roads would be constructed following BMPs to reduce potential sedimentation (constructed in the dry, appropriate crossing structures installed, etc) and will be removed within a year. Opening of Closed Roads for Haul- 2.7 miles of currently closed roads may be opened for vegetation treatments and hauling. This includes several crossings on Goose Creek and its tributaries, along the Big Meadow marsh RR, several segments within the Clear Creek drainage, and other headwater, intermittent streams. Other Roads Used for Haul- about 4.6 miles of currently open roads in RRs are proposed for log haul, with 2.7 miles being ML2 roads. These roads may require maintenance, such as resurfacing, grading, and brushing, before, during, and after use. All these actions will follow BMPs to reduce sediment input. Unpaved log haul crossings over perennial streams will occur over Clear Creek (3 crossings), Deep Creek, Goose Creek (2 crossings), Alder Creek (3 crossings), Elder Creek, Twin Creek (2 crossings), Gate Creek, and Brush Creek. Road Closure and Decommissioning- Post-project, 8.3 miles of roads within RRs will have on-the-ground changes (closure or decommissioning). These actions will follow BMPs and all applicable ARBO II design criteria and conservation measures to reduce the potential of sedimentation into streams.

Probability: Temporary Roads- Since temporary roads would be constructed and removed when the intermittent channels are dry and isolated, it is extremely unlikely that construction would allow for sediment to enter the waterway. Opening of Closed Roads for Haul- closed roads that are being reopened either have existing crossings in place or are over intermittent channels and it is unlikely that reopening will increase sediment to streams. Other Roads Used for Haul- it is likely that log haul crossings will increase sediment in the stream channel (see Direct Effects section above). BMPs and road maintenance will help reduce the probability. Road Closure and Decommissioning- Decommissioning and closure of roads within RRs will occur along the Chiwawa River RR, adjacent to Clear Creek, in Brush Creek, and several other intermittent channels (headwaters of Goose Creek and unnamed tributaries of Twin Creek). The only place where decommissioning of perennial stream crossings would occur is in Brush Creek, where two crossings are set to be removed. These crossings have the highest potential to input sediment into the system because, even though the crossings will be removed in dry conditions, following the WDFW MOU and ARBO II guidelines, the re-watering of the channel may temporarily suspend sediment into the channel. Sediment will likely not travel far and effects to sediment load and pools would be limited to the area in Brush Creek immediately downstream of the construction location.

Magnitude: Road Closure and Decommissioning- While the majority of the road work will be on the outer edges of RRs or on intermittent streams, the crossings over Brush Creek are likely to have **short-term minor negative effects** to stream sediment. But, for all road decommissioning and closure actions, there will be a **minor long-term positive effect** on sediment and pool indicators because the overall riparian road densities will decrease and will reduce the potential for sediment inputs to streams. Other Roads Used for Haul- Road crossings will likely increase sediment into streams, but the effects are expected to be limited to directly below road crossings. BMPs and road maintenance (such as graveling of the road) will reduce the magnitude to a minor effect to sediment.

Element Summary: With the BMPs, only two perennial stream crossings, and actions completed in the dry, there is limited mechanism to deliver sediment to streams or affect pool habitat. Log hauling will have a minor effect of stream sediment. Therefore, transportation treatments would result in a **minor negative effect** in the short-term but a **minor positive effect** in long-term on the sediment and pool indicators in the Chiwawa River watershed. The effects are localized and will not change the FAR rating for the watershed.

Channel Condition: Streambanks and Channel Geometry

PE: Vegetation Treatments

Timber felling, yarding, and thinning actions occur spatially distant (100 feet from perennial streams during commercial treatments) and have no causal mechanism to affect the habitat indicators. There may be potential for upland-sourced fine sedimentation to change channel geometry via sedimentation; however, the analysis of the sediment indicators found that that magnitude of short-term increases would be much less than those sufficient to measurably aggrade the channel miles downstream. Prescribed fire treatments generally occur spatially distant from streambanks. All pile burning would occur away from stream channels and little risk of fire creep. Analysis of the sediment delivery from project activities found that sediment would have a slight increase in sediment – but of small magnitude not likely sufficient to measurably aggrade a channel or change its width:depth ratio. This PE would have an **insignificant negative effect** to streambanks and channel geometry.

PE: Transportation System Management

Streambanks are generally only affected where changes to road-stream crossings occur. No other project action would directly affect streambanks, particularly at the watershed scale.

Proximity: Opening of Closed Roads for Haul- There are no crossings over perennial channels that will need to be constructed for haul. Road Closure and Decommissioning- There are only two crossings on perennial streams that are proposed for decommissioning after vegetation treatments, and they are both on Brush Creek. Other crossing that will be decommissioned or closed are on intermittent headwater channels.

Probability: Road Closure and Decommissioning- There will be direct effects streambanks and channel geometry when crossings are decommissioned or closed. For areas not directly adjacent to active closure or decommissioning, there may be potential for upland-sourced fine sedimentation to change channel geometry via sedimentation; however, it is unlikely that the magnitude would be sufficient to measurably change channel process/geometry.

Magnitude: Road Closure and Decommissioning- The direct effects of closure and decommissioning would be isolated to the crossings that restoration is occurring in. There are only 2 crossings over perennial streams, other crossing are intermittent, and overall, the localized effects will be a **minor positive effect**. In the long-term and at the watershed scale, the proposed road treatments would result in a reduction in fine sediment delivery, though it is expected to be a **minor positive effect**.

Element Summary: The direct impact to streambanks with this PE are isolated to only 2 perennial stream crossings. Incorporation of standard BMPs such that downstream changes in the sediment yield would be insignificant and not capable of measurably aggrading or degrading the channel. Based on these findings, we expect that there would be a **minor positive effect** to the streambank stability and width:depth ratio indicators.

Flows/Hydrology: Roads and Drainage Network

The Increased Drainage Network, Road Density/Location, and Change in Peak/Base Flows were lumped together because forest roads are believed the primary anthropogenic agent influencing stream flow relating to water quantity. Forest roads artificially increase the drainage network in a watershed. As an example, Wemple (1996) documented a substantial increase in drainage network from the road network in a forested watershed in western Oregon, which has shown to increase peak flows (Jones et al. 2000). In the Big Meadow and Lower Chiwawa subwatershed, there are about 221.9 miles of artificial drainage with a relatively high road density (Big Meadow: 3.9 miles/miles^2 and Lower Chiwawa: 1.4 miles/miles^2). Big Meadow subwatershed has a 17% increase in the drainage network and Lower Chiwawa has an increase of 21%. Because of the increased drainage network, the project fish biologist assumes the road drainage network has altered peak and base flows to some degree. Commercial harvest can affect runoff and is discussed below, but the assessment concludes it would have an insignificant effect to peak and base flows.

PE: Vegetation Management

Vegetation management would not affect water yield in any measurable way from vegetation cover removal. Potential commercial harvest accounts for 18,275 acres of the watershed, or 15.1%. Out of these acres, a total of 1,510 acres of clear-cut are proposed for disease control and off-site genetic material plantation management. This is about 1.3% of the total watershed. When less than 25% of a watershed is harvested, no detectible change in peak flows have been observed (Stednick 1996; NOAA Fisheries Memorandum 2005). The commercial harvest would only result in a negligible impact to peak flows and baseflows. Felling and thinning actions lack causal mechanism to affect road or drainage network indicators. Landings are not proposed within RRs, except in already disturbed areas, such as old landings.

Proximity: All harvest would be at least 100 feet or further from any stream and in the outer edges of RRs, harvest actions would leave 50% canopy cover and not allow any actions that would cause soil disturbance.
Probability: With the riparian harvest/treatment buffers, it is unlikely and discountable that there would be a change to flow/hydrology indicators.

Element summary: With existing buffers, BMPs, and soil disturbance standards, it is likely that there will be a **neutral (0) effect** to flow/hydrology indicators in the Wenatchee River watershed.

PE: Transportation System Management

Proximity: Temporary Roads and Opening Closed Roads- During this project, we expect there to 23.3 miles of temporary roads (0.2 within intermittent headwater stream RRs). Temporary roads are required to be removed within one year of construction and, since vegetation treatments will occur in stages, not all the temporary roads will be opened at the same time. Similarly, 44.2 miles (2.7 miles within RRs) of currently closed roads will be opened for vegetation management and will temporarily increase the drainage network and road densities. Road Closure and Decommissioning- During and post-project, we will be closing and decommissioning roads and, as a result, there will be a net decrease from 122.0 miles of open roads to 75.8 miles of open roads in the Lower Chiwawa subwatershed and a decrease from 41.7 miles of open roads to 28.4 miles of open roads in the Big Meadow subwatershed, post-project.

Probability: During the project, it is likely that the overall road densities within the watershed will increase. But, based on the locations of the temporary roads and roads that will be opened for use, it is unlikely that there will be any change to flow/hydrology or that the new roads will add significantly to the drainage network. In the long-term, the road closures and decommissioning actions will impact the flow/hydrology by reducing the drainage network, reducing the likelihood of changes to flow regime, and reducing road densities.

Magnitude: With the multi-year implementation, location of new roads, and BMPs, any potential negative effects to flow/hydrology would be insignificant. In the long-term, reduction in the road network may have a minor positive effect on flow/hydrology in the watershed. The increase in drainage network post-project will reduce to 14% for both the Lower Chiwawa and Big Meadow subwatersheds due to the reduction in road densities.

Element summary: Based on the slight increases to road density and riparian road drainage, the project would have a short-term minor negative impact to these metrics and to peak and base flows. The road closures and decommissioning would result in a long-term positive (+) effect via reductions in the overall road network. The post-project road decommissioning and closures would all provide further movement towards restoration for the project area drainages. These reductions will also allow the roads program to better focus shrinking maintenance budgets on roads that needed, thus reducing their effects. The proposed harvest-related road activities would result in a **short-term minor negative (-)** and **long-term minor positive (+) effect** on the Drainage Network, Road Density, and Changes to Peak/Base Flows.

Indicator summary: The harvest, prescribed fire, and road management PEs would change the drainage network slightly. There will some minor short-term negative for the drainage network, but mitigation measures will effectively decouple this disturbance and potential for rill development from the stream network. Temporary road construction, management, and hauling will have an inconsequential negative short-term on the drainage network. Long term, road management activities associated with this project will minimally reduce the total size of the drainage network associated with roads by reducing open road density. The magnitude of change resulting from these improvements would be a **short-term insignificant negative (-) effect** and a **long-term minor positive (+) effect** in the long-term for these indicators.

Watershed Indicators

Disturbance History

The project proposes to complete vegetation treatments on 26,330 acres of the Chiwawa River watershed. These treatments will range from strictly prescribed fire, to hand thinning, to commercial timber harvest. 1,536 acres of treatments will occur in RRs. The project will have a short-term increase in road densities but, post-project, a long-term reduction in open roads. The objective of the project is to improve conditions in presently overstocked stands with high densities, removing genetically inappropriate trees, reducing disease risk, reducing wildfire risks, and reducing sediment sources. Vegetation and prescribed fire related activities would have insignificant negative and positive effects. The analysis of effects to the peak flow indicator determined the proposed timber harvest would not result in measurable changes in peak and base flow volumes. Consequently, there would be an **insignificant negative (-) effect** and a **long-term insignificant positive (+) effect** in the long-term to the disturbance history.

Riparian Reserves

Harvest and other actions would occur within outer bands of RRs, in areas not described as riparian or wetland, either in soil- or vegetation-type. Setbacks would be sufficient to protect key habitat elements including provision of shade/ maintenance of temperature, recruitment of large woody debris, wildlife connectivity, and buffering capacity for overland transport of fine sediment or other contaminants. Overall, we expect the vegetation management and transportation system management PEs to result in a temporary **insignificant negative (-) effect** to the Riparian Area indicator and have **no effect** to RRs or off-forest riparian areas associated with ESA-listed salmonids. In the long-term, the project would have a **long-term insignificant positive (+) effect** in the long-term to RRs.

Disturbance Regime

The proposed timber harvest, prescribed fire, and road construction activities would result in insignificant effects the disturbance regime. The goal of this project is to help return a natural disturbance regime to the watershed by using appropriate silviculture prescriptions. If all areas proposed are treated, it is about 15% of the total watershed area and treatment will occur over several years. The prescribed no treatment buffers would protect stream conditions and fish habitat. Temporary road construction, management, and hauling will have an inconsequential negative short-term on the drainage network. Long term, road management activities associated with this project will move the project area towards a more stable condition, albeit the improvements would be negligible. The magnitude of change resulting from these improvements would be a **short-term insignificant negative (-) effect** and a **long-term minor positive (+) effect** in the long-term for the disturbance regime indicator.

Effects to White River-Little Wenatchee Watershed

The effects to the White River-Little Wenatchee watershed is summarized below:

Table 15. Effects Summary Table White River-Little Wenatchee Watershed 5th HUC. While there may be isolated, minor changes to watershed indicators, there will be NO CHANGE to the watershed baseline.

DIAGNOSTICS/ PATHWAYS: White River-Little Wenatchee River Watershed HUC 10		**POPULATION AND ENVIRONMENTAL BASELINE**			**EFFECTS OF THE ACTION(S)**		
INDICATORS		PF	FAR	NPF	Restore	Maintain	Degrade
WATER QUALITY	Temperature			X		X	
	Sediment/Turbidity	X (Little Wen and White R)	X (Lake Wen)		X (long term)		X (short term)
	Chemical Contamination/ Nutrients	X (White R)	X (Lake Wen and Little Wen)			X	
HABITAT ACCESS:	Physical Barriers	X (Little Wen)	X (White R and Lake Wen)			X	
HABITAT ELEMENTS	Substrate Embeddedness	X (Little Wen and White R)	X (Lake Wen)		X		
	Large Woody Debris		X			X	
	Pool Frequency & Quality	X (White R and Little Wen)	X (Lake Wen)			X	
	Off-channel Habitat	X				X	
	Refugia	X				X	
CHAN.COND./DYNAMICS:	Width/Depth Ratio	X				X	
	Streambank Condition	X (Lake Wen)	X (White R and Little Wen)			X	
	Floodplain Connectivity	X (Lake Wen)	X (White R and Little Wen)			X	
FLOW/HYDROLOGY:	Change in Peak/Base Flows	X (White R)	X (Little Wen and Lake Wen)			X	
	Increase in Drainage Network		X		X (long term)		X (short term)

WATERSHED CONDITIONS: Road Density/Location		X		X (long term)		X (short term)
Disturbance History		X			X	
Riparian Reserves		X		X (long term)		X (short term)
Disturbance Regime:		X		X (long term)		X (short term)

[1] Ratings are broke out by HUC 12 watersheds if one rating does not accurately describe the HUC 10 watershed

Water Quality: Temperature and LWD

Analysis of potential effects to temperature and wood are lumped because the primary mechanisms affecting them are similar – shade loss (temperature) and physical material loss (reducing wood recruitment) via removal of streamside vegetation and trees either by harvesting, thinning, mortality through fire, or other physical means of removal.

Effects to Temperature: Removal of shade producing trees and vegetation is the primary mechanism that affects stream temperature. PEs that could reduce shade along streams include commercial harvest, non-commercial thinning, prescribed fire, and the TSM such as removal of vegetation while opening closed roads, closing roads, and decommissioning roads.

Effects to Instream Large Wood and Future Recruitment Potential: The primary mechanisms by which instream large wood and future wood recruitment are affected is via removal of trees from the core inner zone of streams where they would otherwise senesce and fall into the channel. No proposed vegetation treatment PEs would remove instream wood, limiting potential wood impacts to just altering future wood recruitment and increases in wood loading.

PE: Vegetation Treatments

Proximity: Up to 3,796 acres of vegetation treatments are proposed in the White River-Little Wenatchee River watershed, which is 2.2% of the total watershed acreage. Of these potential treatments, up to 205 acres of treatment are proposed in the outer edges of Riparian Reserves, as described in the design criteria. The only treatments that may affect the temperature and large wood indicators would be commercial harvest (all other vegetation treatments will only remove small diameter trees and shrubs, <7” dbh, and shrubs). In perennial streams and lakes/ponds, no commercial harvest will occur within 100 ft of the channel/waterbody edge. In intermittent streams and wetlands, no commercial harvest will occur within 50 ft of the channel/waterbody edge and, for harvest outside that no-cut buffer but still within the Riparian Reserve, 50% or more canopy cover would be maintained. These buffers are also the same for non-commercial (mechanical thinning) but hand thinning of small diameter trees may occur closer to the waterway.

Probability: The probability of commercial, non-commercial thinning, yarding, or landings affecting stream temperature or wood recruitment in adjacent streams and critical habitat below ranges from zero to discountable.

Using the prescribed no-treatment buffers would either prevent or minimize impacts to the adjacent channel enough to result an extremely low probability of impacts to critical habitat. Studies reported in FEMAT (p. V-28, 29; USDA et al., 1993) as well as more recent work (Moore et al., 2005; Sridhar et al., 2004) indicate that shade mostly approached 100% effectiveness when harvest buffer widths were between 0.5 and 1 SPT (within the Upper Wenatchee Pilot Project area, SPT is generally about 200ft). Another study cited by FEMAT reported buffer widths of at least 100 feet in western Cascade Mountains provide as much shade as similar undisturbed sites. Benda et al. (2003) also found that there is less than a 5% probability that a tree 100 ft away from the stream will fall and enter the stream channel as large wood. Commercial harvest in the outer areas of the RRs (100ft to 300ft) will retain 50% canopy cover and will work to restore large tree structure. While there may be a short-term reduction in number of trees, the resulting condition will allow for large tree growth which is more likely to provide in-stream canopy cover and large wood inputs. Non-commercial thinning will remove overall biomass within the RRs, but, as the focus is on small trees less than 7" dbh, we expect that this thinning will encourage growth in the large trees which will eventually lead to greater volume of large wood in the stream. We expect the proposed buffer widths along perennial streams would maintain existing shade sufficient to not measurably affect water temperatures or wood recruitment levels along perennial streams. Additionally, managing the outer RRs (beyond 100 feet in perennial streams) for larger, more resilient species, is expected to result in slightly larger trees capable of being delivered to the stream from greater distances, in time. Neither commercial nor non-commercial thinning along intermittent streams would affect temperature because they would be dry during the summer/fall periods. The prescription for prescribed fire is retaining 95% of the existing canopy cover in active ignition areas and is expected to be even higher for areas with backing fires (RRs). Arkle and Pilloid (2010) showed that backing fire into riparian reserves had no change on RR and in-stream habitat metrics, such as large wood, as have other studies (Robichaud and Waldrop 1994; Beche et al. 2005; Cawson et al. 2012). Based on observations in the field and previous studies, effects to stream temperature and wood recruitment from prescribed fire is entirely discountable.

Element Summary: Removing commercial sized trees at least 100ft from would not affect stream shade or wood recruitment. Small diameter thinning along intermittent channels to within 25 feet has potential to affect localized wood recruitment, but the potential for impacts downstream in critical habitat are discountable because these trees are small diameter and not actively contributing to shade or large wood recruitment, especially when the channel is only intermittently flowing. Therefore, the proposed commercial harvest would result in a **neutral (0) effect** to temperature **discountable negative (-) effect** to LWD indicators in critical habitat.

PE: Transportation System Management

The TSM PE includes road treatments and log hauling in association with the vegetation management. Aspects of the TSM PE that could influence shade or LWD are removal of vegetation while opening closed roads (negative), closing roads long-term (positive), and decommissioning roads (positive). The majority of temporary roads will be constructed outside of RRs but a total of 0.1 miles of temporary roads may be constructed in the RRs of intermittent headwater streams within the Wenatchee River watershed.

Proximity: Temporary roads- 0.1 miles of temporary roads are proposed for construction in the RRs in the White River-Little Wenatchee River watershed but this segment is on the outer edge of a small (less than one acre) wetland that is not connected to other surface water. Opening of Closed Roads for Haul- 1.5 miles of currently closed roads are proposed for reopening for log haul but none of these are within RRs. Other Roads Used for Haul- Only 0.1 miles of currently open roads in RRs are proposed for log haul, all being ML3 roads. These roads may require maintenance, such as resurfacing, grading, and brushing, before, during, and after use. All these actions will follow BMPs to reduce sediment input. Road Closure and Decommissioning- Post-project, 0.2 miles of roads within RRs will have on-the-ground changes (closures). These actions will follow BMPs and all applicable ARBO II design criteria and conservation measures to reduce the potential of sedimentation into streams.

Table 53. Road transition status, post-project, in the Lake Wenatchee subwatershed.

Post-Project Transition	Riparian Reserve Roads (miles)	All Roads (miles)
Close Unauthorized Route	0.2	6.3
Decommission Closed Road	0.0	2.2
Decommission Unauthorized Route	0.0	0.3
Remain Closed	0.0	0.2
Remain Open ML2	0.1	5.8
Remain Open ML3	0.5	2.0
Remain Open ML4	0.0	0.2

Table 54. Road actions within the White River-Little Wenatchee watershed, by project phase, in miles of roads. Values in parentheses indicate miles within RRs.

	Phase					
Road Transition	**1**	**2**	**3**	**4**	**5**	**6**
Add ML2	--	--	1.2	--	0.3 (<0.1)	--
Close Unauthorized Route	--	--	0.4	--	4.4 (0.2)	--
Decommission Closed Road	--	--	0.1	--	2.1	--
Decommission Unauthorized Route	--	--	<0.1	--	0.3	--
Closed Roads Open for Haul	--	--	--	--	1.5	--
Temp Roads	--	--	0.2	--	2.1	--

Probability: Temporary Roads- the 0.1 segment of temporary road proposed along the edge of the RR for a small wetland may reduce shade cover slightly but this wetland has no connection to other surface water and it is entirely discountable that it would affect stream temperature or availability of LWD. Opening Closed Roads- none occurring in RRs, discountable effect. Road closures and decommissioning- closing and decommissioning roads will allow for the eventual return of vegetation and, in the very long-term, may include an additional source of shade and large wood recruitment. This would result in a slight increase in riparian function, but a measurable benefit to stream temperature and wood recruitment would be extremely unlikely.

Element Summary: Opening and closing roads would have no mechanism to affect shade or wood recruitment in critical habitat. Riparian road decommissioning would result in a small, inconsequential improvements to watershed processes. Therefore, the roads PE would result in a **discountable negative effect** for opening closed roads and closing roads and a **discountable positive (+) effect** for RR road decommissioning to the temperature and LWD indicators.

Indicator Summary: The proposed treatments within RRs are not expected to measurably affect stream shade or wood recruitment to adjacent streams. Setbacks for harvest or other thinning activities, low severity burning, and the few road activities may result in small, localized reductions in shade, but it is not expected to rise to a measurable impact. Likewise, the benefits of riparian road decommissioning and closure, is not expected to have measurable benefits in the long-term. We expect a **neutral (0) effect** to stream temperature and a **discountable negative (-) short-term** and **positive (+) long-term effects** to LWD indicator.

Water Quality: Chemical Contaminants/Nutrients

Nutrients for all PEs: Clayton and Kennedy (1985) investigated changes in nutrient budgeting and runoff in Idaho streams following timber harvest (primarily clearcuts) and describe significant losses in dissolved nitrogen from disturbed soils. They suggest that use of logging systems that minimize erosion and use adequate buffer strips should not cause unacceptable nutrient loss. Jurgensen et al. (1997) found similar results in investigating Inland Northwest timber harvest operations and noted the importance of carefully planned use of prescribed fire and mechanical site preparation when accomplishing forest management objectives.

PE: Vegetation Treatments

Proximity: All re-fueling and fuel storage must occur outside of RRs. The vegetation treatment PE does not propose to apply chemicals to streams or other water features. Standard mitigating measures include hazardous materials storage in durable containers, use of spill kits, equipment inspection and maintenance, as well as spatial separation of equipment and activities from waterbodies.

Probability: Based on the buffers, mitigations, and lack of chemicals used in vegetation treatments, there is a **zero to discountable** probability of chemical contaminants entering the stream.

PE: Transportation System Management

Proximity: Lignin-based dust abatement may be applied to the road surfaces, as needed. Chemical dust abatements will not be applied within 100 ft of an occupied ESA-list stream and not within 25 ft of other streams.

Probability: Even in areas with relatively high annual rainfall (60-80 inches), there is good evidence that leaching of lignosulfonates from stabilized road soils is minor providing such soils contain 10-20 percent clay to absorb the lignin. Lignonsulfonates have low permeability through soil and pose little, if any, threat to ground water (Heftner 1996). Based on the application rate and buffers, there is a **zero to discountable** probability that chemicals will enter the stream during transportation system management activities.

Element Summary: There will be a **neutral effect** to chemical contaminants/nutrients indicator within the White River- Little Wenatchee River watershed.

Habitat Element: Sediment and Pools

Analysis of potential effects to sediment and pools are lumped because the primary mechanism affecting pool quality and quantity is sediment (in terms of filling in pools or degrading their quality). LWD also plays a role, but the effects to LWD were assessed above with temperature and determined to be insignificant in the analysis such that risk of wood reduction/pool formation is not a concern.

PE: Vegetation Treatments

Proximity: About 205 acres of vegetation treatment is proposed in the Riparian Reserves and all commercial harvest and non-commercial mechanical thinning would occur at least 100 feet from an adjacent stream. See description under effects to temperature and LWD for more details on locations. There would be no soil disturbance within the no-cut buffer because there will not be any heavy equipment use, except in winter harvest conditions. Unmeasurable soil disturbance may occur do to non-mechanical thinning (hand crews) or the burning of hand piles. These impacts would be isolated and discountable. Additionally, any treatment that occurs in the outer edges of Riparian Reserves would be required to harvest during winter or meet the Soil Disturbance Guidelines. No new landings would be constructed within Riparian Reserves, unless no other practical location exists, and they are able to meet Soil Disturbance Guidelines. All skid trails would occur in the outer edges and involves no stream crossings. Manual fuels reduction has a prescribed no-treatment buffer of 50 ft to perennial streams. Prescribed fire activities may occur adjacent to perennial streams.

Probability: All treatments in Riparian Reserves would be have no-cut buffers of at least 100 feet and the only mechanism for sediment to reach streams is from surface runoff via overland flow. Surface runoff over undisturbed ground generally permeates the soil and moves to stream channels via subsurface flow (Chamberlain et al. 1991). Additionally, Sweeney et al. (2014), who looked at buffer widths to prevent the delivery of suspended sediment to streams suggests 30-meter (98ft) buffers are necessary to prevent ultra-fine sediment from reaching streams. Based on this study, the lack of harvest in steep riparian gradients and the prescribed 100-foot buffers, the project fish biologist expects no fine sediment to reach adjacent streams. None of the proposed yarding would cross any streams. Manual fuel reduction thinning will no create soils disturbance that would create sediment sources to streams. Prescribed fire within Riparian Reserves must maintain 50% ground cover reducing the probability of sediment input. Beche et al. (2005) and Arkle and Pilloid (2010) found no change in in-stream habitat metrics following low intensity fire in the RR. With the design criteria and buffers established, there is a zero to discountable probability of any sediment delivery to adjacent streams or affecting the sediment or pool indicators.

Element Summary: With the prescribed 100-foot buffers of undisturbed vegetation, slopes of 0 to 20%, high infiltration rates, and no stream crossing, there is no mechanism to deliver sediment to streams or affect pool habitat. Therefore, vegetation treatments would result in a **neutral (0) effect** on the sediment and pool indicators in the White River-Little Wenatchee River watershed.

PE: Transportation System Management

Proximity: Temporary roads- 0.1 miles of temporary roads are proposed for construction in the RRs in the White River-Little Wenatchee River watershed but this segment is on the outer edge of a small (less than one acre) wetland that is not connected to other surface water. All temporary roads would be constructed following BMPs to reduce potential sedimentation (constructed in the dry, appropriate crossing structures installed, etc.). Opening of Closed Roads for Haul- 1.5 miles of currently closed roads are proposed for reopening for log haul but none of these are within RRs. Other Roads Used for Haul- Only 0.1 miles of currently open roads in RRs are proposed for log haul, all being ML3 roads. These roads may require maintenance, such as resurfacing, grading, and brushing, before, during, and after use. All these actions will follow BMPs to reduce sediment input. Road Closure and Decommissioning- Post-project, 0.2 miles of roads within RRs will have on-the-ground changes (closures), including two crossings on unauthorized roads over Barnard Creek. These actions will follow BMPs and all applicable ARBO II design criteria and conservation measures to reduce the potential of sedimentation into streams.

Probability: Temporary Roads- Since the temporary road will be on the outer edge of a small wetland RR, there is no mechanism for sediment to enter any other surface water. Construction and removal would be the in the dry and there would be no input of sediment into any standing water. Opening of Closed Roads for Haul- none in RRs. Other Roads Used for Haul- following all road maintenance for haul purposes would be unlikely to increase sediment input into streams. Road Closure- Closure of unauthorized routes in RRs will occur in intermittent headwaters streams and on two crossings over Barnard Creek, a fishless perennial tributary to Lake Wenatchee. Based on the proximity of the road actions to Lake Wenatchee, it is unlikely but not entirely discountable that these actions may increase sediment to the Lake Wenatchee.

Magnitude: Road Closure- The active closure work will occur on two crossings over a perennial stream. All in-stream work (like culvert removal, if necessary) will follow ARBO II guidelines and the effect of any actions will be insignificant.

Element Summary: With the BMPs, very limited work occurring in RRs, only two stream crossings, and most actions completed in the dry, there is no mechanism to deliver sediment to streams or affect pool habitat. Therefore, transportation treatments would result in a **discountable negative effect** on the sediment and pool indicators in the White River-Little Wenatchee River watershed.

Channel Condition: Streambanks and Channel Geometry

PE: Vegetation Treatments

Timber felling, yarding, and thinning actions occur spatially distant (100 feet from perennial streams during commercial treatments) and have no causal mechanism to affect the habitat indicators. There may be potential for upland-sourced fine sedimentation to change channel geometry via sedimentation; however, the analysis of the sediment indicators found that that magnitude of short-term increases would be much less than those sufficient to measurably aggrade the channel miles downstream. Prescribed fire treatments generally occur spatially distant from streambanks. All pile burning would occur away from stream channels and little risk of fire creep. Analysis of the sediment delivery from project activities found that sediment would have a slight increase in sediment – but of small magnitude not likely sufficient to measurably aggrade a channel or change its width:depth ratio. This PE would have a **neutral (0) effect** to streambanks and channel geometry.

PE: Transportation System Management

Streambanks are generally only affected where changes to road-stream crossings occur. No other project action would directly affect streambanks, particularly at the watershed scale.

Proximity and Probability: There are two changes to road-stream crossings in the White River-Little Wenatchee River watershed as part of the transportation system management. Closing these two crossings will affect streambank condition in a very localized area and the probability of having any effect on the watershed streambank conditions or channel geometry is unlikely. There may be potential for upland-sourced fine sedimentation to change channel geometry via sedimentation; however, it is unlikely that the magnitude would be sufficient to measurably change channel process/geometry. In the long-term, the proposed road treatments would result in a reduction in fine sediment delivery, though it is expected to be immeasurable as well. Due to the lack of impacts downstream and proximity, this PE would have a **neutral (0) effect** to streambanks and channel geometry.

Element Summary: There will be very limited direct impacts to streambanks (only at two crossing locations) with this PE and incorporation of standard BMPs such that downstream changes in the sediment yield would be insignificant and not capable of measurably aggrading or degrading the channel. Based on these findings, we expect that there would be **neutral (0) effect** to the streambank stability and width:depth ratio indicators.

Flows/Hydrology: Roads and Drainage Network

The Increased Drainage Network, Road Density/Location, and Change in Peak/Base Flows were lumped together because forest roads are believed the primary anthropogenic agent influencing stream flow relating to water quantity. Forest roads artificially increase the drainage network in a watershed. As an example, Wemple (1996) documented a substantial increase in drainage network from the road network in a forested watershed in western Oregon, which has shown to increase peak flows (Jones et al. 2000). In the Lake Wenatchee subwatershed, there are about 51.8 miles of artificial drainage with a moderately high road density of 3.1 miles/miles^2. The Lake Wenatchee subwatershed has an increase in the drainage network of 8%. Because of the increased drainage network, the project fish biologist assumes the road drainage network has altered peak and base flows to some degree. Commercial harvest can affect runoff and is discussed below, but the assessment concludes it would have an insignificant effect to peak and base flows.

PE: Vegetation Management

Vegetation management would not affect water yield in any measurable way from vegetation cover removal. Potential commercial harvest accounts for 2,744 acres of the watershed, or 1.6% and no units are proposed for clearcutting. When less than 25% of a watershed is harvested, no detectible change in peak flows have been observed (Stednick 1996; NOAA Fisheries Memorandum 2005). The commercial harvest would not impact peak flows and baseflows. Felling and thinning actions lack causal mechanism to affect road or drainage network indicators. Landings are not proposed within RRs, except in already disturbed areas, such as old landings.

Proximity: All harvest would be at least 100 feet or further from any stream and in the outer edges of RRs, harvest actions would leave 50% canopy cover and not allow any actions that would cause soil disturbance.
Probability: With the riparian harvest/treatment buffers, it is unlikely and discountable that there would be a change to flow/hydrology indicators.

Element summary: With existing buffers, BMPs, and soil disturbance standards, it is likely that there will be a **neutral (0) effect** to flow/hydrology indicators in the Wenatchee River watershed.

PE: Transportation System Management

Proximity: Temporary Roads and Opening Closed Roads- During this project, we expect there to 4.8 miles of temporary roads (0.1 within a small wetland RRs). Temporary roads are required to be removed within one year of construction. Similarly, 1.5 miles (none within RRs) of currently closed roads will be opened for vegetation management and will temporarily increase the drainage network and road densities. Road Closure and Decommissioning- During and post-project, we will be closing and decommissioning roads and, as a result, there will be a net decrease from 34.9 miles of open roads to 17.5 miles of open roads in the Lake Wenatchee subwatershed, post-project.

Probability: During the project, it is likely that the overall road densities within the watershed will increase. But, based on the locations of the temporary roads and roads that will be opened for use, it is unlikely that there will be any change to flow/hydrology or that the new roads will add significantly to the drainage network. In the long-term, the road closures and decommissioning actions will impact the flow/hydrology by reducing the drainage network, reducing the likelihood of changes to flow regime, and reducing road densities.

Magnitude: With the multi-year implementation, location of new roads, and BMPs, any potential negative effects to flow/hydrology would be insignificant. In the long-term, reduction in the road network may have a minor positive effect on flow/hydrology in the watershed.

Element summary: Based on the slight increases to road density and riparian road drainage, the project would have a short-term minor negative impact to these metrics and to peak and base flows. The road closures and decommissioning would result in a long-term positive (+) effect via reductions in the overall road network. The post-project road decommissioning and closures would all provide further movement towards restoration for the project area drainages. Post-project, the increase in drainage network will reduce to 6% in the Lake Wenatchee subwatershed. These reductions will also allow the roads program to better focus shrinking maintenance budgets on roads that needed, thus reducing their effects. The proposed harvest-related road activities would result in a **short-term insignificant negative (-)** and **long-term minor positive (+) effect** on the Drainage Network, Road Density, and Changes to Peak/Base Flows.

Indicator summary: The harvest, prescribed fire, and road management PEs would change the drainage network slightly. There will some minor short-term negative for the drainage network, but mitigation measures will effectively decouple this disturbance and potential for rill development from the stream network. Temporary road construction, management, and hauling will have an inconsequential negative short-term on the drainage network. Long term, road management activities associated with this project will minimally reduce the total size of the drainage network associated with roads by reducing open road density in the Lake Wenatchee subwatershed from 2.1 to 1.0 mi/mi^2. The magnitude of change resulting from these improvements would be a **short-term insignificant negative (-) effect** and a **long-term minor positive (+) effect** in the long-term for these indicators.

Watershed Indicators

Disturbance History

The project proposes to complete vegetation treatments on 3,796 acres of the White River- Lake Wenatchee watershed. These treatments will range from strictly prescribed fire, to hand thinning, to commercial timber harvest. 205 acres of treatments will occur in RRs. The project will have a short-term increase in road densities but, post-project, a long-term reduction in open roads. The objective of the project is to improve conditions in presently overstocked stands with high densities, removing genetically inappropriate trees, reducing disease risk, reducing wildfire risks, and reducing sediment sources. Vegetation and prescribed fire related activities would have insignificant negative and positive effects. The analysis of effects to the peak flow indicator determined the proposed timber harvest would not result in measurable changes in peak and base flow volumes. Consequently, there would be an **insignificant negative (-) effect** and a **long-term insignificant positive (+) effect** in the long-term to the disturbance history.

Riparian Reserves

Harvest and other actions would occur within outer bands of RRs, in areas not described as riparian or wetland, either in soil- or vegetation-type. Setbacks would be sufficient to protect key habitat elements including provision of shade/ maintenance of temperature, recruitment of large woody debris, wildlife connectivity, and buffering capacity for overland transport of fine sediment or other contaminants. Overall, we expect the vegetation management and transportation system management PEs to result in a temporary **minor negative (-) effect** to the Riparian Area indicator and have **no effect** to RRs or off-forest riparian areas associated with ESA-listed salmonids. In the long-term, the project would have a **long-term minor positive (+) effect** in the long-term to RRs.

Disturbance Regime

The proposed timber harvest, prescribed fire, and road construction activities would result in insignificant effects the disturbance regime. The goal of this project is to help return a natural disturbance regime to the watershed by using appropriate silviculture prescriptions. If all areas proposed are treated, it is less than 3% of the total watershed area and treatment will occur over several years. The prescribed no treatment buffers would protect stream conditions and fish habitat. Temporary road construction, management, and hauling will have an inconsequential negative short-term on the drainage network. Long term, road management activities associated with this project will move the project area towards a more stable condition, albeit the improvements would be negligible.

The magnitude of change resulting from these improvements would be a **short-term insignificant negative (-) effect** and a **long-term minor positive (+) effect** in the long-term for the disturbance regime indicator.

ESA Effects Determination

PROJECT EFFECTS DETERMINATION KEY FOR SPECIES AND DESIGNATED CRITICAL HABITAT: UPPER WENATCHEE PILOT PROJECT

*Project effects determination key for **Upper Columbia Spring Chinook Salmon**, and their Designated Critical Habitat*

1) Do any of the indicator summaries have a positive (+) or negative (-) conclusion?
   Yes – Go to 2
   No – No Effect
2) Are the indicator summary results only positive?
   Yes – NLAA
   No – Go to 3
3) If any of the indicator summary results are negative, are the effects insignificant or discountable?
   Yes – NLAA
   No – LAA, fill out Adverse Effects Form

*Project effects determination key for **Columbia River Bull Trout** and **Upper Columbia River steelhead** and their Designated Critical Habitat*

1) Do any of the indicator summaries have a positive (+) or negative (-) conclusion?
   Yes – Go to 2
   No – No Effect
2) Are the indicator summary results only positive?
   Yes – NLAA
   No – Go to 3
3) If any of the indicator summary results are negative, are the effects insignificant or discountable?
   Yes – NLAA- for designated Critical Habitat
   No – LAA, fill out Adverse Effects Form

Summary of Effects to Listed Fish and Critical Habitat

The Upper Wenatchee Pilot Project, would make substantial improvements to restoring watershed processes related to road-stream interactions that include reducing chronic sediment sources, reducing artificial drainage networks, reducing road density, storm-proofing the road network, improving fish passage, increasing habitat in important fish habitat reaches, increasing natural water storage, and increasing resiliency in RRs. The actions analyzed in this BA would range from neutral to insignificant impacts to steelhead, bull trout, and spring chinook critical habitat.

Chinook Salmon and Steelhead

The 2005 CH designation for UCR spring-run Chinook and steelhead provided a list of six PCEs to evaluate in addition to the Matrix of Pathways and Indicators (MPI) subsequently discussed in this assessment (70 FR 52630). The PCEs consist of the physical and biological features (PBFs) identified as essential to the conservation of the listed species in the documents that designate critical habitat. A summary of the PBFs are freshwater spawning areas, freshwater rearing areas, freshwater migration corridors, estuarine areas, nearshore marine areas, and offshore marine areas. According to the NMFS designation of where the six PBFs would apply for these species, only the first three apply for the Wenatchee River basin. In addition, no Forest actions or action areas occur within estuarine habitats, nearshore marine habitats, or offshore marine habitats.

The following crosswalk tables show how PBFs within the range of habitat types within the scope of effects from the proposed project and how they correspond to the MPI habitat indicators that are considered in this assessment.

PBF 1. Freshwater spawning *features include water flow, quality and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles.*

Site Attribute	MPI Habitat Indicator(s)	Species Life History Event
Substrate	Substrate	Adult Spawning Embryo Incubation Alevin Growth and Development
Water Quality	Water temperature Sediment/Turbidity Chemical contamination/nutrients	
Water Quantity	Change in peak/base flows	

Effect Determination to UCR steelhead and chinook DCH PBF 1: This PCE will not be adversely affected because project related fine sediment delivery would be immeasurable in DCH. Only 2 unpaved crossings that will be used for haul routes are over DCH (steelhead: Alder Creek and Chinook: Goose Creek). Sediment input will be minimal and isolated at those crossings and will not alter DCH characteristics. Any sedimentation will be short-term and overall the project will reduce sediment inputs into streams. Effects to water temperatures and flow regimes would be immeasurable and insignificant at the sub-watershed scale.

PBF 2. Freshwater rearing *habitat features include sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.*

Site Attribute	MPI Habitat Indicator(s)	Species Life History Event
Floodplain connectivity	Floodplain connectivity	Fry emergence from gravel Fry/parr/smolt growth and development
Water Quality	Water temperature	

	Sediment/Turbidity Chemical contamination/nutrients	
Water Quantity	Change in peak/base flows	
Forage*	Water quality indicators Riparian reserves Substrate Large woody debris	
Natural Cover	Water temperature (shade) Riparian reserves Large woody debris Substrate Pool frequency Pool quality Width/depth ratio Floodplain connectivity Off-channel habitat Streambank condition	

*There is no directly corresponding MPI habitat indicator for forage. We do not typically collect biological data to assess aquatic food webs and nutrient cycles; therefore "Forage" will be indirectly assessed by the following relevant/related MPI habitat indicators in this assessment. The primary food items for juvenile anadromous salmonids are aquatic and terrestrial invertebrates. Production of aquatic invertebrates is influenced by water quality. Fine sediment and substrate embeddedness affect living space for aquatic invertebrates and sustained elevated turbidity may reduce aquatic invertebrate production and the ability of juvenile fish to find invertebrate food items. Chemical contamination may reduce or eliminate production of certain aquatic invertebrates and excess nutrient levels may lead to lethal or sublethal effects to aquatic invertebrates. "Forage" is also influenced by the extent and condition of riparian vegetation as evaluated by the MPI Riparian Reserve indicator. Shade provided by streamside vegetation influences water temperatures which, in turn, affects aquatic invertebrate production. Organic matter from riparian vegetation provides allocthonous inputs that sustain aquatic food webs. Woody debris provides substrate and a food source for aquatic invertebrates. Riparian vegetation provides food and substrate for terrestrial invertebrates which become a significant food source when they drop to the water below.

Effect Determination to UCR steelhead and chinook DCH PBF 2: This PCE will not be adversely affected because project related effects to water quantity, quality, and habitat conditions would be immeasurable in DCH. Slight short-term increases in stream sediment may occur but there will be a long-term reduction in overall sedimentation in the project area due to the road improvements and reductions in road density.

PBF 3. *Freshwater migration habitat features include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles.*

Site Attribute	MPI Habitat Indicator(s)	Species Life History Event

<table>
<tr><td>Water Quality</td><td>Water temperature
Sediment/Turbidity
Chemical contamination/nutrients</td><td rowspan="4">Adult sexual maturation
Adult upstream migration and holding
Kelt (steelhead) seaward migration
Fry/parr/smolt growth, development, and seaward migration</td></tr>
<tr><td>Water Quantity</td><td>Change in peak/base flows</td></tr>
<tr><td>Freshwater migration corridors free of obstruction</td><td>Physical barriers</td></tr>
<tr><td>Natural Cover</td><td>Water temperature (shade)
Riparian reserves
Large woody debris
Substrate
Pool frequency
Pool quality
Width/depth ratio
Floodplain connectivity
Off-channel habitat
Streambank condition</td></tr>
</table>

Effect Determination to MCR steelhead DCH PCE 3: Effect to this PCE would be neutral because migratory conditions within DCH or potential steelhead/Chinook habitat would not be changed.

We expect a slight increase in sediment delivery from the use of unpaved haul routes over minimal CH crossings (steelhead: Alder Creek and Chinook: Goose Creek). The use of BMPs and design criteria such as low impact harvest methods would reduce potential sediment impacts so they are not likely measurable. Because the impacts would be immeasurable, the result would be insignificant. Thus, the proposed actions included in this BA would result in a ***may affect, not likely to adversely affect*** steelhead and chinook critical habitat.

Bull Trout

Bull trout critical habitat is designated throughout the project area and bull trout use project area streams and rivers for all life history stages. The only action related to vegetation treatments or transportation system management is the use of open roads for haul routes over occupied or CH streams. Any maintenance or management needed for these roads will follow BMPs and will not results in any direct effects to fish or critical habitat.

Bull Trout PCE

The 2010 CH designation for CR bull trout provided a list of nine PCEs to evaluate in addition to the Matrix of Pathways and Indicators (MPI) subsequently discussed in this assessment (75 FR 63897). The nine PCEs elate to: (1) Water quality; (2) migration habitat; (3) food availability; (4) instream habitat; (5) water temperature; (6) substrate characteristics; (7) stream flow; (8) water quantity; and (9) nonnative species. All of these PCEs are present within Wenatchee River basin except for the marine shoreline component of the 'instream habitat' PCE. No Forest actions or action areas occur within marine shoreline habitats.

The following crosswalk tables show how PCEs 1 through 9 correspond to the MPI habitat indicators that are considered in this assessment.

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

PCE 1 Criterion	MPI Habitat Indicator(s)
Water Quantity	Change in peak/base flows
Water Quality	Water Temperature Sediment/turbidity Chemical contamination/nutrients
Thermal Refugia	Water Temperature

Effect Determination to bull trout Designated Critical Habitat (DCH) PCE 1: Effect to this PCE would not be adversely affected because no changes to water quantity or stream temperature are expected. Short-term, insignificant increases in stream sediment levels would occur followed by long-term reductions in road related sediment delivery. Bull trout spawning life stages occur above the ESA Action Area. Sub-adult and juvenile bull trout are likely to occupy the ESA Action Area.

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.*

PCE 2 Criterion	MPI Habitat Indicator(s)
Permanent, partial, intermittent, or seasonal barriers	Physical barriers Water temperature

Effect Determination to bull trout DCH PCE 2: Effect to this PCE would be neutral because migratory conditions within DCH or potential bull habitat would not be measurably changed or have a slight positive change.

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

PCE 3 Criterion	MPI Habitat Indicator(s)
Food Base*	All MPI habitat indicators

*There is no directly corresponding MPI habitat indicator for food base. Bull trout are opportunistic feeders that prey upon other organisms such as terrestrial and aquatic insects, macrozooplankton, and small fish and adult migratory bull trout feed almost exclusively on other fish. Habitat must provide the necessary aquatic and adjacent terrestrial conditions to harbor and maintain prey species in sufficient quantity and diversity to meet the physiological requirements necessary to maintain bull trout populations. We do not typically collect biological data to assess aquatic food webs. All the MPI habitat indicators influence the production of aquatic and terrestrial invertebrates and small native fish; therefore, "Food Base" will be indirectly assessed by all of the MPI habitat indicators.

Effect Determination to bull trout DCH PCE 3: Effect to this PCE would not be adversely affected because no changes to water quantity or stream temperature are expected. Short-term, insignificant increases in stream sediment levels would occur followed by long-term reductions in road related sediment delivery. It is unlikely any measurable change would occur to bull trout's prey base or prey habitat.

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.*

PCE 4 Criterion	MPI Habitat Indicator(s)
Complex Aquatic Environment*	Water temperature Substrates Large wood Off-channel habitat Pool frequency and quality Large pools Refugia Width/Depth ratio Streambank condition Floodplain connectivity

*There is no marine shoreline habitat in the Action Area therefore it would not apply.

Effect Determination to bull trout DCH PCE 4: Effect to this PCE would not be adversely affected because no changes to water quantity or stream temperature are expected. Short-term, minor increases in stream sediment levels would occur followed by long-term reductions in road related sediment delivery. In the long-term, less sediment delivery would improve existing rearing and foraging habitat.

PCE 5. *Water temperatures ranging from 2 to 15 [deg]C (36 to 59 [deg]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.*

PCE 5 Criterion	MPI Habitat Indicator(s)
Thermal Refugia	Water temperature

Effect Determination to bull trout DCH PCE 5: This PCE would not be adversely affected because stream shading will not be measurably changed by the project.

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.*

PCE 6 Criterion	MPI Habitat Indicator(s)
Substrate amount, size and composition	Substrate

Effect Determination to bull trout DCH PCE 6: Effect to this PCE may be adversely affected but the project design criteria and mitigation would limit changes to sediment to be short-term, minor levels. The long-term change would be reductions in road related sediment delivery, which would improve rearing and foraging habitat.

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.*

PCE 7 Criterion	MPI Habitat Indicator(s)
Flow/Hydrology	Change in peak/base flows Increase in drainage network

Effect Determination to bull trout DCH PCE 7: This PCE would not be adversely affected at the sub-watershed scale because no part of the proposed project would alter hydrology such that measurable changes to summer base flows or peak flows would occur. In the long-term, road decommissioning slightly reduce the drainage network.

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

PCE 8 Criterion	MPI Habitat Indicator(s)
Water Quantity	Change in peak/base flows

	Increase in drainage network
Water Quality	Water Temperature Sediment/turbidity Chemical contamination/nutrients

Effect Determination to bull trout Designated Critical Habitat (DCH) PCE 8: Effect to this PCE would not be adversely affected because no changes to water quantity or stream temperature are expected. Additionally, no part of the project would put chemicals or other like materials into streams. Short-term, minor increases in stream sediment levels would occur followed by long-term reductions in road related sediment delivery. The artificial road drainage would have an inconsequential increase during the project and a larger decrease in the long-term. Bull trout spawning life stages occur above the ESA Action Area. Sub-adult and juvenile bull trout are likely to occupy the ESA Action Area.

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.*

PCE 9 Criterion	MPI Habitat Indicator(s)
Non-native Fish Species*	Summary/Integration of all Species and Habitat Indicators

*There is no directly corresponding MPI habitat indicator for non-native fish species that present risks to bull trout. Eastern brook trout is a non-native trout species stocked within the Upper Columbia Basin that poses the greatest risk to bull trout relating to predation, displacement, and interbreeding. Brook trout competes with bull trout for food and space, they can hybridize with bull trout and adult brook trout are known to feed on juvenile bull trout. Brook trout can also displace bull trout from rearing areas. In some streams, brook trout are so well established that they may have greatly reduced the number of bull trout in them (USFWS 2002). We do not collect data on brook trout population size but do have data on their distribution. Non-native fish species will be indirectly assessed by the Summary/Integration of all Species and Habitat Indicator.

Effect Determination to bull trout DCH PCE 9: This PCE would not be adversely affected.

In Summary, we expect some short, temporary increases in fine sediment delivery that would be minor and localized. Road maintenance and log hauling would occur under dry conditions. Slight improvements in road density and reduction of potential sediment inputs would occur all project subwatersheds, but they would not result in measurable improvements. Thus, the proposed actions covered under this stand-alone BA would result in a ***may affect, likely to affect*** bull trout habitat.

Effects to Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267) requires federal agencies to consult with NOAA Fisheries on activities that may adversely affect essential fish habitat (EFH). In addition, the law requires fishery management councils to include descriptions of EFH and potential threats to EFH in all federal fishery management plans.

The objective of this EFH assessment is to determine whether or not the proposed action(s) "may adversely affect" designated EFH for relevant commercially, federally managed fisheries species within the proposed action area. It also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to the designated EFH resulting from the proposed action.

Essential fish habitat is defined in the Magnuson-Stevens Act as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The law provides the following additional definitions for clarification:

- "Waters" include aquatic areas and associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish as appropriate.
- "Substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities.
- "Necessary" means the habitat required to support a sustainable fishery and the managed species contribution to a healthy ecosystem.
- "Spawning, breeding, feeding, or growth to maturity" covers the full species life cycle.

Essential Fish Habitat has been designated by the National Marine Fisheries Service (NMFS) within the Wenatchee River basin under the Magnuson-Stevens Fishery Conservation and Management Act. EFH includes all Chinook and coho salmon habitat, either currently occupied or historically accessible.

Potential Adverse Effects of Proposed Action on EFH for Salmonids

For the proposed actions, effects analyses pertain to species protected under both EFH status and Endangered Species Act protection. Consequently, the effects analysis for EFH cross-references the effects analyses and findings provided within this BA for ESA salmonid critical habitat. The effects analysis pertains to critical habitat for UCR steelhead and spring Chinook, and mid-Columbia bull trout. Collectively, these species' life histories and habitat requirements represent the needs of chinook and coho salmon well and are appropriate for use as a surrogate for EFH habitat effects determinations. ESA effects determinations are limited to findings of either *no effect* or *may affect not likely to adversely affect* for all habitat indicators. As such, we conclude that there may be minor, temporary effects to some habitat indicators; however, any effects would be limited to short-term, temporary effects, or effects with insignificant magnitude. Therefore, this project as proposed with the implementation of conservation measures will **not result in an adverse effect to Essential Fish Habitat** in any of the three project area watersheds.

Aquatic Conservation Strategy (ACS) Consistency Finding

The Aquatic Conservation Strategy (ACS) is an integral part of the 1994 Northwest Forest Plan (USDA and USDI 2004) that was developed to restore and/or maintain the ecological health of watersheds and aquatic ecosystems within public lands. The ACS has nine objectives (USDA and USDI 2004: B-11) toward meeting the goal of healthy ecosystems and watersheds. Design criteria and mitigation measures for the proposed Upper Wenatchee Pilot project are designed so the project would be consistent with the ACS at sub-watershed and watershed scales.

The ACS most pertinent to the desired conditions and riparian management objectives within the project area, and that were tracked through the analysis are as follows:

- ACS objective #4 - Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems.
- ACS objective #5 - Maintain and restore the sediment regime under which aquatic ecosystems were formed.
- ACS objective #6 - Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.
- ACS objective #8 - Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

Due to the high to moderate volume of roads and their extensive hydrologic connectivity across the project area, the proposed road treatments have the greatest potential to affect the sediment regime ASC objective #8. There would some minor short-term sediment produced during project activities. However, with the modified road treatment proposal of rock-armoring, road closure, and decommissioning, the project would result in a net reduction in sediment production during and after the project. In the long-term, the project would move sediment rates (ACS objective #5) toward naturally occurring conditions.

Objective 1: Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted.

Past timber harvest, road construction, fire suppression, and grazing have altered aquatic systems and landscape scale processes in the project area sub-watersheds. Past timber harvest and fire suppression within the dry forest vegetation types converted forest conditions from a structure and composition typical of high frequency, low intensity fire to over-stocked forest conditions with high intensity stand replacement fires.

Forest fire regime, road densities, climate, and the distribution of soil types and plant communities are some of the landscape-scale features affecting aquatic systems in project area. The objective for the thinning and hazard fuel reduction is to compensate for an altered fire regime and restore certain plant communities. The project objective is to restore the function of landscape-scale processes, such as wildfire, in order to protect the complexity and distribution of plant communities (including riparian areas) across the landscape. The Upper Wenatchee Pilot Project is expected to maintain and slightly improve the distribution, diversity and complexity of watershed and landscape features.

Objective 2: Maintain and restore spatial and temporal connectivity in and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.

This project would not create any barriers and would work to remove all existing barriers on streams with known fish populations or salmonid intrinsic potential. Although not analyzed in this BA, the project has prioritized upgrading 13 barrier culverts and design is already underway. This project would help to provide spatial and temporal connectivity.

Objective 3: Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

Removing culverts through road decommissioning, improving road storm-proofing, and road closure will eliminate some artificial constraints on the shape of small streams in the project area. This will help restore the physical integrity of these streams. Some activities would result in a minor temporary increase in fine sediment levels within project area streams. Improvements to coarse wood levels would increase channel stability and create more desirable channel conditions. Projects are expected to maintain the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

Objective 4: Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain in the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

Water temperature and sediment (turbidity) levels are the main water quality indicator functioning at risk across the project area. The proposed commercial harvest would maintain shade levels and not affect stream temperature.

Within non-fish bearing Riparian Reserves, active lighting has a resource objective of maintaining 95% survival of overstory trees, 2/3 survival (~66%) of understory/shrub layer, and 50% ground cover/organic material on surface. In all Riparian Reserves, fire would be allowed to back towards streams when resource objectives can be met. Consequently, vegetation mortality levels are expected to be low. It is very unlikely that measurable change in stream shade levels would occur, especially where fish occur. However, some localized shade reduction could occur, but it is expected to be insignificant to stream temperatures, especially where listed fish occur, miles downstream. Therefore, proposed fuels treatments would result in an insignificant negative effect to temperature. The proposed projects are expected to maintain water quality necessary to support healthy riparian, aquatic, and wetland ecosystems at the project and watershed scale. See the discussion below for effects to turbidity.

Objective 5: Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

Thinning within the outer portion of Riparian Reserve has a low probability of introducing sediment to streams. There will be no mechanical treatment within 100 ft of perennial streams and any treatment in the outer edges of RRs (100 ft – 300 ft) will be done in winter or under other conditions to meet soil disturbance requirements. Sweeney et al. (2014), who did consider suspended sediment, suggests 30-meter (98ft) buffers are necessary to trap ultra-fine sediment from reaching streams. Based on these measures and recent research, we expect little to no sediment delivery to occur. Activities outside of Riparian Reserves, such as tree harvest using mechanical equipment and fuels reduction, are unlikely to contribute sediment to the streams because the full reserve widths would prevent sediment from reaching streams.

The proposed road maintenance, decommissioning, closure, and log hauling would increase sediment yield. Due to hydrologic connectivity with roads, sediment could reach fish habitat, although it is unlikely. Design Features and BMPs would minimize sediment delivery to streams. Measures like rock armoring perennial stream crossings prior to log hauling and working under dry weather conditions would minimize fine sediment mobilization. The amount of sediment reaching streams, using design features and BMPs would be minor. Once the road construction, maintenance, and decommissioning sites stabilizes and log hauling ceases, the net sediment yield for the al project sub-watersheds would reduce. The reduction in sediment delivery to streams, coupled with other efforts across the watershed, would act cumulatively to provide long lasting improvements to watershed health in the project area. At the watershed scale, the short-term increase in sediment delivery and long-term reduction would improve the sediment regime.

Objective 6: Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.

The proposed harvest, fuels treatment, and road management activities would change the drainage network. There would be a temporary increase in the drainage network. Most new temporary drainages would be disconnected to the stream network. In the long-term, once the skid trails and fire lines recover, the miles of road decommissioning would result in a net decrease in the miles of artificial streams associated with roads and reduce the likelihood of changes to the flow regime.

Objective 7: Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

Existing meadows and wetlands would be protected with the project design features. Proposed projects are expected to maintain the timing, variability, and duration of floodplain inundation and water table elevation in meadows, wetlands and floodplain development.

Objective 8: Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

The treatments in Riparian Reserves are designed to restore the species composition and structural diversity of riparian plant communities that would occur under natural fire regimes in dry forests. This includes forbs, grasses, shrubs and trees; snags, "old-growth," and thickets of young trees; rotten logs and newly downed wood of various sizes. Thinning competing small-diameter Douglas fir from larger riparian trees may improve the long-term supply of coarse woody debris at a few sites. Decommissioning riparian roads would increase the amount of vegetated riparian area. Therefore, the proposed harvest, prescribed burning, and road management would help maintain and restore riparian species composition and structural diversity of plants capable of providing the above protection and complexity at the project scale.

Objective 9: Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.

The vegetation treatments are designed to restore the species composition and structural diversity of riparian plant communities. Projects are expected to maintain habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

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Appendix A. Aquatic Actions

The Upper Wenatchee Pilot Project includes several restoration actions that cannot be fully described at this point in time, during the planning process, but these actions are consistent with categories of actions from the 2013 Aquatic Restoration Activities in States of Oregon and Washington programmatic Biological Opinions (ARBO II; USDC-NMFS 2013):

ARBO II Project Categories

1. Fish Passage Restoration (Stream Simulation Culvert and Bridge Projects; Headcut and Grade Stabilization; Fish Ladders; Irrigation Diversion Replacement/Relocation and Screen Installation/Replacement)
2. Large Wood (LW), Boulder, and Gravel Placement (LW and Boulder Projects; Engineered Logjams; Porous Boulder Weirs and Vanes, Gravel Augmentation; Tree Removal for LW Projects)
3. Channel Reconstruction/Relocation
4. Off- and Side-Channel Habitat Restoration
5. Streambank Restoration
6. Reduction/Relocation of Recreation Impacts

The list of aquatic restoration actions presented below will occur later in time and undergo individual consultation under ARBO II. Therefore, ARBO II restoration actions will not be reanalyzed in this BA and are included here for information sharing purposes.

Aquatic Proposed Actions

Restoration opportunities, including recommended prioritization of actions, have been identified utilizing the UWPP Habitat Assessment and Restoration Report, Appendix C (Cramer Fish Sciences 2019), Upper Wenatchee River Stream Corridor Assessment and Habitat Restoration Strategy (Inter-Fluve 2012), A Biological Strategy to Protect and Restore Salmonid Habitat in the Upper Columbia Region (UCSRB 2017), Fish Passage Project Prioritization in the Upper Columbia (UCSRB 2018), and Forest Service road and stream survey data. Aquatic restoration opportunities fall into five categories, described below. Reach-Based Ecosystem Indicators (REI) analyses have been conducted for portions of the Project Area that provide a comparison of habitat conditions to established functional thresholds and assign reach-scale functional ratings including *adequate*, *at risk*, or *poor/unacceptable* (Interfluve 2012, Cramer Fish Sciences 2019).

The projected range of accomplishments has been identified in order to acknowledge the upper and lower limits of work to be completed in each category. Restoration objectives (1-5) and corresponding actions with an estimated range of accomplishment for each action are described below.

Aquatic restoration will improve habitat conditions for project area fish including Threatened and Endangered species that occur within all subwatersheds of the project area: Upper Columbia (UC) steelhead, UC spring Chinook and Columbia River bull trout and their designated Critical Habitat. Restoration actions would be designed and implemented to follow the Project Design Criteria in ARBO II including approved work windows for freshwater and other Mitigation Measures and Best Management Practices outlined in Appendix A, and the effects to UCR steelhead, UCR spring Chinook, and CR bull trout would be consistent with those described in ARBO II – May Affect, Likely to Adversely Affect.

Figure 2.2-4 displays stream reaches with survey data and Threatened and Endangered species and Critical Habitat distribution in the project area.

Watershed and Aquatic Restoration Categories

1. **Habitat Access and Connectivity Improvement:**

Both action alternatives include the removal, replacement, or modification of culverts and water crossings in the project area to eliminate fish passage barriers and improve fish distribution within the Project Area. Site-specific opportunities for improvement have been identified where culverts currently block or partially block passage by one or more life stages of fish in multiple streams within Big Meadow, Lower Chiwawa, Beaver Creek-Wenatchee River and Lake Wenatchee subwatersheds. Figure 2.2-5 shows the spatial distribution of passage barriers. It is expected that additional barriers may be identified during implementation, as not all roads have been surveyed for this project. Culverts that impeded passage would be removed or replaced with a bridge or bottomless, countersunk, or oversized culverts designed to improve fish passage potential for all life stages and all design criteria developed for ARBO II would be applied to passage barrier removals.

Figure 2.2-5. Documented Passage Barriers in Project Area.

2. **Instream Habitat Quality Improvement:**

Both action alternatives include the restoration of instream habitat in project area stream reaches where Large Woody Debris (LWD) and Pool Frequency is deficient (REI of *at risk* or *poor*) and where improvements to the impaired indicators could be made primarily with large wood supplementation. The addition of engineered log jams would increase stream habitat complexity, including the creation of pool habitat, improving LWD and pool indicators at both the site and watershed scales. Improvements would be spread throughout the project area subwatersheds.

Reach-specific opportunities include options to add LWD to project area streams currently rated as *at risk* or *poor*. See UWPP Habitat Assessment and Restoration Report, Appendix B Sections 4 & 5 (Cramer Fish Sciences 2019).

3. **Floodplain and Off-Channel Habitat Connectivity Improvement:**

Both action alternatives include reconnecting streams to their floodplains and reconnecting off-channel habitat in streams segments where connectivity is deficient. Site specific opportunities have been identified by stream reach. However, not all stream reaches have been surveyed for habitat connectivity; un-surveyed reaches are considered as potentially deficient and in order to maximize restoration opportunities in the project area. Restoration actions could occur in all stream reaches currently rated as *at risk* or *poor* for Channel Dynamics Indicators.

See *UWPP Habitat Assessment and Restoration Report: Appendix B Sections 6, Appendix C* (Cramer Fish Sciences 2019).

4. **Riparian Condition Improvements:**

Both action alternatives include restoring riparian condition through the decommissioning of valley bottom roads, replanting of currently degraded sites and the construction or placement of barriers (boulders, fences, and deterrent vegetation) to discourage driving and parking within 100 feet of streams and waterbodies. The intent of these actions is to reduce sediment delivery from roads and currently disturbed sites, increase stream canopy cover on smaller streams and to maintain optimal opportunities for LWD recruitment. Opportunities to reduce riparian road density would be addressed under Category 5 actions. Reach-specific opportunities that have been identified include restoring streamside cover on an incised stream channel and adjacent to developed campgrounds and within a dispersed campsite. If a specific reach was not surveyed for riparian indicators, then that reach will be considered as potentially deficient in order to maximize riparian restoration opportunities in the project area. Additional treatments designed to improve existing riparian conditions are described as part of terrestrial vegetation treatments. Improvements should be spread throughout the project area subwatersheds.

See *UWPP Habitat Assessment and Restoration Report: Appendix B Section 7* (Cramer Fish Sciences 2019). Riparian restoration will focus on improving REI Riparian Disturbance and Structure indicators that have been identified as deficient (*at risk* or *poor*).

5. ***Reconstructing and relocating existing roads or trails***

Site specific opportunities have been identified to relocate sections of road and redesign trails that may be contributing sediment loading into nearby streams within a dispersed site, developed campground and on existing motorized trails with stream crossings. Minor trail relocation or reconstruction actions could occur on as few as four sites, as described in *UWPP Habitat Assessment and Restoration Report, Appendix C* (Cramer Fish Sciences 2019), but could extend to as many as ten sites on the high end. Trail work would typically involve up to 500 feet of redesigned trail.

6. ***Improve existing road condition through maintenance actions.***

Specific opportunities have been identified in the *UWPP Habitat Assessment and Restoration Report, Appendix C (Tables C1-4)* for maintenance actions needed to reduce current erosion problems. Figure 2.2-6 shows the spatial distribution of maintenance actions. These actions would occur over time.

Insert Revised Figure 2.2-6 Road Maintenance Opportunities

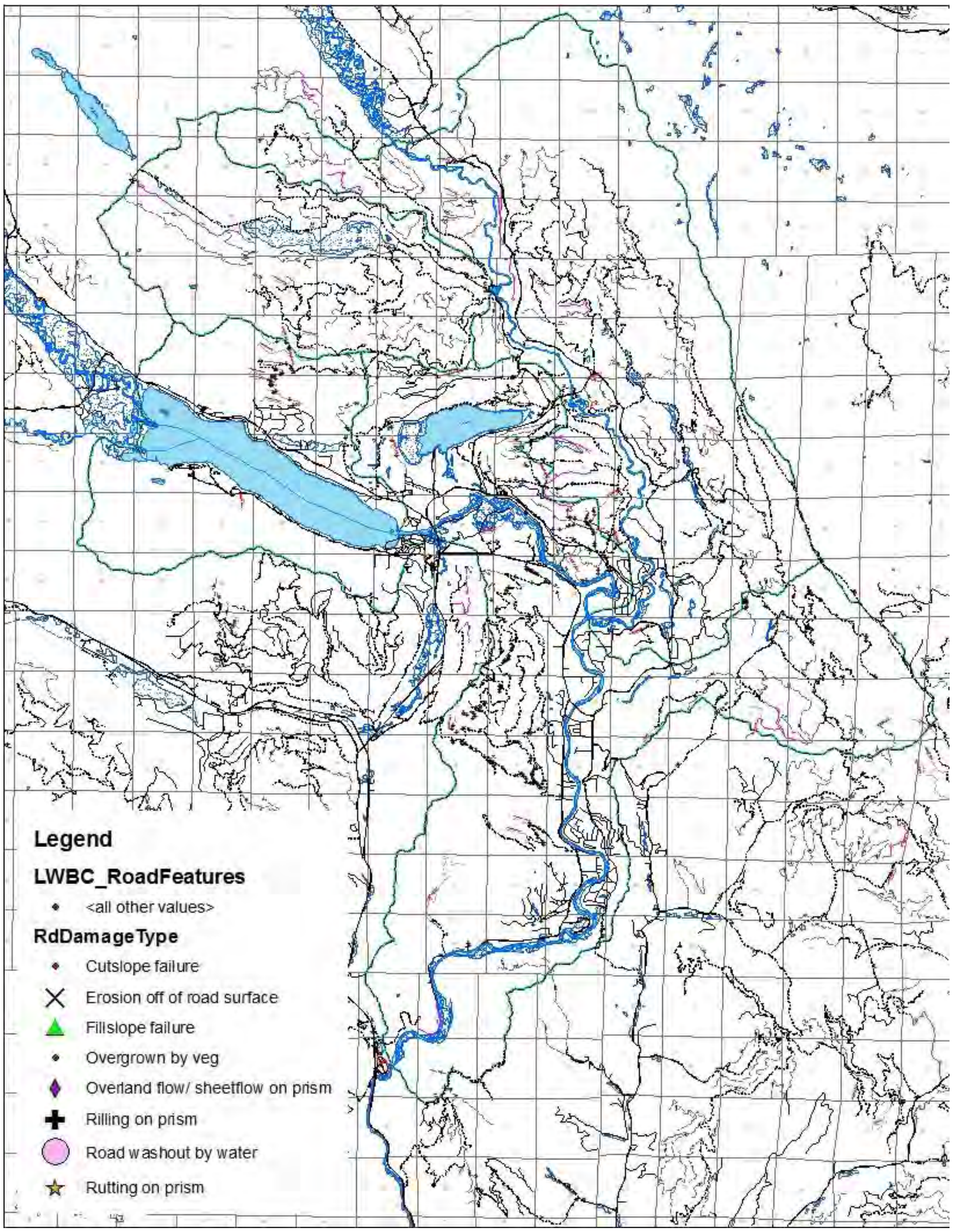

Figure 2.2-6. Road Maintenance Opportunities. [to be updated]

Maintenance actions by subwatershed:

Roads within the Beaver Creek-Wenatchee River subwatershed were surveyed to support development of the Landscape Evaluation (*Table C1*). Across the subwatershed, 236 road damage locations were found that provide restoration opportunities. The predominate damage types are erosion-related, including rilling (149 locations), rutting (21 locations), surface erosion (36 locations), and sheetflow (10 locations) along with several cutslope (6 locations) of fillslope (10 locations) failures. Damage severity levels are primarily low (146 locations), though 89 locations have medium (70 locations) and high (19 locations) severity, and 33 locations delivering sediment directly to ditches (11 locations) or streams (20 locations). Restoration opportunities for these sites include resurfacing roads to reduce erosion, especially where the road surface is highly-erodible native soils (224 locations), stabilizing cutslopes and fill slopes, reconfigure drainage to minimize the delivery of sediment and water to streams, and rebuild or relocate steep roads to reduce gradient and the potential for erosion.

Roads within the Lake Wenatchee subwatershed were surveyed to support development of the Landscape Evaluation (*Table C2*). Across the subwatershed 38 road damage locations were found that provide restoration opportunities. The predominate damage types are erosion-related, including rilling (26 locations), surface erosion (7 locations), and sheetflow (1 location) along with cutslope (1 location) and fillslope (3 locations) failures. Damage severity levels are primarily low (27 locations), though 10 locations have medium (7 locations) and high (3 locations) severity, and two locations delivering sediment directly to ditches (1 location) and streams (1 location). Restoration opportunities for these sites include resurfacing roads to reduce erosion, especially where the road surface is highly-erodible native soils (37 locations), stabilizing cutslopes and fill slopes, reconfigure drainage to minimize the delivery of sediment and water to streams, and rebuild or relocate steep roads to reduce gradient and the potential for erosion.

Roads within the Lower Chiwawa River subwatershed were surveyed to support development of the Landscape Evaluation (*Table C3*). Across the subwatershed 118 road damage locations were found that provide restoration opportunities. The predominate damage types are erosion-related, including rilling (100 locations) and rutting (13 locations) along with cutslope (5 location) failures. Damage severity levels are primarily low (105 locations), though 13 locations have medium (12 locations) and high (1 locations) severity, and 26 locations delivering sediment directly to ditches (6 location) and streams (20 location). Restoration opportunities for these sites include resurfacing roads to reduce erosion, especially where the road surface is erodible native soils (63 locations), stabilizing cutslopes, reconfigure drainage to minimize the delivery of sediment and water to streams, and rebuild or relocate steep roads to reduce gradient and the potential for erosion.

Roads within the Big Meadow Creek subwatershed were surveyed to support development of the Landscape Evaluation (*Table C4*). Across the subwatershed 47 road damage locations were found that provide restoration opportunities. The predominate damage types are erosion-related, including rilling (31 locations), rutting (3 locations), surface erosion (2 locations) and sheetflow (7 locations) along with cutslope (2 locations) and fillslope (2 locations) failures. Damage severity levels are primarily low (38 locations), though 9 locations have medium severity – no high severity sites were found, and 17 locations delivering sediment directly to ditches (10 locations) and streams (7 location). Restoration opportunities for these sites include resurfacing roads to reduce erosion, especially where the road surface is erodible native soils (28 locations), stabilizing cutslopes, reconfigure drainage to minimize the delivery of sediment and water to streams, and rebuild or relocate steep roads to reduce gradient and the potential for erosion.

Project design criteria for aquatic actions proposed in the Upper Wenatchee Pilot Project (road maintenance, culvert removal/replacements, in-stream channel work, large wood placement, riparian protection/plantings, etc.) will be incorporated from the Programmatic Biological Assessment for Fish Habitat Restoration Activities Affecting ESA-Listed Animal and Plant Species and their designated or proposed Critical Habitat and Designated Essential Fish Habitat under MSA found in Oregon, Washington and portions of California, Idaho and Nevada (USFS/USDI/BIA 2013). Other design criteria incorporated into the project include the following;

1. All provisions and standards in the Memorandum of Understanding between Washington State Dept. of Fish and Wildlife and USDA Forest Service, Pacific Northwest Region (USFS and WDFW 2012) will be followed.

2. All conditions and requirements within the U.S. Forest Service Aquatic Restoration Program regional general permit (RGP-8) (USACE 2011) will be met.

3. All design criteria and conservation measures in the 2013-2017 Programmatic Biological and Conference Opinions (BiOps) for Aquatic Restoration Activities in Oregon, Washington and portions of California, Idaho and Nevada will be met (NMFS 2013 and USFWS 2013).

Appendix B. Transportation Analysis and Roads Actions

Upper WenatcheePilot Project

Travel Analysis Report

February 25, 2021

Wenatchee River Ranger District Okanogan

Wenatchee National Forest

Upper Wenatchee Pilot Project
Travel Analysis Report

February 25, 2021

Introduction

Travel Analysis is a science-based process used "to inform decisions related to: a) identification of the minimum road system needed for safe and efficient travel and for administration, utilization, and protection or National Forest System (NFS) lands per 36 CFR 212.5(b)(1) and b) designation of roads, trails and areas for motor vehicle use per 36 CFR 212.51" (FSH 7709.55, section 20.2). Travel Analysis informs travel management decisions by examining key issues related to the portion of the forest transportation system under analysis, as well as management options and priorities. The process used is describedin FSH 7709.55, Chapter 20. A Travel Analysis for all roads in the project area was completed as part of proposed action development for the Upper Wenatchee Environmental Assessment.

Step 1: Setting Up the Analysis

To complete the Travel Analysis, an interdisciplinary process was used involving resource specialists from the Wenatchee River Ranger District and other Okanogan-Wenatchee National Forest specialists. The Interdisciplinary Team (IDT) included resource specialistsrepresenting Wildlife, Fisheries, Hydrology, (Aquatics), Soils, Invasive Weeds/Botany, Silviculture/Timber, Fire/Fuels, Recreation, Public Access, and Engineering.

The scope of the analysis was set to examine the existing forest transportation system to determine appropriate management direction for each road. Considerations included Maintenance Level (ML), closure or decommissioning recommendations, motorized accessrestrictions, new access needs, etc.

The scale of the analysis included all existing roads in the Upper Wenatchee project area. Additional roads adjacent to the project area were included in the analysis to be inclusive. These roads are either segments of roads partly in the project area or spurs off of those roads. In addition, data for mapped roads on Forest Service and other ownership outside ofthe project area was used for analysis at both the watershed scale.

A complete inventory of National Forest System (NFS) roads in the project area was compiled. In addition, an inventory of existing unauthorized roads was developed and added. Most of the roads were field checked and data updated to reflect existing conditions.This information was used to update the project GIS database. Roads inventory surveys were conducted in the summers of 2016 and 2017. As unmapped roads were discovered, they were added to the inventory of unauthorized roads.

Data used to compile the specialists' ratings included notes from field visits, GIS data(roads, streams, topography, etc.), plant and animal survey data and historical data (previous project files, reports, etc.).

Step 2: Describing the Situation

a. *Current Direction*

Construction of the major access roads in the area occurred from the 1920's to the 1940's. Records for Lower Chiwawa & Lake Wenatchee are roads (6100000 & 620000). Road construction for timber sale access intensified in the 1960's, continuing into the 1980's withmost of the road network developed over that time frame. At this time, under the current *Wenatchee LRMP*, it is expected that "roads necessary for resource management will essentially be in place. Road management activities will continue road maintenance and use planning to meet use patterns. Many roads will continue to be closed during certain seasons in cooperation with other resource management activities or other agency objectives."

A Watershed Condition Framework Assessment was completed for the Okanogan– Wenatchee National Forest in 2010. Project roads are in all or part of nine 6th level Hydrologic Unit Codes (HUCs). As shown in Table 2.1, the watershed condition rating for all but two of them is "Functioning at Risk". The "Roads and Trails" condition rating (including factors for open road density, road and trail maintenance, proximity to water andmass wasting), along with the "Soils" condition rating, make up the Terrestrial Physical processes category, which is weighted at 30% of the total Watershed Condition Rating.

Table 2.1: Watershed Condition Framework Assessment by 6th Level HUCs

HUC Name	Watershed Condition Rating	Roads and Trails Condition Rating
Lake Wenatchee	Functioning at Risk	Fair
Beaver Creek Wenatchee River	Functioning at Risk	Fair
Big MeadowCreek	Functioning at Risk	Poor
Lower Chiwawa River	Functioning at Risk	Poor

Note the above table pends final Hydrologist review validating ratings. The Upper Wenatchee Pilot Lancsape Evaluation addresses roads and density without a specifce rating. It does provide a measure for scoring these relative to road density in relation to length thant the catchment area, riparian road density within the 300 m stream buffer, andstream corssing.

Under the Forest Service's 2005 Travel Management Rule, each unit of the NFS wasdirected, by the end 2015, to identify the minimum road system needed for safe and efficient travel and for the protection, management, and use of NFS lands. A Travel

Analysis Process is being used to accomplish this at the Forest level. The minimum road system is "the road system determined to be needed to meet resource and other management objectives adopted in the relevant land and resource management plan (36 CFR part 219), to meet applicable statutory and regulatory requirements, to reflect long- term funding expectations, to ensure that the identified system minimizes adverse environmental impacts associated with road construction, reconstruction, decommissioning,and maintenance" (36 CFR 212.5 (b) (1)).

Preparation of a new forest Travel Management Plan is underway and should be finished inthe next few years. Additional road closures or seasonal restrictions may result from this planning effort.

b. Current Road System

A map of the existing roads in the analysis area along with a list of roads and their currentstatus can be found in Appendix B: Road Table with Current MLs & IDT recommendation of Post Project(s) MLs.

There are currently approximately 386 miles of road in the analysis area including 272 miles of open roads and 91miles of closed roads (these figures includes 23 miles of existingunauthorized roads).

Table 2.2: Current Road System

	Open Roads (miles)	Closed Roads (miles)	All Roads (miles)
NFS Roads	231	89.2	320.2
Unauthorized Roads	-	22.2	22.2
Total	231	411.4	342.4

The primary access routes into the analysis area are:

These roads are located within the access corridor of Washington State Highway 2, which isroute of Steven's pass. Therefore these provide public access for use and recreation within the areas of Wenatchee, and commonly service the Puget Sound area. Although this meansthere is recreational use and opportunity, other uses for mananagement are also evaluated.

- NFS road 6200000 north of State Highway 2 (off WA207 accessing the Wenatchee and Fish Lake Areas; this is currently a Maintenance Level (ML) 4 & 3 road with apaved surface. It is the main arterial for accessing several recreation areas campgrounbds and trail heads.
- NFS road 6100000 located off the Chumstick highway (WA state Highway 209), access several rectreation sites (campgrounds, trailheads, and like FSR 6200000, provides additional access for management and recreation opportunities (groomedsnowmobile routes, , dispersed camping, firewood gathering, hunting access, etc.)

- NFS road 6300000 through 6600000 also provide recreation and public access into the area with similar to the afore mentioned recreation and management activities.
- NFS roads7906 & spurs, coming off the Washington State Highway 2, are access for (both &either or) recreation and private) access. Beginning on private land on the western edge of the analysis area extending southeast to a junction with the 4100000 road at the south edge of the analysis area; this is currently a ML 3 road with an aggregate surface. Part of the road was activily decommissioned in previousdecision and part naturally decommission. Current data base shows it as closed, but this project will activily remove the decommissioned portion from the Forest System by approximately 0.3 mile. The rest remains closed. Private land portions are outside the jurstiction of the National Forest.

NFS roads in the analysis area are primarily managed for resource management, recreation and fire control access. Other current uses of the roads in the area include snowmobiling, groomed cross-country ski trails, hunting, firewood gathering, access to several developed campgrounds, and dispersed camping and driving for pleasure. Access toprivate and state inholdings and property adjacent to Forest Service land is also provided by roads in the analysis area.

Under the Watershed Condition Framework (*Forest Service Watershed Condition Classification Technical Guide*, Potyondy and Geier 2010), "Roads therefore include FS system roads (paved or non-paved) and any temporary roads (skid trails, legacy roads) notclosed or decommissioned including private roads in these categories". Current open road density by 6th level HUC is shown in Table 2.3. Examining the "Open Road Density" attribute of the Road and Trail Condition indicator: ratings are assigned based on road density as follows: <1 mi./sq. mi. = "Good", 1 – 2.4 mi./sq. mi. = "Fair", >2.4 mi./sq. mi. = "Poor". Ratings based on current conditions are shown in Table 2.4 below.

c. ***Current Economic Analysis***

Administratively, roads in the Methow Valley and Tonasket Ranger Districts have been managed under the North Engineering Zone. There are approximately 2720.48 miles of NFS roads in the North Engineering Zone. The NFS roads in the Upper Wenatachee Pilot Travel Analysis represent 8.8% of the total Central & South Engineering Zone road system.A breakdown of miles of current NFS roads by Maintenance Level is shown in Table 2.3.

Table 2.3: Total Miles of Current NFS Roads

ML	Wenatchee (Central & South Zone Engineering CSEZ)		Upper Wenatchee (UW)Pilot Project Area		
	Miles		Miles	% of UW totalCSEZ	
1	1786.7		89.2	5.0%	

2	2648.9		208.0	7.9%	
3	658.6		10.9	1.7%	
4	91.7		10.0	10.9%	
5	111.8		2.1	1.9%	
Total	5297.7		231.0	22.4%	

Road maintenance costs vary according to the Maintenance Level the road is managed under, the amount of traffic the road receives, the frequency at which maintenance is performed and other environmental factors (soils, slopes, precipitation, etc.). For the NorthEngineering Zone, projected annual road maintenance costs for current NFS roads are shown in Table 2.6.

Note that the "Average Annual Maintenance Cost per Mile" is not the amount it would costfor road maintenance on a given mile of road each year, but rather an average of what it would cost over time *(for example: over a 15 year period, a mile of asphalt surfaced ML 4 road might need a chip seal treatment - estimated cost: $30,000/application, 10 visits for ditch and culvert cleaning - estimated cost: $800/mile, roadside brushing every 3 years - estimated cost: $1,200/mile and several visits to clean bank slough and debris - estimated cost: $1,285, for a total cost of $45,285, or $3,019/year).*

Table 2.6: Average Annual Road Maintenance Cost Projections (Current NFS Roads)

ML	Average Annual Maintenance Cost per Mile	Central & South Engineering Zone (CSEZ)		Upper Wenatchee (UW) Pilot Project Area	
		Miles	Projected Annual Cost	Miles	Projected Annual Cost
1	$62	1786.7	$110,775.40	89.2	$5,530.40
2	$644	2648.9	$1,705,891.60	208.0	$133,952.00
3	$1,538	658.6	$1,012,926.80	10.9	$16,764.20
4	$3,019	91.7	$276,842.30	10.0	$30,190.00
5	$3,791	111.8	$423,833.80	2.1	$79,361
Total		5297.7	$3,530,269.90	320.2	$235,637.79

In the past, road maintenance has been funded through various means such as Legacy Road or other grants, Timber Sales (both through deposits and purchaser road maintenanceresponsibilitieswith the main source of funding being Congressional appropriations. The average annual amount of funding available for road maintenance fpor one Engineering Zone over the pastyears was approximately $581,700. However, this amount has been declining at a steep rate. As a result, the amount of funding expected to be available in the foreseeable future for the two Zones was double. With recent delcines has dropped each aonce to approximately is probably closer to the average of the last two years funding - approximately $287,765

The funding needed over a firteen year period for the current road system would total mostof one year's budgeted maintenance funds for one zone. Given this project area has a rangeof 15% of the total zones, it would result in a ahortfall, if the number of reoads are not reduced.

The difference between the amount of annual funding needed for road maintenance in theone Engineering Zone and the amount available is approximately $2,621,095 – a shortfallof over 90%.

Step 3: Identifying Issues

Field assessment and analysis conducted by resource specialists were used to identifyissues to address with the Travel Analysis.

Recommendations and issues identified from the scoping process (Copies of response lettersand a summary of public responses and comment dispositions are available in the project record) and a public field trip were considered as well.

Step 4: Assessing Benefits, Problems, and Risks

To conduct the travel analysis, each resource specialist evaluated each road or segment of road and assessed the relative risk or benefit posed by the road to their respective resource.

The team met several times with this criteria as base information, along with maps, noteand review of past project decisions to make recommendatins captured in the Travel Analysis spreadsheets as post project recommendations.

In addition to attending the Interdisciplinary meetings to review each road segment, specialists provided spreadsheets with each road segment, ratings or notes, narrative rationale or input to review roads. These summaries are documented in emails and spreadsheets the specialist provided to support their input. The following summarizestheir criteria or rationale for assessiong either Risk or Benefit ratings.

The criteria used to rate High, Moderate or Low, risk or benefit was developed by thespecialists as follows:

Upper Wenatchee Travel Analysis road rating criteria (as of June2018)

d. Wildlife

In general, wildlife input assessed the ratings based upon Washtshed Analyais and Late Successional Reseerve Area (LSRA). There was a emphasis to reduce open road densities throughout the Chiwawa LSR from 1.9 to < 1.0 mile/mi^2. Close roads to improve habitat effectiveness, prioritizing those in LSR/MLSA and adjacent to core areas. And reduce road densities in riparian reserves within the LSR from 3.14 to < 1.0 mile/mi^2. Increase wildlife security habitat from 36% to >70%. Reduce roads in unique habitats, forest interior patches, and meadows. Improve habitat effectiveness by reducing road densities, especially in riparian habitats.

Increase grizzly bear core area within the Chiwawa, Lower Wenatchee, and Upper Wenatchee Bear Management Units by eliminating use of roads by motorized vehicles – Grizzly Bear Recovery Plan.

Risk Ratings

For wildlife, road segments were rated as High, Medium, or Low risks.

- High risk was defined as those open road segments within an LSR or MLSA where the current road density was greater than 1 mile/mile^2, or those within a Riparian Reserve running parallel to a stream or shoreline.
- Medium risk was defined as those open road segments that cross a Riparian Reserve in a perpendicular manner, or within a unique habitat.
- Low risk was defined as open roads in areas with < 1 mile/mi^2 outside those described above, or closed roads.

No wildlife needs were located in these watersheds.

e. Aquatics

Ranking of thye Risk factors occurred for the area via potential influence or effects on aquatic organisms, including bt not limited to threatened, endangered or sensitive (TES)fish species and/or their designated critical habitat.

The following summarizes the Risk rating factors:

f. Risk: (1 of 3): Riparian Road Risk

Roads can cause erosion, alter water movement on the landscape, and change how streams function when they cross or confine the stream. Roads within 300 ft. of streams, rivers, lakes, etc. can reduce shade which increases water temperatures, increase sediment delivery, simplify channel form (cut off side channels, straighten streams through confinement), and create impediments to aquatic species movement. Roads in riparian areas that parallel streams with occupied threatened, endangered or sensitive (TES) fish species and/or their designated critical habitat present the greatest risks.

The road matrix risk rating considered miles of road adjacent to streams, miles of road on sensitive soils, and number of road-stream crossings. Due to the varying length of roads, relative percent of road affected by each factor was considered rather than absolute miles.

Roads where all or a portion of the road falls within 300 feet of a stream channel (perennial or intermittent), lake, pond or wetland were assigned high, medium or low risk rating depending % of road length within 300 feet. Hydrology and aquatics also used 300 feet distance for assigning resource risks (this is not a duplication score).

HIGH – > 10% of the road prism is within 300 ft. of a stream or river where TES fish species are present and/or the stream is designated critical habitat.

MEDIUM – < 10% of the road prism is within 300 ft. of a stream or river where TES fish species are present and/or the stream is designated critical habitat.

LOW - None of the road prism is within 300 ft. of a stream or river where TES species are present and there is no designated critical habitat.

g. **Risk: (2 of 3): Road-Stream Crossing Risk to Aquatic Organisms**

Road-stream crossings (culverts, fords, etc.) are a significant source of fine sediment to streams. As the number of road-stream crossings increases, the potential to transport sediment from the road prism to the stream network also increases. Roads that cross streams and rivers with TES fish species and/or designated critical habitat, can have serious impacts to water quality and aquatic habitat for these fish species. (Evaluation rating was rerun 05-07-14, no changes in wording were needed.)

HIGH – Roads that have > 2 stream crossings that intersect streams or rivers with occupied TES fish habitat and/or designated critical habitat.

MEDIUM – Roads with 1 stream crossing that intersect streams or rivers with occupied TES fish habitat and/or designated critical habitat.

LOW- Roads with no road-stream crossings. Or the road crosses a stream with no occupied or critical habitat. Crosses a stream with no occupied or critical TES habitat.

h. **Risk 3 of 3: Passage barrier presence, Roading in RR, Roading adjacent to fish-bearing evaluated on a case-by-case basis: rates as M**

Risk 1 & 2 from: Okanogan - Wenatchee National Forest, Forest Wide Travel Analysis Report 2015

For the Upper Wenatchee Pilot TAP, when summing the risk rating for each road, the highest risk will be reflected in the aquatics rating (For example, if risk 1 is High and risk 2 is Low for a road segment,, the rating will be High)

i. Hydrology

DEM was used to create a matrix of ratings considering such factors as road grade, stream crossings, hillslope gradient, etc. Each factor was weighted to come up with the final rating.

1. Surface Water Capture - Scored on Road segment (by DEM) - length of slope * slope^2 :raw number added into total score

2. Road Density - Roads in high road density watersheds flagged. H >2.4 mi/mi, M 2.3-1.0mi/mi, L < 1.0 mi/mi - from WCF

3. % of road w/in 300 feet of water - From WCF - H > 25%, M 25-10%, L < 10%

4. Stream Crossings - Ranking by number of stream crossings per road segment. Roads without crossings scored zero points, roads with 1 crossing scored 2 points, roads with >1 crossing scored4 points

5. Most input provided in spreadsheet notes to roadsegments and IDT participation.

j. Soils

For Soils concerns, the Soils Scientist attentended the first Interdisciplinary meeting, provided direct verbal input. In later meetings review information provided via the assignHydrologist. The Soils Scientist provided documentation of concurrence (proxy of the Hyrdologist) with that input.

k. Botany & Invasives Plants

Botany- For Sensitive plants, the NRIS sensitive plant layer was used with site recordreviewed where populations intersected or were near a road.

- In most cases, populations & habitat were sufficiently off the road right-of-way sothat no changes were proposed.

Invasive Plants- For Invasive plant species, the NRIS invasive plant layer was used todetermine the presence of invasive species intersecting or adjacent to each road.

- Roads with relatively high weed acres were rated as High risk.
- Roads with relatively low weed acres were rated as Moderate risk.
- Roads with no weeds were rated as Low risk.

l. Silviculture/Timber

Roads were assessed with the 6th field sub-waterdss (1w Code HUC) iand provided as Silvicutrue/Timber Specialist Input for the Upper Wenatchee Pilot. These were basedupon access needs or “Benefit”.

Each road was rated based on vegetation management needs to support ecosystem management and access for future stand management treatments.

During the review timber and silviculture team specifically considered the influence of disturbance processes, currently sold timber sales including post harvest treatments, active and ongoing stand improvement activities, management of plantations, investments in intermediate stand management (planting, non-commercial thinning), potential for stands to develop structural attributes needed on the landscape, present road conditions, cost share, easement holders, logging systems, haul route, and future economic viability. The team used professional judgment to adjust timber access need ratings where necessary. Notes were tracked in rating spreadsheets. If a road was rated low with minimal need for management access, it was proposed to be decommissioned.

Several factors were weighted based on their perceived potential for commercial tree thinning for forest stand structural restoration.

1. Commercial treatment acres accessed per mile
2. Commercial treatment acres in a given watershed
3. Site productivity
4. Estimated stand volumes
5. Stand ages
6. Elevation
7. Direct or indirect access level

Low: Road is duplicative or is no longer needed for stand management. Road does not access area actively managed or road does not provide prudent logging access for ground-based or skyline systems. User-built access.

Medium: Road is needed but may be left in a closed condition. Road provides prudent access for skyline logging, which is considered a secondary priority to ground-based logging due to higher cost of harvest and management.

High: Road is needed and should be open to provide access for management. Road provides prudent access for ground-based logging, which is considered the priority for logging access due to lower cost of harvest and management.

m. Fire/Fuels

Upper Wenatchee Pilot Project
Travel Analysis Report

February 25, 2021

This roads analysis was based on fire suppression & fuels treatments, namely access.

Fire Management and Hazardous Fuels Transportation analysis was based on the followingcriteria rational:

Fire and Fuels High

1) The geography of the landscape and the spatial relationship of a roads location within the landscape. In general, roads that are on well-defined features such as

traversing ridgelines or valley bottoms are desirable. Roads that provide; access to private lands, inholdings, allow for quicker response times, infrastructure protection, protection of sensitive features or values, access to water pump chances,or could be used as a strategic holding or control point are desired.

2) In general the National Wildland Fire Response Strategic Objective on non- wilderness wildland fires would be full suppression, and containment within the first operational period. This is typically implemented under the Type 5 and 4 operational incident framework. These road systems allow for quicker initial attackresponse times, and significantly reduce the resistance to control, on a developing incident. In general maintenance Level 2,3,4, and 5 roads provided these opportunities.

3) Roads that provide access to hazardous fuels treatments, as well as previously treated hazardous fuels treatments are considered desirable. Typically road networks are desirable when conducting prescribed burns, as they are utilized as control features, or dissects the unit into smaller subunits, provide containment opportunities in the event of an escape, and are considered desirable. As such the abundance, spatial arrangement, and maintenance level are valued differently thanFire Suppression, and roads with a lower maintenance level such as 1 or 2 could be rated high.

Fire and Fuels Moderate

1) In general, roads provide alternative access to ridgelines or valleys and are considered moderately desirable; however other roads exist that provide better access and egress. Roads that provide; access to private lands, inholdings, quicker response times, infrastructure, sensitive features, water pump chances, or could beused as a strategic holding or control point is desired; however other routes are in close proximity that would afford better opportunity.

2) In general the National Wildland Fire Response Strategic Objective on non- wilderness wildland fires would be full suppression, and containment within thefirst operational period; this is typically implemented under the Type 5 and 4 operational incident framework. These road systems provide, and or allow for quicker initial attack response times; however better opportunities exist. These roads moderately reduce the resistance to control on a developing incident. In general Maintenance Level 2, and 3 roads provided these opportunities.

3) Alternative routes that provide some access to hazardous fuels treatments, as well as previously treated hazardous fuels treatments are considered Moderately desirable. These road networks are moderately desirable when conducting prescribed burns, as they provide some opportunities to dissect the unit into smallersubunits, and or provide containment opportunities in the event of an escape. Theseroads are considered to be moderately desirable, but not critical to prescribed burn operations. As such the abundance, spatial arrangement, and maintenance level are

valued differently then Fire Suppression, and roads with a lower maintenance levelsuch as 1 or 2 could be rated moderate.

Fire and Fuels Low

1) In general, these roads provide limited or no access to ridgelines or valleys and are considered Low. These roads provide poor to limited access, egress, or parallel another road, short in length, and are of limited benefit to fire suppression, or othervalues described in the Moderate and High categories. Roads in this category applyto both fire and fuels.

n. Recreation and Public Access

Recreation Rational for TAP Process – Upper Wenatchee Pilot Project

The following was used as rationale for the TAP process for the Upper Wenatchee Restoration Pilot Project. Recreation sites or amenities, communication sites or otherpermitted uses and recreation roads drove the rationale.

o. Recreation Priority Rating Rationale

HIGH	MEDIUM	LOW
• Campgrounds, trailheads, day use areas • Winter trails • Special Use permit sites, Organizational Camps	Dispersed camp sites or day use areas	Recreation roads; driving for pleasure

Resource specialist's ratings and recommendations made by the IDT for each road segmentare shown in Appendix A: Road Tables.

Step 5: Describing Opportunities and Setting Priorities

Through proposed road closure and decommissioning, open road density in both alternatives would stay the same or decrease in all discrete management areas (MAs).

During Harvest open road density values are summarized once the proposed action alternatives analysized and a preferred once is selected. In addidiont to the above table, columns displaying During Harvest (if timber sale activity used) Post Harvest, During Project Activities are added to display what is being open and when. Then densities maybe calculatedrelative the 6th level HUCs to meet resource objectives and Forest plan requirements. Of course this is assuming that all closed roads would be opened at one time. A more likely scenario is staged opening and closing of roads because timber sale contracts are arranged by payment unit and the purchaser must complete all activities in apayment unit (including closing roads) prior to obtaining approval to move on to the next payment unit. This would result in lower open road mileage and densities occurring at anygiven time. In addition, harvest activities for Upper Wenatchee Pilot project could involve at least two separate Timber Sale or Stewardship Contracts. These contracts will be awarded at different times over the next few years and it is unlikely that they would be operating at the same time.

Open road density by 6th level HUC will be shown for each alternative in when developedin Table 5.2 when alternatives are delveloped, and subsequent roads analysis is summarized.

subwatershed	Subwatershed Area (mi.²)	Current		Post-Project	
		Open Road Miles*	Open Road Density (mi./mi²)	Open Road Miles	Open Road Density (mi./mi²)
Lower Chiwawa	39.2	104.82	2.7	76.9	2.0
Lake Wenatchee	17.17	16.1	0.9	17.7	1.0
Big Meadow	15.83	39.9	2.5	28.6	1.8
Beaver Creek	44.6	103.4	2.3	84.9	1.9

Notes:

The above table pends final Hydrologist review validating ratings. The Upper Wenatchee Pilot Lancsape Evaluation addresses roads and density without a specifce rating. It does provide a measure for scoring these relative to road density in relation to length thant the catchment area, riparian road density within the 300 m stream buffer, and stream crossing.

The above Open Road includes county and state roads, but excludes unauthorized, even in Current state

Economic Analysis

Implementation of the recommendations made in the Upper Wenatchee Travel Analysiswould decrease the expense of road maintenance mainly by reducing the total miles of paved road to maintain and increasing the miles of closed roads. The total cost reduction would be approximately 27%. Table 5.3 shows the change in annual road maintenance cost.

Table 5.3: Change in Average Annual Road Maintenance Cost Projections

ML	Average Annual Maint. Cost per Mile	Current NFS Roads		Post-Project NFS Roads		
		Miles	Projected Annual Cost	Miles	Projected Annual Cost	Difference from Existing Condition
1	$62	89.2	$5,530.40	114.5	$7,099.00	$1,568.60
2	$644	208.0	$133,952.00	162.3	$104,521.20	$29,430.80
3	$1,538	10.9	$16,764.20	8.2	$12,611.60	($4,152.60)
4	$3,019	10.0	$30,190.00	10.0	$30,190.00	-
5	$3,791	2.1	$7,961.10	2.1	$7,7961.10	-
Total		320.2	$194,397.70	327	$232,382.90	-$26,846.80

The above table shows an increase in costs, however in conducting this analysis, several roads managed and documented for needs and current used were documented. More roadswere put into hydrologically stable storage, and will reduce further potential resource damage.

Specific opportunities identified in the Travel Analysis include:

p. Road Decommissioning

Road decommissioning is defined as “activities that result in the stabilization and restoration of unneeded roads to a more natural state” (36 CFR 212.1). One of the main goals is reestablishing vegetation and, as necessary, initiating restoration of ecological processes interrupted or adversely impacted by the unneeded road (FSM 7700, Chapter 7730, section 7734.1). These activities are planned and implemented in such a way as tominimize the environmental impacts associated with road decommissioning.

Decommissioning includes applying various treatments, including one or more of thefollowing (FSM 7700, Chapter 7730, section 7734.1):

- Reestablishing former drainage patterns, stabilizing slopes, and restoringvegetation;
- Blocking the entrance to a road or installing water bars;
- Removing culverts, reestablishing drainages, removing unstable fills, pulling backroad shoulders, and scattering slash on the roadbed;

- Completely eliminating the roadbed by restoring natural contours and slopes; and

- Other methods designed to meet the specific conditions associated with theunneeded road.

Appropriate construction and in-stream work seasons would be followed as well as applicable Best Management Practices for "Road Decommissioning" found in *National BestManagement Practices for Water Quality Management on National Forest System Lands* (*USFS National BMPs*), (USDA Forest Service 2012) for erosion control during the project.

q. Road Closure

"Road Closure" is a common term for roads placed in Maintenance Level 1 status. ML 1 roads are roads that have been placed in storage between intermittent uses (FSH 7709.59,Chapter 20, section 25.12). They have the following attributes (from *Guidelines for Road Maintenance Levels*, USDA Forest Service SDTDC 2012)

- They are in a period of storage between intermittent uses for periods exceeding 1year.
- They are not designated for motor vehicles as a road - motor vehicular traffic isprohibited, including administrative motor vehicle traffic.
- They may be managed and designated as a motorized trail and/or may be availableand suitable for non-motorized uses.
- The road entrance is physically blocked or disguised.
- Emphasis is given to maintaining drainage facilities and runoff patterns.
- Culverts may be removed.
- Planned road deterioration may occur.
- Basic custodial maintenance is performed to prevent damage to adjacent resourcesand to perpetuate the road for future resource management needs.
- No road maintenance other than a condition survey may be required if no potentialexists for resource damage.

National Best Management Practices for Water Quality Management on National ForestSystem Lands (*USFS National BMPs*) (USDA Forest Service 2012) addressing "Road Storage" would apply as well.

r. Reduced Maintenance Level

The maintenance levels would be reduced for a number of roads. Table 5.4 shows the milesof proposed maintenance level reductions. Detailed information on the transportation system changes proposed for each road segment can be found in Appendix A: Road Tables and Appendix B: Maps.

The following section would only be completed after a final PROPOSED ACTION is analyzed so that roads used during project activities are assessed. Other future foreseeable actions (ex: Mackinsie Beverly PUP special use permit EA) would address roaddecisions within it.

Table 5.4: Proposed Maintenance Level Changes

Road Category	*Pre-Project Miles*	*Roads Staying or Becoming This Category*	*Miles*	*Roads Changing From This Category*	*Miles*	*Post-project Miles*
Decommissioned (D)	0	UA to D	10.6	-	-	65.2
		ML 1 to D	32.0			
		ML 2 to D	22.6			
Unauthorized (UA)	22.2	-	-	UA to D	10.5	0
				UA to ML 1	9.2	
				UA to ML 2	2.5	
Maintenance Level 1	89.2	UA to ML 1	9.2	ML1 to D	32.0	114.5
		ML 1 to ML 1	60.9	ML 1 to ML 2	1.0	
		ML 2 to ML 1	44.4			
Maintenance Level 2	209.0	UA to ML 2	2.5	ML 2 to D	22.6	162.3
		ML 1 to ML 2	1.1			
		ML 2 to ML 2	156.0	ML 2 to ML 1	44.4	
		ML 3 to ML 2	2.7			
				ML2 to ML2a	13.6	
		ML 3 to ML 3	8.2			

Maintenance Level 3	10.9	ML 4 to ML 3	0	ML 3 to ML 2	2.7	8.2
		ML 5 to ML 3	0			

Road Category	*Pre-Project Miles*	*Roads Staying or Becoming This Category*	*Miles*	*Roads Changing From This Category*	*Miles*	*Post-project Miles*
Maintenance Level 4	10.0	ML 4 to ML 4	9.98	ML 4 to ML 3	0	10.0
Maintenance Level 5	2.1	ML 5 to ML 5	2.13	ML 5 to ML 3	0	2.1

The roads listed in table 5-5 are those which the Forest Service is entering into a Road Right-of-Way Construction and Use Agreement (informally known as Cost-Share) with thestate of Washington (WDNR). These roads would be added to the NFS road system and managed by the Forest Servce.

s. Table 5-5: New Cost Share Roads

Road	New Forest System Road Number	Length (miles)
null	null	0

Note At time of this Road Analysis (TAP), none areproposed

t. Table 5-6: Roads USFS is acquiring Easements from Washington State

Road	New Forest System Road Number	Length (miles)
null	null	0

Note At time of this Road Analysis (TAP), none areproposed

u. Addition of Unauthorized Roads to the Forest Transportation System

A total of 12.3 miles of existing, unauthorized roads would be added to the NFS. Of these, 11.4 miles would be managed as ML 1 and 0.9 mile would be managed as ML 2. Theseroads mainly access other ownership or are existing easement or permit access roads.

DESIGN DETAILS

Specific features are incorporated into the design of the proposed action to prevent potentialresource impacts. The design requirements are an integral part of the proposed action and would apply in addition to applicable *USFS National BMPs*.

v. Road Decommissioning

Operationally, all roads identified for decommissioning would be evaluated by engineering staff and site-specific prescriptions for decommissioning developed. Input from other resource specialists would be provided as appropriate. Evaluation would include items suchas: existing drainage structures, slope stability of fills and cut slopes, signs of erosion, adequacy of vegetation, etc. Existing site conditions for each road segment would dictate whether light, medium or heavy road decommissioning practices are applied. General descriptions for each of these are below.

Light Decommissioning

Light decommissioning may consist of: blocking the entrance to the road, decompacting theroad base, constructing water bars, reestablishing former drainage patterns, scattering slash and woody debris and restoring vegetation (through the use of native plant or other appropriate species) or other methods designed to meet the specific conditions associated with the road.

Site conditions on road segments where light decommissioning activities would be appliedtypically include gentle side slopes and ridgetop locations and well established vegetationon stable side cast fills on gentle side slopes.

Medium Decommissioning

Medium decommissioning may consist of: blocking the entrance to the road, removing crossdrain culverts and small fills; decompacting the road base, pulling back road shoulders andplacing and shaping the material onto cut banks, constructing water bars, establishing drainage patterns, scattering slash and woody debris and restoring vegetation (through theuse of native plant or other appropriate species) or other methods designed to meet the specific conditions associated with the road.

Site conditions on road segments where medium decommissioning activities would be applied typically include moderate side slope locations, cross drain culverts and small fillsand side cast fills on moderate side slopes.

Heavy Decommissioning

Heavy decommissioning may consist of: blocking the entrance to the road, removing streamculverts and fills (restoring slopes and stream channels closer to adjacent conditions upstream and downstream), removing unstable fills and decompacting the roadbed and restoring most natural contours and slopes, establishing drainage patterns, scattering slash and woody debris and restoring vegetation (through the use of native plant or otherappropriate species) or other methods designed to meet the specific conditions associatedwith the road.

Site conditions on road segments where heavy decommissioning activities would be appliedtypically include steep side slope locations and close proximity to streams, stream crossingsand large fills, side cast fills on steep side slopes and potentially unstable fills.

Road segments identified as necessary access for range permittees would be decommissioned in such a way that does not preclude travel by cows and horses and, as appropriate, could accommodate administrative ATV/UTV access for maintenance of stocktanks or other permitted reasons. This access would be for authorized individuals only.

These administrative motorized access routes would be managed and maintained by therange department as part of the grazing permit.

w. Road Closure

Additional standards for closing roads (changing to ML 1 status) were developed as part ofthe *Okanogan-Wenatchee Forest Roads Policy* (Okanogan-Wenatchee National Forest 2013). These guidelines are intended to disconnect roads from the hydrologic system and address culvert removal and treatment of the road prism:

- Culverts are removed
- Decompact and shape road prism to a stable condition that promotes vegetativerecruitment
- Provide channel bed-level grade control if necessary
- Replace culvert cross drains with rolling dips at roads or place rolling dips belowcross drains in roads as a means of self-maintenance
- At a minimum, waterbars will be placed:
    - At every ten foot change in grade
    - At a minimum of one waterbar every 200 feet and
    - To prevent road drainage from directly entering the stream channel

<u>Accommodations for non-motorized or non-motor vehicle use</u>

<u>Barrier Design</u>

Barriers installed on roads which will be open for non-motorized or non-motor vehicle usewill be designed so they do not pose a hazard.

x. Gates

To reduce potential sediment production due to vehicle traffic and to control illegal firewoodcutting in riparian areas in the Frazer Creek / Okanogan PUD corridor, gates would be installed in suitable locations on the 4108650, 4100810, and 4100810 roads:

y. Temporary Roads

Proposed Temporary Roads would be constructed to the minimum standards necessary toaccess units for harvest activities while providing adequate resource protection. These roads would be decommissioned following harvest activities.

z. Step 6: Reporting

This report provides the basis for developing proposed actions to implement the minimumroad system and/or to change existing travel management decisions. These proposals are subject to appropriate public involvement and environmental analysis under NEPA beforetravel management decisions are made. Site-specific environmental analysis should buildon and incorporate relevant information developed during travel analysis.

Note in the following Appendix A – road columns of During project Actvities should be added during the project planning. One column of During Sale/Haul Treatments & anotherof other Project activities. Thereby it identifies which project closes, decommissions, rehabilitates or conditions each road. This will not be known till the contractors prepare proposed actions and alternatives.

aa. Appendix A: Road Table

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
5200000	2	2	12.43	25.5	38.7
5200900	2	2	0.25	0.0	0.8
6100000	3	3	1.59	0.0	1.6
6100000	3	3	2.46	1.6	4.1
6100100	1	1	0.64	0.0	0.6

6100111	2	2	0.54	0.0	0.6
6100150	2	1	0.11	0.0	0.1
6100160	1	1	0.10	0.0	0.1
6100170	2	2	0.05	0.0	0.1

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6100180	1	1	0.11	0.0	0.2
6100880	2	2	2.02	0.0	2.0
6100900	2	2	0.35	0.0	0.4
6100920	2	1	0.54	0.0	0.6
6100930	2	1	0.27	0.0	0.3
6101000	2	2	0.80	2.3	3.1
6101000	2	2	2.62	3.1	5.7
6101000	2	2	2.31	0.0	2.3
6101100	1	1	0.70	0.0	0.7
6101200	1	1	0.56	0.0	0.4
6101201	1	1	0.30	0.0	0.2
6101300	2	2	2.48	0.0	3.1
6101301	1	1	0.14	0.0	0.1
6102000	2	2	0.52	0.0	0.5
6102000	2	2	0.62	0.5	1.1
6102000	2	2	1.13	1.1	2.2
6102200	2	2	1.88	0.0	1.9
6102210	1	1	0.36	0.0	0.2
6102213	1	1	0.16	0.0	0.1
6102230	1	D*	0.17	0.0	0.2
6102240	1	1	0.32	0.0	0.2
6102250	1	D*	0.16	0.0	0.2
6102300	2	D	0.70	0.0	1.1
6102300	2	2	0.10	0.0	1.1
6102302	2	1	0.60	0.0	0.5
6102302	2	D	0.26	0.0	0.5
6102302	2	D	0.17	0.0	0.5
6102400	2	2	3.16	0.0	3.4
6102400	2	2	3.16	0.0	3.4
6102405	1	1	0.12	0.0	0.1
6102410	1	1	0.32	0.0	0.5

6102410	1	D	0.26	0.0	0.5
6102415	1	1	0.49	0.0	0.5
6102415	1	D	0.14	0.0	0.5
6102416	1	1	0.32	0.0	0.3
6102420	1	2*	0.70	0.0	0.2
6102425	1	1	0.33	0.0	0.4

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6102425	1	D	0.18	0.0	0.4
6102430	1	D	0.44	0.0	0.7
6102430	1	D	0.24	0.0	0.7
6102435	1	1	0.19	0.0	0.2
6103000	2	2	7.07	0.0	7.0
6103300	1	1	0.51	0.0	0.6
6104000	2	2A	2.89	5.2	8.1
6104000	2	2	5.08	0.0	5.2
6104111	2	1	2.14	0.0	2.5
6104113	1	1	1.37	0.0	1.3
6104113	1	1	0.18	0.0	1.3
6104113	1	D	0.23	0.0	1.3
6104115	1	D	0.12	0.0	0.5
6104121	1	D	1.02	0.0	1.0
6104123	1	D	0.90	0.0	0.6
6104200	1	1	0.54	0.0	0.5
6104300	1	1	0.78	0.0	0.9
6104350	1	D	0.31	0.0	0.3
6104660	1	1	0.23	0.0	0.5
6104660	1	D	0.25	0.0	0.5
6105000	2	2	4.59	0.0	4.6
6105113	2	1	0.96	0.0	1.0
6105115	1	D	0.20	0.0	0.3
6105125	2	2	0.65	0.0	0.5
6105130	1	D	0.44	0.0	0.2
6105140	2	D	0.79	0.0	1.0
6105150	1	D	1.20	0.0	0.8
6105155	1	1	0.87	0.0	0.8
6105160	1	1	1.10	0.0	1.0

6106000	2	2	1.58	0.0	1.5
6106000	1	1	1.63	2.3	3.9
6106000	2	2	0.77	1.5	2.3
6106000	2	2	1.81	3.9	5.6
6106000	2	1	0.11	1.5	2.3
6106215	2	2	2.36	0.0	2.7
6106217	1	1	0.61	0.0	0.5
6106219	1	1	0.27	0.0	0.3

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6106250	1	1	1.21	0.0	1.0
6106315	2	2	1.64	0.0	1.6
6106317	1	1	0.59	0.0	0.6
6106320	1	1	2.34	0.0	1.3
6106322	1	1	0.22	0.0	0.3
6106340	1	1	1.11	0.0	1.1
6106510	2	1	2.68	0.0	2.5
6106520	2	1	0.29	0.0	0.3
6106550	1	1	0.75	0.0	0.7
6106553	1	1	0.28	0.0	0.4
6106610	1	1	2.67	0.0	2.6
6106611	1	1	0.92	0.0	1.1
6107000	3	3	0.90	0.0	0.9
6120000	2	2	2.98	0.0	3.1
6120105	2	2	0.86	0.0	1.0
6120108	1	D	0.47	0.0	0.3
6120111	2	2	1.40	0.0	1.5
6120115	1	1	0.97	0.0	0.8
6120120	2	D	0.93	0.0	0.9
6120123	1	D	0.59	0.0	0.5
6120124	2	2	0.96	0.0	1.0
6120127	1	D	0.59	0.0	0.5
6120128	1	D	0.25	0.0	0.2
6120129	1	D	0.15	0.0	0.2
6120135	2	1	1.63	0.0	2.0
6120136	2	D	0.53	0.0	0.9
6120140	1	1	0.83	0.0	0.9

6120160	1	1	0.92	0.0	0.9
6121000	2	2	3.36	0.2	5.5
6121110	2	2	0.17	0.0	0.2
6121117	2	1	0.48	0.0	0.5
6121120	2	D	0.21	1.2	1.4
6121120	2	D	1.13	0.0	1.1
6121120	2	D	0.09	1.1	1.2
6121125	2	D	0.20	0.0	0.6
6121127	2	D	0.57	0.0	0.5
6121915	2	2	0.24	0.0	0.2

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6121917	2	D	0.25	0.0	0.3
6121920	1	D	0.15	0.0	0.1
6121922	1	D	0.20	0.0	0.1
6121924	1	D	0.17	0.0	0.1
6122000	1	D	1.49	0.0	1.7
6122100	2	2	0.84	0.0	1.0
6122100	2	2	0.13	1.0	1.1
6122210	1	D	0.62	0.0	0.7
6122310	1	D	0.25	0.0	0.3
6122410	1	D	1.00	0.0	0.6
6122415	1	D	0.26	0.0	0.2
6122510	1	1	0.78	0.0	0.8
6122670	2	1	0.09	0.0	0.1
6122674	1	1	0.39	0.0	0.5
6122674	1	D	0.09	0.0	0.5
6122675	1	1	0.21	0.0	0.2
6122675	1	D	0.08	0.0	0.2
6122906	1	D	0.09	0.0	0.1
6122907	1	1	0.64	0.0	0.6
6122909	1	D	0.13	0.0	0.1
6122910	1	1	0.52	0.0	0.5
6122912	1	D	1.35	0.0	1.4
6122918	1	D	0.31	0.0	0.1
6200000	4	4	1.46	8.4	9.9
6200000	4	4	6.05	2.2	8.4

6200000	5	5	2.13	0.0	2.2
6200100	2	2	0.44	0.0	0.5
6200111	2	2	0.18	0.0	0.2
6200111	2	D	0.04	0.0	0.2
6200120	1	1	0.22	0.0	0.3
6200125	2	2	0.24	0.0	0.3
6200130	2	2	0.11	0.0	0.1
6200140	1	1	0.41	0.0	0.3
6200143	1	1	0.17	0.0	0.3
6200148	1	1	0.21	0.0	0.2
6200200	2	2	0.98	0.0	1.0
6200200	2	2	1.96	1.0	3.0

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6200202	2	D	0.11	0.0	0.1
6200216	1	1	0.20	0.0	0.2
6200221	1	D	0.60	0.0	0.5
6200250	1	1	0.46	0.0	0.3
6200270	2	1	0.55	0.0	0.7
6200310	2	D	0.19	0.0	0.2
6200330	1	D	0.76	0.1	1.0
6200330	1	D	0.08	0.0	0.1
6200340	2	D	0.90	0.0	0.9
6200345	2	D	0.40	0.0	0.3
6200360	1	1	0.59	0.0	0.6
6200364	1	1	0.13	0.0	0.1
6200370	1	D	1.05	0.0	1.0
6200380	1	2	0.04	0.4	0.4
6200380	1	2	0.01	0.0	0.0
6200380	1	2	0.38	0.0	0.4
6200385	2	1	0.29	0.0	0.4
6200386	1	1	0.19	0.0	0.1
6202000	2	2	1.72	2.6	4.3
6202000	2	2	1.39	0.0	1.4
6202000	2	2	0.77	1.4	2.1
6202000	2	2	0.51	2.1	2.6
6202000	2	2	0.01	2.1	2.1

6202111	2	2	1.20	0.0	1.3
6202112	1	2	0.17	0.0	0.3
6202113	1	D	0.26	0.0	0.3
6202118	2	2	1.76	0.0	1.8
6202118	2	2	0.18	1.8	2.0
6202120	1	D	2.05	0.0	1.6
6202131	2	D	0.20	0.0	0.1
6202133	2	2	0.11	0.0	0.3
6202135	2	D	0.19	0.0	0.2
6202140	2	D	0.36	0.0	0.9
6202141	1	D	0.25	0.0	0.2
6202142	2	D	0.31	0.0	0.3
6202144	2	D	0.21	0.0	0.3
6202151	1	D	0.14	0.0	0.2

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6202903	1	D	0.19	0.0	0.2
6208000	2	2	5.12	0.0	5.2
6208000	2	1	1.20	5.2	6.4
6208000	2	1	0.07	0.0	5.2
6208111	1	1	0.63	0.0	0.7
6208112	2	1	0.79	0.0	0.9
6208115	2	2	0.68	0.0	0.8
6208130	1	1	0.69	0.0	0.4
6208160	2	2	1.19	0.0	0.4
6208413	1	1	0.53	0.0	1.3
6208413	1	1	0.54	0.0	1.3
6208413	1	D	0.23	0.0	1.3
6208417	1	1	0.35	0.0	0.3
6209000	2	2	2.15	0.0	2.2
6209000	2	1	0.10	0.0	2.2
6209107	2	1	0.20	0.0	0.3
6209111	2	2	0.91	0.0	0.9
6209112	1	D	0.22	0.0	0.4
6300000	4	4	3.03	0.0	3.0
6300000	4	3	1.31	3.0	4.3
6300000	4	2	3.03	4.3	7.3

6300000	4	2	2.02	7.3	9.3
6300000	4	2	0.12	9.3	9.4
6300107	2	D	0.20	0.0	0.2
6300111	2	2	0.56	0.0	0.4
6300121	2	D	0.66	0.0	0.5
6300123	1	1	0.38	0.0	0.3
6300131	2	2	1.92	0.0	1.6
6300135	1	D	0.34	0.0	0.3
6300140	2	D	1.21	0.0	1.3
6300143	1	D	0.99	0.0	1.0
6300151	1	D	0.11	0.0	0.5
6300211	2	2	0.22	0.0	0.3
6300215	1	D	0.09	0.0	0.3
6300411	2	1	0.12	0.0	0.1
6300511	2	2	1.76	0.0	2.0
6300611	1	1	0.73	0.0	0.3

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6300615	1	1	0.21	0.0	0.2
6304000	2	2	1.53	3.7	6.6
6304000	2	2	1.96	0.0	3.7
6304000	2	2	0.26	6.6	7.1
6304000	2	1	2.13	7.1	12.5
6304000	2	2	0.76	7.1	12.5
6304114	2	D	0.20	0.0	0.3
6304115	2	1	1.89	0.0	2.0
6304115	2	1	0.57	2.0	2.6
6304116	2	D	0.15	0.0	0.2
6304117	2	1	0.76	0.0	0.6
6304119	2	2	1.65	0.0	1.7
6304120	2	D	0.21	0.0	0.2
6304121	1	1	0.69	0.0	0.8
6304125	1	1	0.71	0.0	0.9
6304130	2	1	1.60	0.0	1.6
6304133	2	1	0.66	0.0	0.9
6304140	2	1	1.04	0.0	1.1
6304142	1	D	0.25	0.0	0.3

6304144	2	1	0.62	0.0	0.6
6304160	1	D	0.37	0.0	0.4
6304170	1	1	0.29	0.0	0.3
6305000	2	2	6.67	0.0	4.5
6305111	2	2	2.21	0.0	2.3
6305211	1	1	0.67	0.0	0.5
6305211	1	1	0.67	0.5	1.0
6305213	1	1	0.35	0.0	0.3
6305221	1	D	0.44	0.0	0.6
6305223	1	D	0.22	0.0	0.3
6305241	1	1	0.33	0.0	0.2
6305271	1	1	2.73	0.0	2.9
6305273	1	D	0.11	0.0	0.4
6305275	1	D	0.11	0.0	0.1
6305277	1	1	0.33	0.0	0.3
6305311	1	D	0.73	0.0	0.7
6305315	1	D	0.51	0.0	0.4
6305331	2	D	1.06	0.0	1.4

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6305350	1	1	1.70	0.0	1.2
6305411	2	2	1.05	0.0	0.7
6305412	1	D	0.44	0.0	0.4
6305414	1	1	0.13	0.0	0.0
6305418	1	D	0.21	0.0	0.3
6305432	2	2	0.77	0.0	0.4
6305511	2	2	1.61	0.0	2.2
6305511	2	1	0.51	0.0	2.2
6305555	1	D	0.37	0.0	0.2
6305556	1	D	0.26	0.0	0.2
6305575	2	2	0.42	0.0	0.4
6306000	2	2	4.46	0.0	8.1
6306000	2	1	3.58	0.0	8.1
6306210	2	1	0.55	0.0	0.5
6306300	2	1	1.22	0.0	1.4
6306310	2	D	0.20	0.0	0.2
6306320	2	D	1.09	0.0	0.8

6306324	2	D	0.08	0.0	0.1
6306325	2	D	0.18	0.0	0.3
6306400	2	D	1.55	0.0	1.4
6306430	2	1	1.23	0.0	1.2
6306450	1	1	0.85	0.0	1.0
6306470	1	D	0.52	0.0	0.4
6306500	2	D	1.08	0.0	1.1
6306510	2	D	0.92	0.0	0.9
6306520	2	D	0.74	0.0	0.8
6306550	2	D	2.01	0.0	1.3
6306555	2	D	0.43	0.0	0.3
6306600	2	1	0.33	0.0	0.4
6306602	2	1	0.43	0.0	0.3
6306610	1	1	0.06	0.0	0.2
6306612	2	2	0.21	0.0	0.3
6306750	2	1	1.04	0.0	1.1
6306770	2	1	0.42	0.0	0.5
6306790	2	1	0.52	0.0	0.5
6307000	2	2	4.58	0.0	4.6
6307000	2	1	0.30	4.6	5.1

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6307000	2	2	0.19	4.6	5.1
6307150	2	1	0.43	0.0	0.5
6307200	1	1	1.18	0.0	1.2
6307300	2	1	1.16	0.0	1.2
6307400	1	D	0.18	0.0	0.2
6309000	1	D	1.97	0.0	2.5
6309000	1	D	0.50	0.0	2.5
6309117	1	D	0.32	0.0	0.4
6309215	1	1	2.65	0.0	4.1
6309215	1	D	1.54	0.0	4.1
6309217	1	D	0.18	0.0	0.3
6309300	1	D	0.36	0.0	0.4
6601000	2	2	3.80	0.0	3.9
6601000	2	2	5.75	3.9	9.8
6601110	2	2A	2.60	0.0	3.2

6601110	2	2	0.22	0.0	3.2
6601111	1	D	0.27	0.0	0.3
6601121	2	2A	0.76	0.0	1.0
6601121	2	D	0.34	0.0	1.0
6601210	2	1	3.21	0.0	2.1
6601250	2	1	1.09	0.0	1.5
6601310	2	1	1.21	0.0	0.7
6601315	1	1	0.30	0.0	0.3
6601350	2	1	1.14	0.0	1.2
6601410	1	1	0.72	0.0	0.7
6601450	2	2	0.30	0.0	0.3
6601510	1	1	0.32	0.0	0.3
6601550	2	2	0.51	0.0	0.5
6601551	2	2	0.31	0.0	0.3
6601560	2	1	0.14	0.0	0.2
6601610	1	1	0.26	0.0	0.3
6601650	2	D	0.89	0.0	1.0
6601660	2	2	0.21	0.0	0.1
6601660	2	2	0.07	0.1	0.2
6601710	2	1	0.32	0.0	0.6
6601710	2	D	0.29	0.0	0.6
6601810	2	2A	4.19	0.0	4.1

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6601810	2	2	0.70	0.0	4.1
6601815	1	2	0.15	0.0	0.2
6601825	2	2	0.50	0.0	1.1
6601850	2	2A	0.36	0.0	0.3
6602000	2	2	0.59	0.0	1.1
6602000	2	1	0.90	1.1	3.4
6602000	2	1	0.16	1.1	3.4
6602000	2	1	1.44	1.1	3.4
6602000	2	2A	0.48	0.0	1.1
6602100	1	1	0.73	0.0	0.7
6602200	1	1	0.14	0.0	0.1
6605000	2	2	0.16	0.0	0.2
6605000	2	2	0.85	0.2	1.0

6606000	2	2	0.47	0.0	0.4
6606020	2	2	0.34	0.0	0.2
6606100	2	1	0.76	0.0	0.6
6606100	2	2	0.16	0.0	0.6
6606102	2	1	0.15	0.0	0.1
6606103	2	D	0.28	0.0	0.2
6607000	3	3	0.11	1.3	1.4
6607000	3	3	1.32	0.0	1.3
6607100	2	2	0.31	0.0	0.6
6607111	2	2	0.79	0.0	1.5
6607112	2	2	0.18	0.0	0.3
6607125	3	3	0.19	0.0	0.2
6608000	2	2	2.68	0.0	2.8
6608120	1	1	0.19	0.0	0.2
6608125	1	1	0.37	0.0	0.6
6608200	1	1	0.79	0.0	0.8
6608300	1	1	0.44		
6751000	4	4	0.16	0.0	0.3
6751111	3	3	0.07	0.0	0.1
6920114	2	2	4.76	0.0	4.7
6920119	2	2	1.47	0.0	0.8
6920120	2	2	0.89	0.0	0.4
7705000	1	1	2.72	1.6	4.1
7705701	2	1	0.17	0.0	0.2

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
7707000	2	2	1.89	0.0	2.4
7903400	2	2	1.97	0.0	1.9
7903405	1	1	0.16	0.0	0.2
7903406	1	1	0.08	0.0	0.1
7903408	1	1	0.25	0.0	0.3
7903410	1	1	0.36	0.0	0.4
7903412	1	1	0.12	0.0	0.1
7903415	2	1	0.65	0.0	0.7
7906000	1	1	0.51	1.9	3.1
7906000	2	2A	0.89	0.1	1.1
7906000	1	1	0.5	4.2	4.7

7906000	1	D	0.4	4.7	5.1
7906000	2	2A	0.35	1.5	1.9
7906000	1	1	0.36	1.9	3.1
7906000	1	D	0.39	3.1	3.1
7906000	1	1	0.77	3.1	4.2
7906000	2	2A	0.35	1.1	1.5
7906000	2	2	0.54	0.0	1.1
7906200	1	1	0.56	1.5	2.1
7906215***	2	2A	0.70	0.0	0.7
7906217	1	D	0.17	0.0	0.1
6100000-0.2R-1		D	0.16	0.0	0.2
6100000-1.9L-1		D	0.02	0.0	0.1
6100111-A	2	2	0.12	0.0	0.1
6100111-B	2	2	0.21	0.0	0.2
6100111-C	2	2	0.25	0.0	0.3
6101000-1.6R-1		D	0.03	0.0	0.0
6101000-2.2L-1		D	0.10	0.0	0.1
6102200-0.4R-1		D	0.07	0.0	0.1
6102430-0.7R-1		D	0.12	0.0	0.1
6104113-0.6L-1		D	0.07	0.0	0.1
6104113-1.1L-1		D	0.18	0.0	0.2
6104113-1.2L-1		1	0.22	0.0	0.2
6104113-1.2L-2		D	0.06	0.0	0.1
6106320-1.30-1		D	0.12	0.0	0.1
6106340-0.542R-1		D	0.40	0.0	0.2
6120115-0.7L-1		D	0.10	0.0	0.1

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6120120-0.2L-1		D	0.51	0.0	0.5
6120123-0.1R-1		D	0.06	0.0	0.1
6120127-0.2L-1		D	0.14	0.0	0.1
6120127-0.33L-1		D	0.09	0.0	0.1
6120136-0.9R-1		D	0.31	0.0	0.3
6121000-3.5R-1		D	0.20	0.0	0.2
6121000-3.5R-2		D	0.02	0.0	0.0
6121120-1.3L-1		D	0.26	0.0	0.3
6121920-0.1R-1		D	0.17	0.0	0.2

6122100-0.32R-1		D	0.14	0.0	0.1
6122415-0.01L1		D	0.07	0.0	0.1
6122415-0.03L-1		D	0.03	0.0	0.0
6122674-0.27L-1		1	0.36	0.0	0.5
6122674-0.27L-1		D	0.09	0.0	0.5
6200000-7.0R-1		D	0.05	0.0	0.1
6200125-0.02L-1		D	0.56	0.0	0.6
6200125-0.2R-1		D	0.11	0.0	0.1
6200125-0.3R-1		D	0.09	0.0	0.1
6200130-0.08R-1		D	0.06	0.0	0.1
6200200-2.5R-2		1	0.13	0.0	0.1
6200200-2.8L-1		D	0.18	0.0	0.2
6200310-0.2R-1		D	0.06	0.0	0.1
6200340-0.01L-1		D	0.12	0.0	0.1
6200385-0.06R-1		1	0.20	0.0	0.2
6202000-2.73R-1		2	0.61	0.0	0.6
6202000-3.78R-1		D	0.53	0.0	0.5
6202111-0.29R-1		D	0.12	0.0	0.1
6202113-0.28L-1		D	0.99	0.0	0.9
6202118-1.65L-1		D	0.07	0.0	0.1
6208000-3.4R-1		1	0.56	0.0	0.6
6300000-2.5L-1		D	0.05	0.0	0.1
6304150-0.8R-1		1	0.22	0.0	0.2
6305000-3.3R-1		2	0.52	0.0	0.6
6305000-3.3R-2		1	0.64	0.0	0.5
6305000-3.7L-1		1	2.23	0.0	2.1
6305000-3.7L-2		1	0.45	0.0	0.4
6305000-3.7L-3		1	0.18	0.0	0.2

Route No	Current ML	Post Project ML	Segment Lenght	BMP	EMP
6305000-3.7L-5		1	0.58	0.0	0.5
6305000-4.1R-1		1	0.28	0.0	0.3
6305300-0.3R-1		D	0.41	0.0	0.4
6305511-1.5L-1		2	1.06	0.0	1.1
6305511-1.5L-2		D	0.13	0.0	0.1
6305511-1.5L-3		1	0.41	0.0	0.4
6305511-1.5L-4		D	0.20	0.0	0.3

6305511-1.9R-1		D	0.36	0.0	0.2
6306000-1.1R-1		D	0.04	0.0	0.0
6306300-0.3R-1		D	0.14	0.0	0.1
6306300-1.0L-1		1	0.25	0.0	0.3
6306300-1.0L-2		D	0.08	0.0	0.1
6306300-1.11L-1		D	0.20	0.0	0.2
6306300-1.11L-2		D	0.03	0.0	0.0
6306310-0.06R-1		D	0.03	0.0	0.0
6306320-0.7R-1		D	0.14	0.0	0.1
6306500-0.53L-1		D	0.10	0.0	0.1
6601121-0.2R-1		D	0.14	0.0	0.1
6601121-0.3L-1		D	0.12	0.0	0.2
6601315-0.3R-1		D	0.47	0.0	0.5
6601315-0.3R-2		D	0.09	0.0	0.1
6601660-0.08L-1		1	0.57	0.0	0.6
6601710-0.3R-1		D	0.09	0.0	0.1
6601710-0.4R-1		1	0.49	0.0	0.2
6602000-0.98R-1		1	0.55	0.0	0.6
6602000-1.0R-1		D	0.12	0.0	0.2
6602000-2.0R-1		D	0.73	0.0	0.3
6606020-0.4R-1	1	1	0.84	0.0	0.1
6606100-0.70R-1		D	0.24	0.0	0.2
6606102-0.04L-1		D	0.20	0.0	0.2
6607000-0.1L-1		2	0.33	0.0	0.3
6607000-A	3	3	0.23	0.0	0.2
6607000-B	3	3	0.06	0.0	0.2

Note 1: To prevent the possibility of duplicating road numbers some will be assigned afterthis decision is finalized.

***MackinsieBeverly Decision Special Use permit transferred this to NON system road, a2A designation. Not counted in open road miles

On “D” Decomission post promect but leave wide spot at

beginning2 A = Administrative access only, not open to public

2 on 6102420 segment- DNR easement at beginning,

Refer to Excel spreadsheet in TAP folder of Box- UpperWenatcheePilot_TAP2021updatefor Append Table

Appendix C: Results from GRAIP Lite

The GRAIP Lite model was run on existing roads to estimate the baseline condition of the watersheds and the relative sediment input from each road segment. See Nelson et al. (2018) for full model background. GraipLite determines road-related sediment impacts to streams using a 30m DEM and USFS INFRA roads to calculate the following for road segments: **Sediment production (kg yr^{-1})**: Surface erosion generated on the road tread and ditch, estimated for each road segment as E = BRSV where E is the total sediment production for the road segment, B is the baserate (for this model run: 1 kg yr^{-1} m^{-1}), R is the elevation difference between road segment ends, S is the surface type factor, and V is the vegetation factor. **Sediment delivery (kg yr^{-1})**: The portion of sediment produced on the road surface that makes it into the stream network.

The stream network modeled by GraipLite differs from the NHD layers commonly used by the USFS. The drainage network within GraipLite is derived from a DEM and thresholds of contributing area. The following are modeled by GraipLite for the stream network: **Sediment accumulation (Mg yr^{-1}):** The sum of all delivered sediment that is routed to a given stream reach. **Specific sediment delivery (Mg yr^{-1} km^{-2}):** Sediment accumulation normalized by contributing area. This last metric can be used to determine areas where roads present a higher risk to stream habitats when prioritizing areas for restoration or remediation efforts: this metric allows comparisons of actual masses of sediment in watersheds having more than about 10 km of road (personal communication with Nathan Nelson on 2/10/2020). Use of this metric required: (1) multiplying sediment production, delivery, and accumulation by the local baserate (i.e., 79 kg yr^{-1} m^{-1}; Nelson et al. 2019); and (2) recalculating the specific sediment as the sediment accumulation divided by area (km^2) (personal communication with Nathan Nelson 2/10/2022). Note: these calculations are needed as initial model results were based on calculations with a baserate of 1, which provided a set of relative index values for comparison.

The model was then run using the post-project road status in order to look at the overall reduction in stream sedimentation. Specific sediment delivery will reduce in all stream reaches post-project, with some areas, like Brush Creek and Goose Creek, improving by a greater magnitude (Figure 28, Figure 29, Figure 30, and Figure 31).

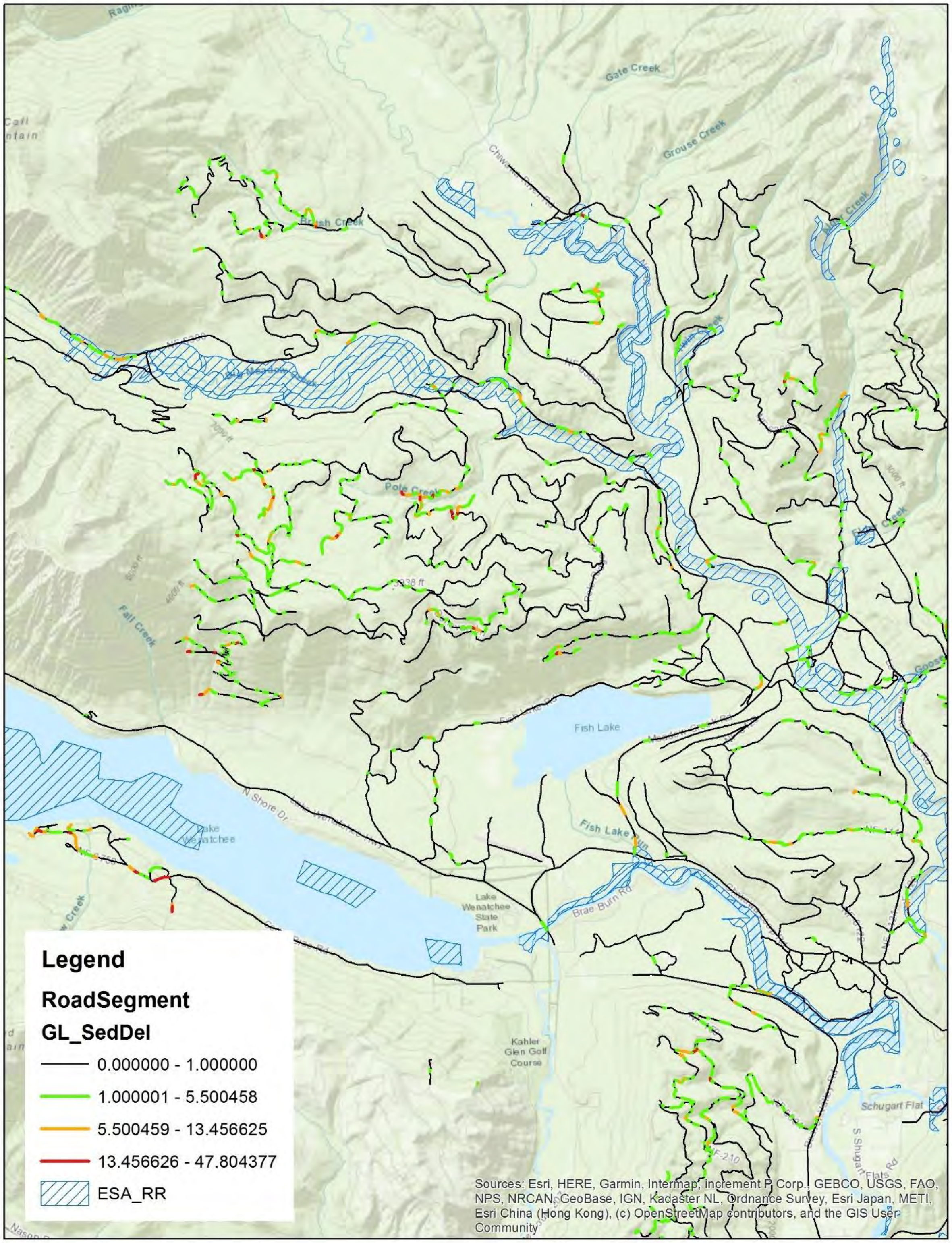

Figure 24. Results of GRAIP Lite on road segments, north section. Values less than 1 indicate that the road segment is not delivery sediment above the base rate of natural erosion. Note that most road segments are adding to any

sedimentation are on headwaters ephemeral and intermittent channels. With intermittent flow and small discharge, these headwaters streams have less potential to lead to increased sedimentation downstream.

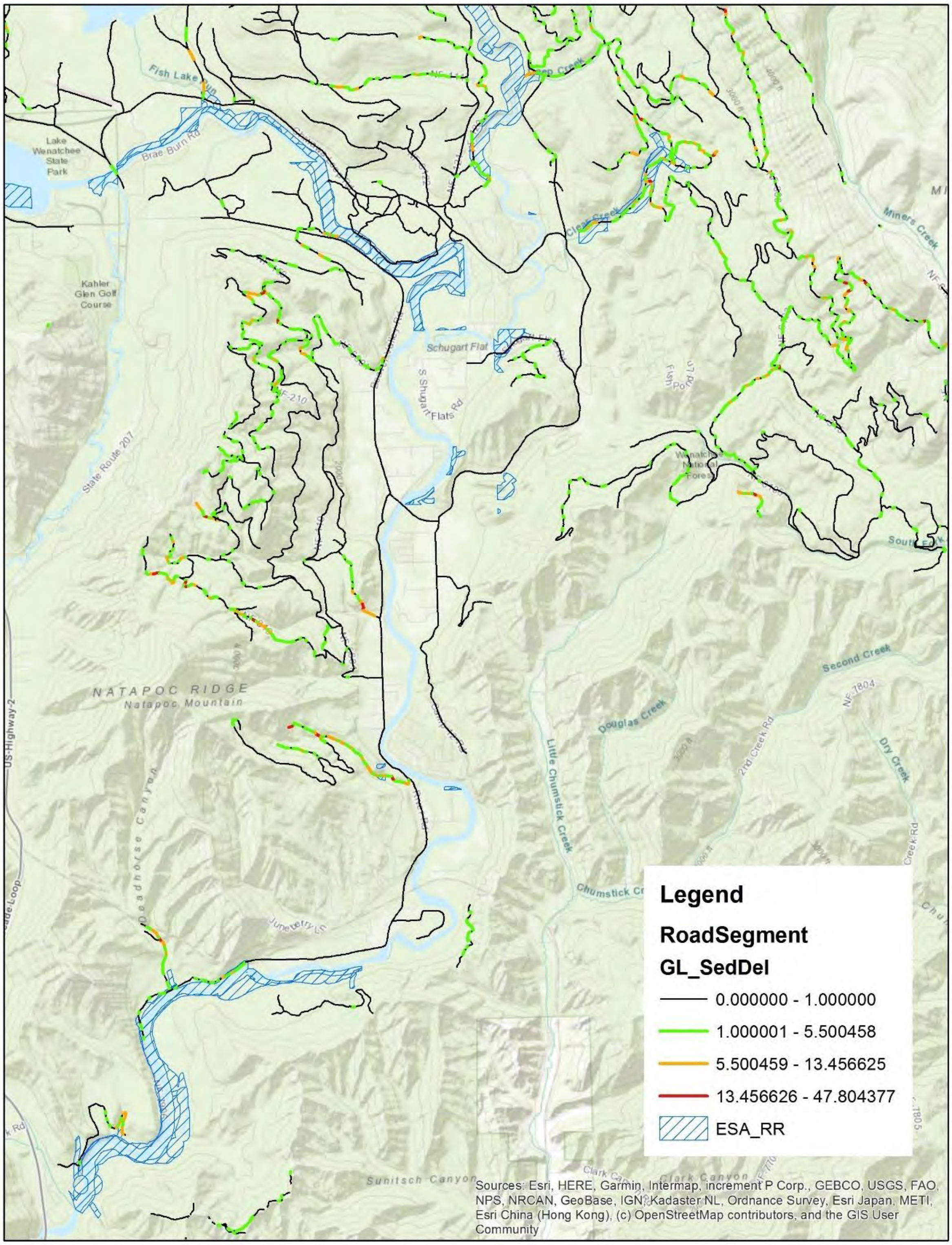

Figure 25. Results of GRAIP Lite on road segments, south section. Values less than 1 indicate that the road segment is not delivery sediment above the base rate of natural erosion. Note that most road segments are adding to any

sedimentation are on headwaters ephemeral and intermittent channels. With intermittent flow and small discharge, these headwaters streams have less potential to lead to increased sedimentation downstream.

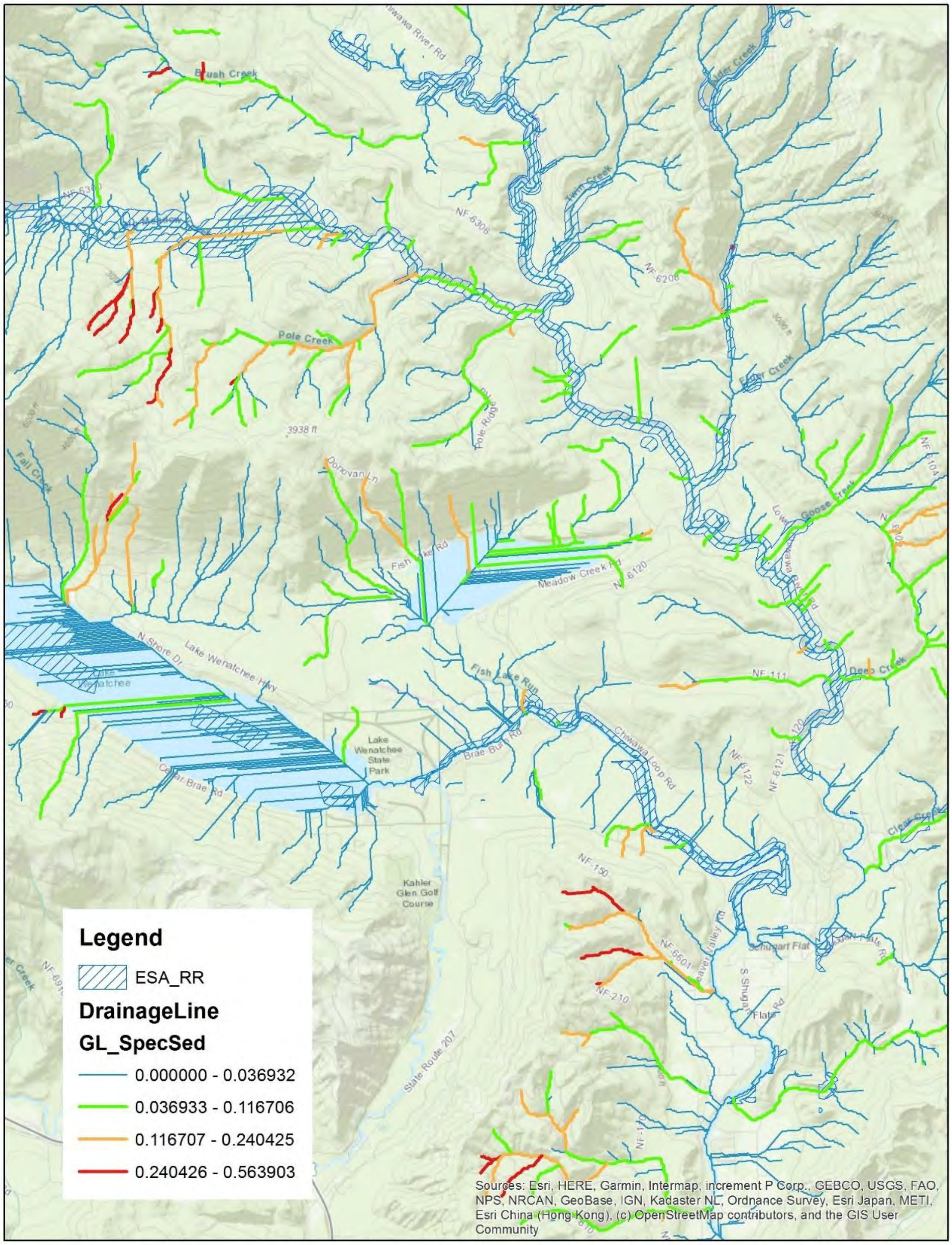

Figure 26. Pre-project sediment accumulation (Mg yr-1 km-2), standardized by drainage size, by stream segment due to increase in roads. Note that most of the impacted streams are in headwaters where effects are expected to be localized. Sediment either settles out or becomes diluted as it moves down the system.

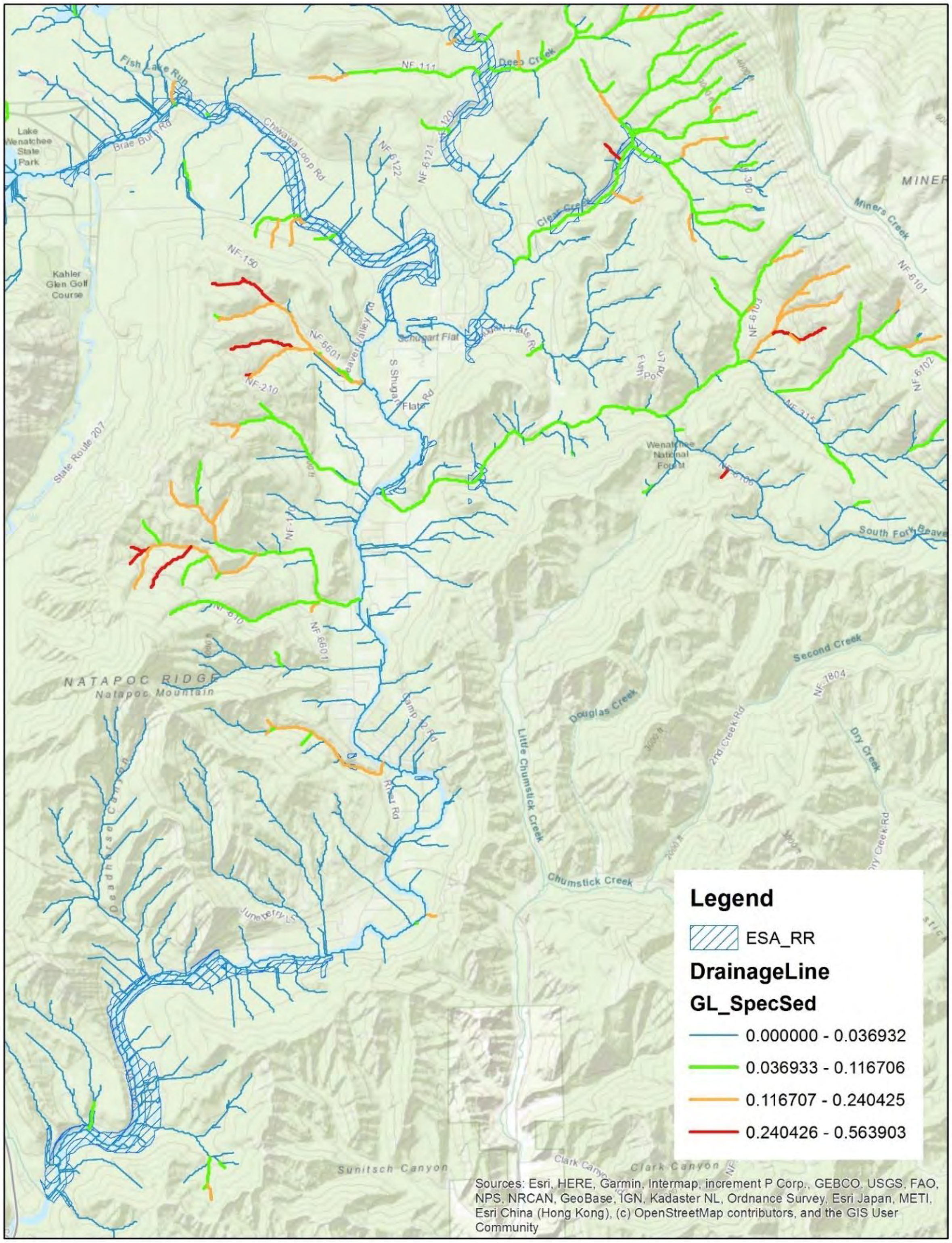

Figure 27. Pre-project sediment accumulation (Mg yr-1 km-2), standardized by drainage size, by stream segment due to increase in roads. Note that most of the impacted streams are in headwaters where effects are expected to be localized. Sediment either settles out or becomes diluted as it moves down the system.

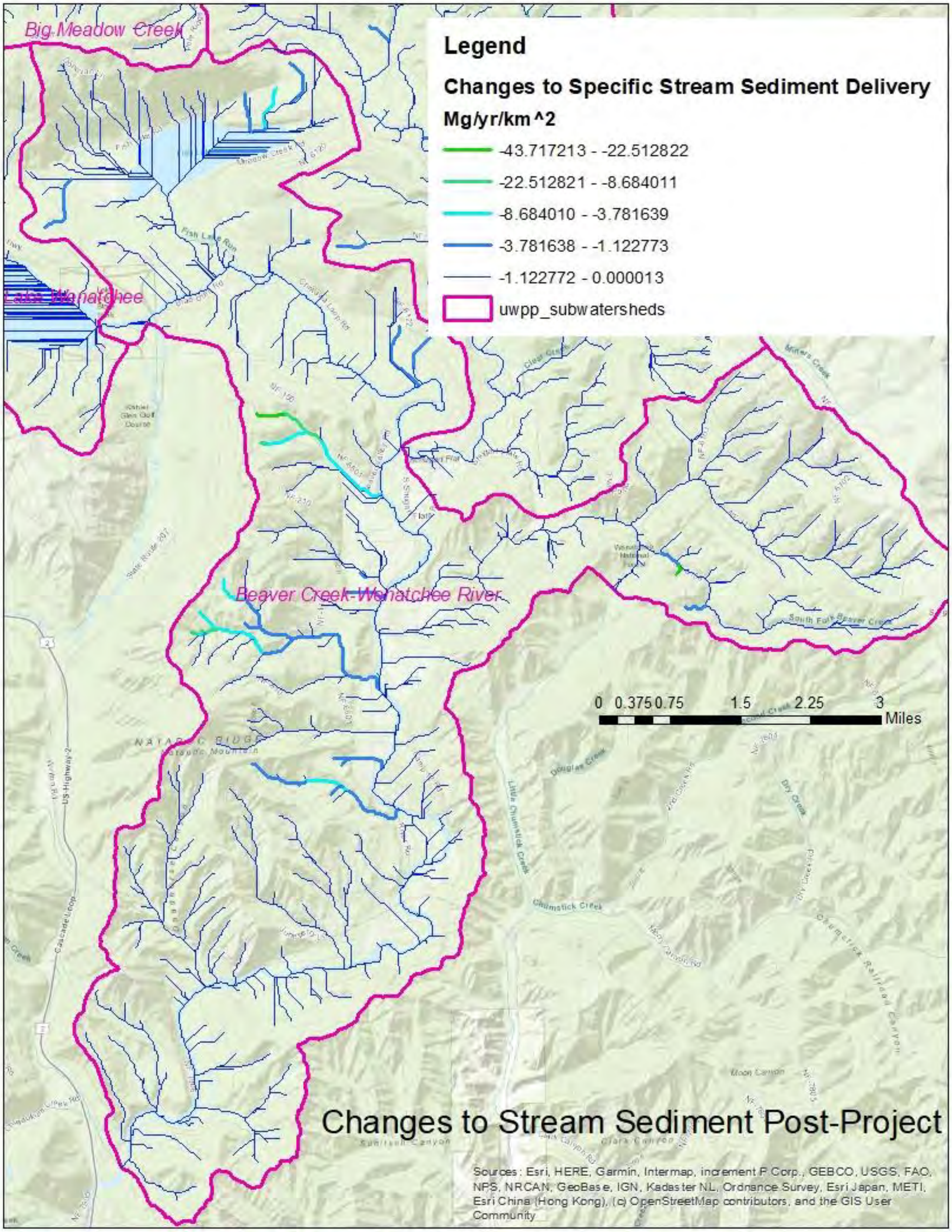

Figure 28. Changes in specific sediment delivery in stream reaches, post-project, in Beaver Creek-Wenatchee River.

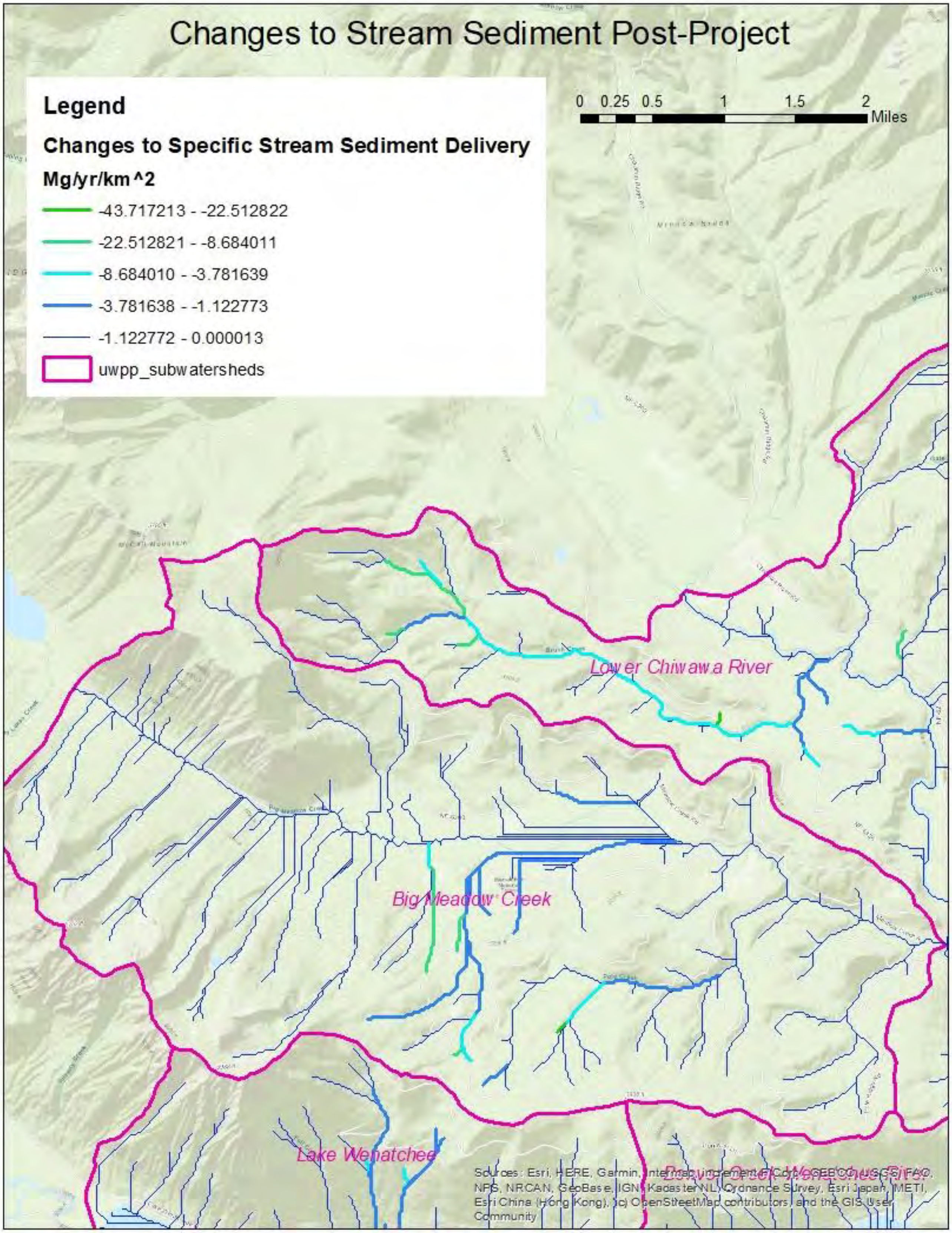

Figure 29. Changes in specific sediment delivery in stream reaches, post-project, in Big Meadow Creek.

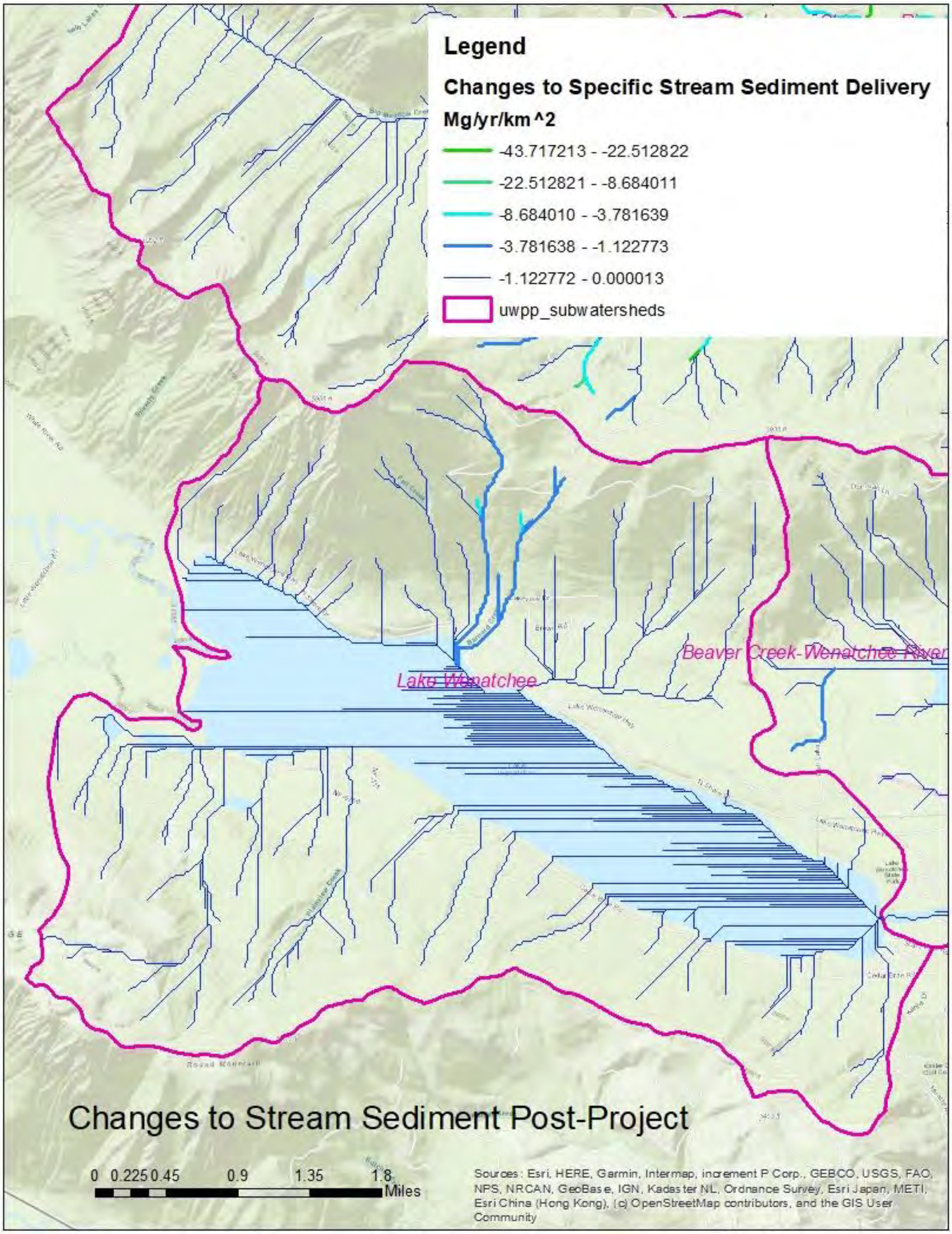

Figure 30. Changes in specific sediment delivery in stream reaches, post-project, in Lake Wenatchee.

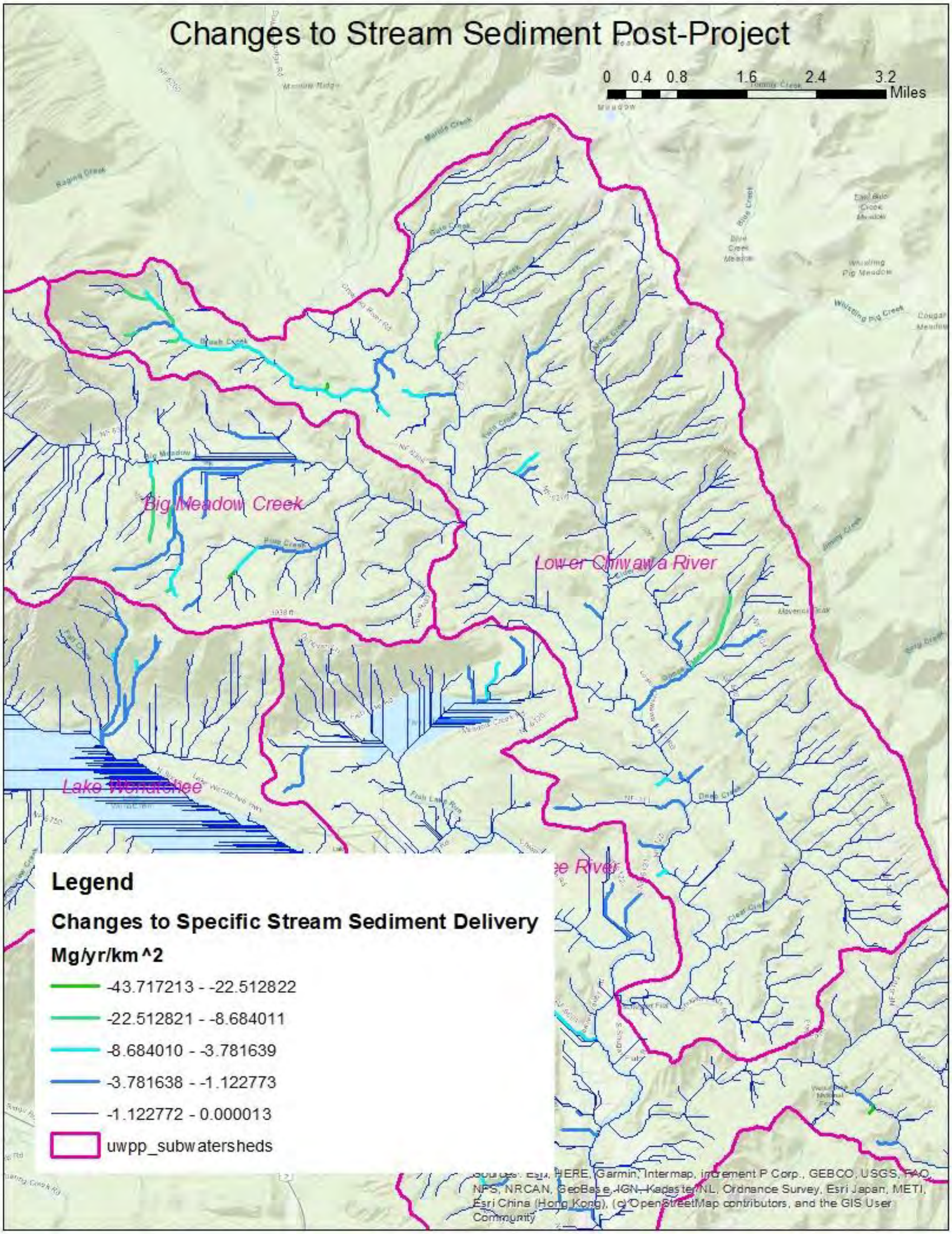

Figure 31. Changes in specific sediment delivery in stream reaches, post-project, in Lower Chiwawa River. Note the larger reductions in Goose Creek and Brush Creek.