CHAPTER 3: WILDERNESS CHARACTER

The project is located within the Alpine Lakes Wilderness of the Okanogan-Wenatchee National Forest (**Figure 3-1;** see Figure 1.1 for a vicinity map showing the region). In 1946, 256,000 acres within the central Cascades were designated as the Alpine Lakes Limited Area by the Pacific Northwest Forester, but mineral extraction activities were allowed (USFS 1981). In 1976, 306,934 acres were designated by congress and signed into law by President Gerald Ford as the Alpine Lakes Wilderness, with 86,426 acres of land to be included after the acquisition of private lands within the wilderness boundary (USFS 1981). The Alpine Lakes Wilderness was expanded again in 2014 and now contains 414,000 acres (Wilderness.net 2022).

Key Findings for Wilderness Character

- Construction would affect wilderness character by drawing down the lake, reducing vegetation, and causing mechanical noise over one summer construction season.
- Operation of any action alternative would affect wilderness character by continuing water level manipulation and creating a more developed appearance at the dam.
- Alternative 1 would facilitate more manipulation of water level than would the other action alternatives, and would include more conspicuous man-made elements in the dam, particularly the inflatable gates.
- Alternative 2 would require more material and time to construct, and have a larger footprint area than the other action alternatives, particularly the secondary spillway that would be armored with rock and must be kept clear of trees.
- Alternative 3 would have the same footprint area as Alternative 1, would have fewer conspicuous man-made elements (no gates), and would not allow as much water storage and ease of water level manipulation as Alternative 1.
- The No Action Alternative would not result in any direct change to the wilderness but could risk failure of the dam and/or trigger enforcement action by DSO, which would have temporary impacts on the natural and undeveloped character of the wilderness but would reduce trammeling due to the dam.
- None of the action alternatives would significantly impact wilderness qualities due to the limited scale and duration of construction, and limited scale and severity of the operational impacts compared to existing conditions at Eightmile Lake.
- The operation and maintenance of the existing dam impairs some qualities of wilderness character called for by the Wilderness Act (see Section 3.1.2, *Qualities of Wilderness Character*) but is authorized by the Special Warranty Deed.
- The dam was built and in operation before the designation of the Alpine Lakes Limited Area and Alpine Lakes Wilderness.

Motorized equipment, motor vehicles, mechanical transport, temporary roads, permanent structures, or installations are not generally allowed in designated wilderness areas. Wilderness areas are to be primarily affected by the forces of nature, although the Wilderness Act does acknowledge the need to provide for human health and safety, protect private property, control insect infestations, and fight fires within the area. The Wilderness Act also contains provisions that allow pre-existing uses to remain under certain conditions.

The Alpine Lakes Management Act of 1976 is to "*…provide for public outdoor recreation and use and for economic utilization of commercial forest lands, geological features, lakes, streams and other resources in the Central Cascade Mountains of Washington State by present and future generations…*". The project site is within the Enchantment Permit Area, a portion of the Alpine Lakes Wilderness in which permits are required for overnight camping, due to heavy recreational use of the area.

> Designated wilderness is the highest level of conservation protection for federal lands, and is defined as: "*an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain.*" (Wilderness Act Section 2c)

IPID built Eightmile Dam nearly 100 years ago, before the designation of the Alpine Lakes Wilderness. The dam is at the east end of the lake, approximately 1.6 miles inside the wilderness boundary (**Figure 3-1**). Eightmile Dam and some of the inundated bed and shore of Eightmile Lake are on two parcels of land (120 acres) subject to a Special Warranty Deed. Through the Special Warranty Deed, IPID retained certain rights through the land exchange with the Forest Service in 1990 after the creation of the Alpine Lakes Wilderness (see Chapter 2). The Special Warranty Deed (see map in Figure 1-2) reserves IPID's rights to maintain and operate the dam and exercise their water rights. (See Chapter 2 for discussion of the Special Warranty Deed.) These "reservations" explicitly allow uses (motorized transportation and equipment or aircraft) otherwise prohibited by the Wilderness Act. The Deed includes the following description of the rights it reserves:

> *"…a nonexclusive, perpetual easement across, through, along, and upon the property described herein for the purposes of maintenance, repair, operation, modification, upgrading and replacement of all facilities presently located in or upon the property described herein, together with a nonexclusive right of ingress to and egress from all such facilities for all such purposes, in accordance with Rules and Regulations of the Secretary of Agriculture, 36 CFR 251.17 and 251.18, attached hereto and made a part hereof, in such manner as not unreasonably to interfere with its use by the United States, its authorized users or assigns, or cause substantial injury thereto.*
>
> *The Grantor [IPID] may exercise the rights hereunder by any means reasonable for the purposes described, including but not limited to the use of motorized transportation and equipment, or aircraft. These rights include the right to regulate water level of all facilities located upon the property described herein. In performing maintenance, repair, operation, modification, upgrading and replacement of facilities located in or upon the property described herein, the Grantor will not without prior written consent of the Forest Service, which consent shall not unreasonably be withheld, materially increase the size or scope of the facilities."*

As described in Chapter 1, IPID proposes to rebuild the Eightmile Dam to meet current safety standards. To rebuild and restore the dam, IPID will need to access the dam site, on Special Warranty Deed land, which includes traveling and transporting people and equipment into the Alpine Lakes Wilderness.

The high-water level established by the dam was originally 4,671 feet above sea level. Due to multiple factors (for example IPID's management of water levels, erosion of the dam, etc.), the high-water level at present–and for the past several years–is approximately 4,667 feet, when the lake is approximately 76.6 acres in area. An outlet pipe allows drawdown of the lake without pumping to a water level of 4,648 feet, and seepage allows the lake to fall as low as elevation 4,640 feet. (See Chapter 2 for additional details on lake levels.)

The project site would be accessed by helicopter and on land, via the Eightmile Lake Trail. The Eightmile Lake Trail (3.3 miles) leads to Eightmile Lake and is one of two non-motorized National

Forest System trails located in the vicinity of Eightmile Dam. The Eightmile Lake Trailhead is approximately 1.3 miles from the wilderness boundary (Figure 3-1).

3.1 Methodology

This section describes the methods used to analyze impacts on wilderness character. The analysis examines the cumulative impacts expected from the project (visual, noise, biological, and cultural resource) on wilderness character in the Alpine Lakes Wilderness, taking into account the provisions of the Special Warranty Deed.

3.1.1 Study Area

The study area for this analysis includes Eightmile Lake, the viewshed of the lake within the Alpine Lakes Wilderness, and the area within the wilderness where noise from construction would be audible. It includes areas both in and out of the Special Warranty Deed Area.

3.1.2 Qualities of Wilderness Character

Section 2(a) of the 1964 Wilderness Act states that wilderness areas should be managed to preserve their wilderness character. Although the act does not define "wilderness character," in *Keeping in Wild 2* the Interagency Wilderness Monitoring Team describes it as a:

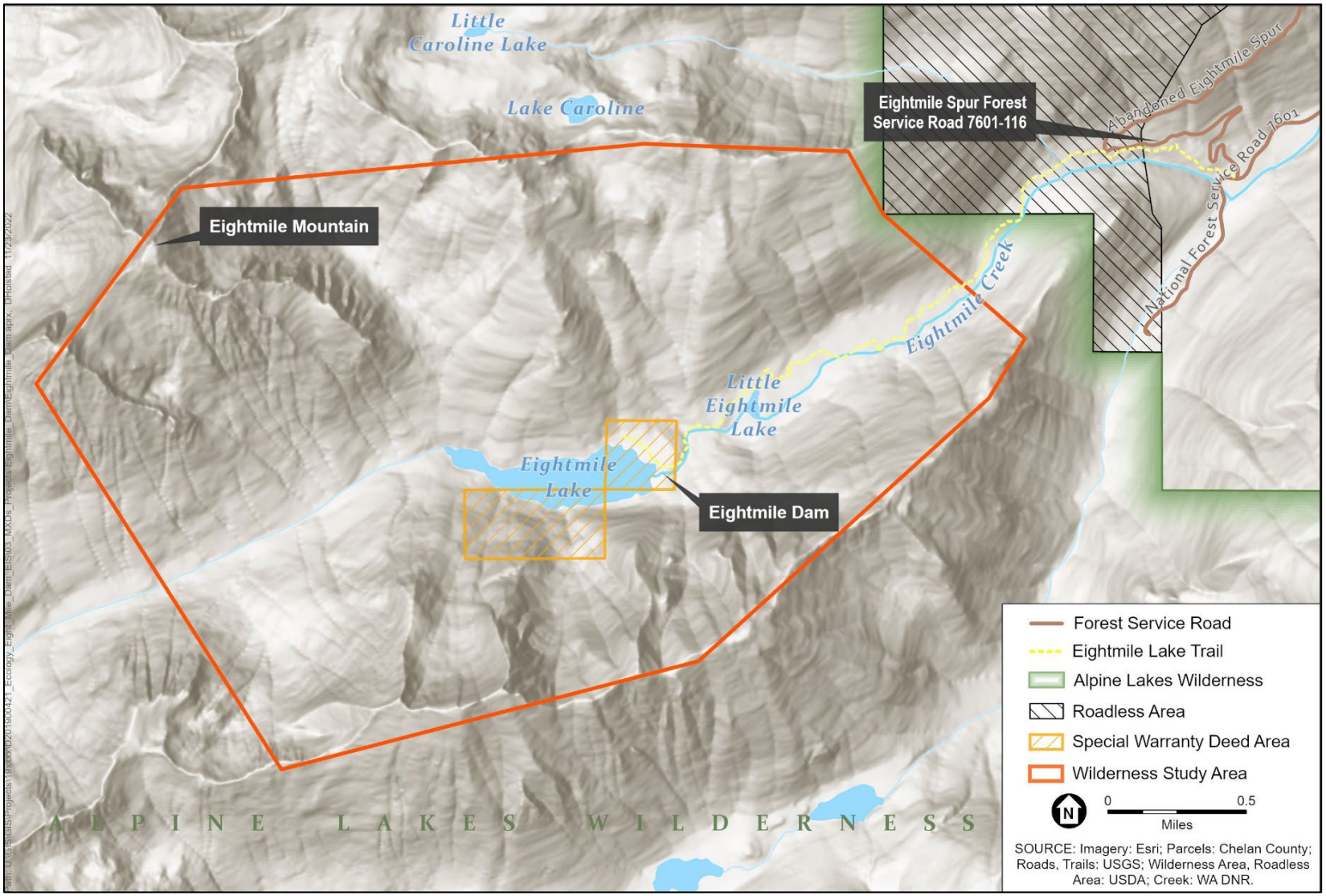
> *"…holistic concept based on the interaction of (1) biophysical environments primarily free from modern human manipulation and impact, (2) personal experiences in natural environments relatively free from the encumbrances and signs of modern society, and (3) symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature."* (Landres et al. 2015)

Together, these values help to define wilderness character and differentiate wilderness areas from other lands. These three ideals combine and form a subtle and complex set of relationships with the land, its users, stewards, and society. Managers of wilderness have developed five key qualities of wilderness character based on the statutory definition of wilderness as defined in Section 2(c) of the Wilderness Act (Landres et al. 2015). Those qualities include:

1. Untrammeled

> In the Wilderness Act, wilderness is defined as *"an area where the earth and its community of life are untrammeled by man,"* that "*generally appears to have been affected primarily by the forces of nature*" and "*retains its primeval character and influence*." The untrammeled quality is the level to which wilderness is unhindered and free from modern human control or manipulation. The untrammeled quality is preserved when actions to manipulate or control ecological systems within the wilderness are absent. Activities to control ecological systems include, but are not limited to, stocking lakes with fish, fire suppression, removing predators, and installing water catchment features. This quality is greatly improved when efforts to modify or suppress habitat are stopped or greatly reduced (Landres et al. 2015).

Figure 3-1. Study Area for Wilderness Character Analysis



2. Natural

The Wilderness Act states that wilderness is "*protected and managed so as to preserve its natural conditions.*" The natural quality is defined as ecological systems within the wilderness that are sustainably free from the effects of people and modern society. This quality is directly related to the "*biophysical environments primarily free from modern human manipulation and impact*" described under the definition of wilderness character. The natural quality of an environment is preserved when only Indigenous plant species and natural ecological functions are present. This quality also may be improved by restoring ecological conditions or by removing non-native species (Landres et al. 2015).

3. Undeveloped

The Wilderness Act defines wilderness in Section 2(c) as "*an area of* undeveloped *Federal land retaining its primeval character and influence, without permanent improvements or human habitation*," *with "the imprint of man's work substantially unnoticeable.*" The undeveloped quality implies that wilderness is without any permanent improvements or modern human occupation. The Wilderness Act also states in section 4(c) that "*there should be no temporary road, no use of motor vehicles, no landing of aircrafts, no other form of mechanical transport, and no other structure or installation*" within wilderness areas. However, it should be noted that very few wilderness areas in the United States are free from modification and modern human occupation. Many developments in wilderness areas (such as buildings, dams, roads, power lines, mines, water pipe corridors, and aircraft landing strips) have been allowed under special provisions. The presence of these structures and developments can have impacts on wilderness character, as the undeveloped quality is degraded by the presence of non-recreational structures and by the use of motorized vehicles and equipment because it increases the ability of human modification and habitation of the environment (Landres et al. 2015).

4. Solitude or Primitive and Unconfined Recreation

Section 2(c) of the Wilderness Act states that wilderness has "*outstanding opportunities for solitude or a primitive and unconfined type or recreation*." These attributes can be defined as followed:

- Solitude refers to few encounters with other people and opportunities for privacy, isolation, and self-paced activities without the distractions of modern society.
- Primitive recreation has been interpreted as travel though wilderness that relies on personal skill and does not involve mechanization (hiking, walking, horseback riding).
- Unconfined recreation provides the opportunity for self-discovery, exploration, and freedom from societal or managerial controls.

This quality of wilderness can be degraded by aspects that reduce these opportunities, including encounters with other visitors, recreational facilities, management restrictions, and other signs or modern civilization (Landres et al. 2015).

5. Other Features of Value

Other features of values are those attributes of wilderness that are not covered by the other four qualities listed above. These could include paleontological and cultural resources as well as other educational, scientific, scenic, or historical features that add value to the wilderness character of an area. Currently, the Forest Service has not designated any "other features of value" within the study area (USFS 2021a).

3.1.3 Determining Impacts

This analysis considers impacts on wilderness quality from construction and operation. Construction impacts include impacts during construction that would detract from the wilderness character in the study area, taking into account visual, noise, and other effects of human activity associated with the construction of the project, individually and cumulatively. Operational impacts include permanent or long-lasting impacts that would detract from the wilderness character in the study area, taking into account visual, noise, and other effects of human activity associated with the operation of the project, individually and cumulatively.

For the evaluation of impacts in this chapter, impacts are considered significant, as follows:

- Significant Impact: Impacts would be considered significant if the project would substantially increase trammeling in the Alpine Lake Wilderness, reduce naturalness, increase development, or reduce opportunities for solitude and unconfined recreation.

3.2 Regulatory Context

Wilderness character within the study area is protected by a variety of federal laws, plans, and policies that promote the preservation of wilderness character. The applicable laws and policies are listed in Table 3-1.

Table 3-1. Regulations and Guidelines Applicable in the Study Area

Program, Plan, or Policy	Description
Wilderness Act 1964 (43 CFR Part 19)	The Wilderness Act created the National Wilderness Preservation System and provides the highest level of conservation protection of federal lands. The purpose of the Act is to manage wilderness areas to preserve and, where possible, to restore their wilderness character.
National Wilderness Preservation System	Designates more than 111 million acres of protected wilderness areas in the United States for enjoyment of the public.
Alpine Lakes Area Management Act of 1976 (Public Law 94-357)	This act designated the wilderness, an intended wilderness, and a management unit. This legislation recognized that there were valid existing rights within the area, which included the Eightmile Dam and other properties.
Alpine Lakes Area Land Management Plan 1981 (USFS 1981)	This plan provides direction for management of the Alpine Lakes Wilderness for recreation and economic utilization of the forest by present and future generations.
Alpine Lakes Wilderness regulations and restrictions	Describes regulations for recreation within the Alpine Lakes Wilderness, including, permit information, group size limitations, trail use, equipment restrictions, restoration areas, dog use and stock, camping, and fire restrictions.

3.3 Affected Environment

This section describes the existing wilderness character of the study area.

The Alpine Lakes Wilderness covers a 414,322-acre area in the North Cascade mountains that is dominated by a mix of forest zones, subalpine meadow communities, and alpine communities (Wilderness.net. 2022; Franklin and Dyrness 1973). It encompasses the headwaters of Icicle Creek, as well as several lakes and tributaries. In addition to Eightmile Lake, the lakes include Upper and Lower Snow Lakes, Nada Lake, Colchuck Lake, Klonaqua Lakes, and Square Lake. The tributaries to Icicle Creek include Eightmile, French, Leland, and Snow creeks. Of these, only Eightmile Creek is within the study area (Figure 3-1).

3.3.1 Wilderness Character

The existing wilderness character is described below in terms of the principal qualities of wilderness described in the Wilderness Act of 1964: untrammeled, natural, undeveloped, opportunities for solitude or primitive and unconfined recreation (Landres et al. 2015). Because no other features of value have been identified, no analysis is provided for "other features."

Untrammeled

The Alpine Lakes Wilderness is affected by historic and current trammeling actions and impacts. There are six other lakes with dams not including Eightmile Lake. In addition, 40 percent of the lakes have been stocked with game fish, many of which were previously fishless (USFS 2021a).

Eightmile Lake is considered a "high lake," which means it was created by tectonic activity and glaciers and is in the high mountains. Past trammeling activities at Eightmile Lake include operation of the dam to manipulate the water storage and flow, and stocking the lake with fish. Manipulation of water levels during summer months is ongoing. The lake is no longer restocked with fish.

The dam was installed in 1929 to store water and release it as needed for use downstream for irrigation. Water levels are highest in the spring and early summer as the snow melts. Water is released in late summer and early fall. Water levels reach their lowest levels during drought periods.

The level of the lake is controlled by an outflow pipe that was installed beneath the dam and by the elevation of the spillway. Flow through the outflow pipe is shut off to force the lake to fill, then opened to release water as needed. The elevation of the intake for the outflow pipe establishes the lower limit that the lake level can be controlled without pumping. As currently configured, the lake covers approximately 41 acres at this low water level. Because of the geology, water can continue to seep and the lake can drop even lower. There is no exact record of the high-water elevation prior to construction of the dam. As originally designed at elevation 4,671 feet, the lake would cover approximately 81 acres at high water. After the dam was constructed, stop logs were placed in the dam each spring to raise the lake to elevation 4,671 feet, to store water for release later in the summer (Anchor QEA 2018a). However, erosion of the dam and current water management restrict the maximum water level to elevation 4,667 feet, which limits the maximum lake area to approximately 77 acres (Anchor QEA 2018a).

Maintenance at the dam includes the removal and burning of naturally occurring woody debris that accumulates near the dam. This maintenance occurs on the Special Warranty Deed parcels and typically includes the use of mechanized equipment such as chainsaws, and helicopter use for access to the site.

Eightmile Lake was previously stocked with trout, a manipulation of the environment for human use. Prior to the introduction of sport fish, Eightmile Lake likely lacked suitable spawning habitat or

productive conditions for rearing juveniles, and like the majority of the high lakes, probably contained no fish (Wydoski and Whitney 2003). However, fish stocking has not occurred at the lake since 2005 (WDFW 2021a). Therefore, the only effect of this trammeling is the continued presence of trout in the lake.

The dam is a form of human manipulation of the water level and flow that existed prior to the establishment of the Alpine Lakes Wilderness, and its continued use is authorized by the Special Warranty Deed (refer to Chapter 2 for discussion of current operations). Assuming the dam was constructed no higher than the existing lake, the primary manipulation is that the dam slows the release of water in late spring and early summer, and increases flows during the drier months of late summer and early fall. These water level changes are often apparent by the "bath tub" ring left from when the water was held at a higher level. As noted, however, the condition prior to construction is not precisely known, in which case the trammeling may include an increase in the lake level.

Natural

The natural character of the Alpine Lakes Wilderness is largely preserved but has been disturbed by human activity, particularly camping and hiking that affect vegetation in high use areas. Within the Eightmile Creek Subbasin, there has been recent change due to wildfire (USFS 2021a). The Jack Creek Fire of 2017, started by a lightning strike, was a natural event that altered the character of the area surrounding Eightmile Lake (USFS 2017a). Prior to the fire, the area was dominated by conifer trees; the area is now dominated by snags, with surviving confers interspersed throughout the burned area. Several rare, sensitive, threatened, and endangered species are present in the study area, as discussed in Chapter 8, *Plants and Animals.*

The Alpine Lakes Area Land Management Plan established standards to protect the natural conditions and wilderness character of the area, as well as protection for the visitor experience (USFS 1981). These standards include locating recreational facilities such as trails and campsites in areas that minimize impacts on key interest features (lake and stream edges, scenic meadows, cultural sites, etc.) and sensitive areas; prohibiting the construction of permanent structures in areas that would detract from the natural landscape; and reducing the impacts of temporary man-made structures on the landscape by ensuring their designs incorporate natural form, lines, color, and textures.

As discussed under the "untrammeled" quality, the natural quality of wilderness character in the study area has been affected by the installation of the dam, which alters the lake's water levels, and the historic stocking of the lake with trout.

Storing and releasing water in Eightmile Lake differs from the natural condition, but fluctuation of the water level is not new. Similar to other undammed lakes in the wilderness, the water level of Eightmile Lake likely fluctuated before it was dammed due to normal variation in rainfall and snowmelt. After installation of the dam, seasonal water level fluctuation continued, but the maximum level has been held until later in the summer, with the water level falling more slowly than in the natural condition. Due to the rocky shoreline, manipulation of water levels has generally not affected shoreline vegetation. One exception is at the west end of the lake. With the current lake full water level (elevation 4,667 feet) being lower than it may have been prior to the installation of the dam and to which the lake level was raised each spring after dam installation (elevation 4,671 feet), a lacustrine wetland has formed in the shallow and relatively flat area at the west end of the lake opposite from the dam, in an area that may have been open water at high water in the time before the dam was built, and which was inundated in the spring each year after the dam existed until it was eroded. Because existing dam affects the lake water level and flow downstream, Eightmile Lake and Eightmile Creek are not free from the effects of modern society.

Trout were not native to the lake but continue to inhabit it. Although fish are no longer stocked in the lake, these introduced fish still live in the lake and will likely persist there because the habitat to support them is intact. The fact that fish still live in the lake means the lake is not free from the effects of modern society, although in this case, the current condition may be sustainable without human intervention.

Recreational use has also affected the natural ecosystem. The Enchantment Permit Area, which includes Eightmile Lake, experiences heavy summer use by hikers and campers, and degradation of the natural conditions has been a concern for many years (USFS 2017b). Concerns include devegetation of camping and day use areas from trampling and associated soil erosion and compaction and improperly disposed of human waste, with associated impacts on water quality. Within the Okanogan-Wenatchee National Forest, some areas are closed for restoration to give the natural vegetation an opportunity to recover after years of heavy recreational use. Camping and walking in restoration areas are prohibited (USFS 2021b). At least one area near the northeastern shoreline of Eightmile Lake is closed for restoration.

Undeveloped

The Alpine Lakes Wilderness is largely undeveloped, as are Eightmile Lake and Eightmile Creek. The primary "imprint of man's work" evident throughout the Alpine Lakes Wilderness is the presence of Forest Service-maintained trails and trail signs, primitive latrines, and dispersed camping areas created by use. Campsites are unimproved, except for visitor improvements such as log or rock benches (USFS 2021c). Along the north side of the lake, just west of the Special Warranty Deed parcels, primitive campsites are available, and a limited number of Alpine Lakes Enchantment Permits are available for overnight use (see Chapter 10, *Recreational Resources,* for more information).

Within the Special Warranty Deed parcels, the project area is primarily undeveloped, except for the dam and associated communications devices. The dam covers less than a quarter of an acre and is composed of native rock, weathered concrete, and soil. It blends into the natural landscape when viewed from a distance. From the upstream side of the dam, which includes any views from the Eightmile Trail and the camp site, the dam structure is most prominent when water levels are low. When the lake is at its highest, a 4-foot-high portion is visible from the lake side, and that is often partially obscured with wood debris that accumulates near the dam. The most pronounced views are those from adjacent to the dam, which can be accessed by a spur trail. This trail and the dam are a common destination for day hikers. See Chapter 11, *Visual Resources*, for additional information about visual impacts, including visual simulations.

Emergency repairs to the dam in 2018 required the use of an excavator that was flown in by helicopter. Near the dam, evidence of the recent repairs to the dam are noticeable due to lighter colored rock on the armored embankment that has not yet weathered, and the presence of the excavator, which remains near the dam. (See Chapter 1 for additional information about the history of the dam.) Trees are not allowed to grow on the armored embankment to protect the integrity of the dam.

The dam does not include any motorized components, and the site is not accessible by motor vehicles. Motorized transport, including by helicopter, is prohibited in the wilderness with limited exceptions. The Forest Service has approved the use of helicopters for servicing six vault toilets in the Alpine Lakes Wilderness, which results in approximately 13 trips annually throughout the wilderness. The Forest Service has also allowed IPID to inspect its four dams using helicopter access, which has historically resulted in one trip annually. However, since the Jack Creek Fire in 2017, more than one trip per year has been required to inspect the Eightmile Lake Dam (personal communication, A. Jantzer 2021). These are all flights that include landing in the wilderness, and

would result in approximately 15 minutes of flight time each. IPID also occasionally flies over its dams to inspect them from the air, an activity not regulated by the Forest Service.

During extreme conditions, IPID has considered pumping water for irrigation supply; however, this option is only rarely considered due to the high cost of transporting pumps and fuel, and operation of pumps in such a remote location, as well as helicopter availability to transport equipment.

Other permanent human features within the Special Warranty Deed parcels include water level monitoring structures, the trail, recreational signs, and a backcountry latrine.

Solitude or Primitive and Unconfined Recreation

The Alpine Lakes Wilderness provides ample opportunity for solitude in its remotest areas. The Alpine Lakes Wilderness provides numerous opportunities for primitive and unconfined recreation, including hiking, backpacking, rock climbing, and fishing. No mechanized travel is allowed with the project area, and only primitive campsites are present. Helicopters are permitted in wilderness areas for authorized use only, including emergency situations, latrine transport, and FS approved operations. However, the Enchantment Permit Area is heavily used during summer months, and there are no restrictions on day use. Because of the relatively short distance to Eightmile Lake from the trailhead, day use is heavy, and campsites are nearly always fully reserved through the summer. Due to the popularity of day use, encounters with other groups are common, as are the sights and sound of others camped in the area (USFS 2022). See Chapter 10, *Recreational Resources,* for additional detail on recreational use.

The Forest Service has analyzed travel encounter data for each Wilderness Recreation Opportunity Spectrum (WROS) classification in the Enchantment Permit Area. WROSs are defined in the 1981 Alpine Lakes Area Land Management Plan and include four zones: transitional, semi-primitive, primitive, and trailless. The Eightmile Lake Trail, Snow Lakes Trail, and a portion of the Stuart Lake Trail are all transitional zones of the Enchantment Permit Area. The transitional zone has the lowest expectation of solitude and is usually located adjacent to major trailheads, where users make the transition from motorized to horse or foot travel and are first introduced into the wilderness. The Forest Service found that daily group encounters within this zone average 54 group encounters per day (USFS 2017b). See Chapter 10, *Recreation* for a description of other recreational zones within the Enchantment Permit Area.

Winter recreation within the project area is extremely limited due to the seasonal closure of FSR 7601 and the weather conditions of the area. The low number of users during this time of year indicates that opportunities for solitude are available.

Operation of the existing dam includes occasional trips by IPID personnel to the site to adjust the flow in the outlet pipe, to clear floating debris from the inlet and dam spillway, and other tasks, which often include the use of handheld motorized equipment, such as chainsaws. These activities occasionally include the use of a helicopter for access. When woody debris is removed, it is typically stacked and burned in the fall after the first snow. As described in Chapter 2, emergency repairs to the dam in 2018 were completed with use of an excavator, which has remained on-site since that date, in anticipation of future replacement of the dam. These types of activities affect solitude at the site and are retained rights under the Special Warranty Deed.

Other Features of Value

As previously noted, the Forest Service has not designated any other features of value within the study area (USFS 2021a).

3.4 Construction Impacts

This section describes how construction would affect wilderness qualities. It references other sections of this EIS for specific impacts including noise, water, recreation, and others. This section examines two options for transporting and staging construction materials, as well as the impacts on wilderness character from construction under the various dam alternatives.

The use of a Special Warranty Deed by IPID provides them retained rights that allow the use of motorized transportation, including aircraft and motorized equipment required to repair or maintain the dam, that would otherwise be prohibited by the Wilderness Act. Although authorized under the Wilderness Act [Section 4(c)], they can adversely affect wilderness qualities.

3.4.1 No Action Alternative

Under the No Action Alternative, no construction would occur; therefore, there would be no construction impacts on wilderness character. There would be a risk of dam failure, which could lead to additional emergency repairs. In addition, if DSO were to exercise enforcement action in accordance with WAC 173-175-620(3), impacts like those described for construction would occur. Abatement would likely require the use of helicopters for access. The duration of removal activities would be substantially shorter than for construction of any of the action alternatives.

3.4.2 Dam Construction

Construction Activities Common to All Action Alternatives

For any of the action alternatives, all construction, construction staging, and camping by personnel at the project site would occur within the Special Warranty Deed Area. Site preparation would begin as soon as permits for the project are issued, and snow conditions allow. Personnel would walk to the site using the Eightmile Lake Trail, both within the Alpine Lakes Wilderness and outside of it. Up to six construction personnel would camp at the project site for the duration of construction. Inspectors and other personnel would make day hikes to the site periodically throughout construction.

A staging area would be established next to the existing dam. This would require temporary relocation of the Eightmile Lake Trail to ensure hiker safety near the active construction zone (see Figure 2-13). Site preparation would include the installation of temporary erosion controls, clearing and leveling of the staging area (including removal of up to 30 trees and all ground cover), and removal of wood and debris from the lake edge within the work area. Excess limbs and wood debris would be burned on-site in accordance with Forest Service protocols.

The lake level would be lowered to allow removal of the existing dam and outflow pipe. Cofferdams made of large bulk bags would be used to constrict water flow, and pumping would be necessary to keep the construction area dry.

Excavators and other equipment such as boulder busters would be used to move rock and earth to construct the dam. Based on geologic information collected to date, blasting with explosives is not expected to be needed for the project. However, because there is still a possibility of encountering rock that is larger than the excavator can move or break up, blasting is being covered in this EIS as a contingency. If needed, blasting with explosives would occur in a single day, involve a temporary trail closure, and generate a high level of noise for a brief period during the day of blasting. A blasting contractor would be called in, likely taking at least one week to schedule. The Forest Service would be notified, and safety measures would be put in place to prevent wilderness users from being injured by blasting. Safety measures would include excluding users from the area near the

construction, and use of blasting mats to prevent flyrock, and limit noise and dust. Blasting with explosives is an allowed use in a wilderness.

Access would also include helicopter flights from a fly yard outside of the Alpine Lakes Wilderness to the project site. Section 3.4.3 discusses two options for helicopter use.

After construction of the dam, the staging area and other areas disturbed during construction will be restored with native vegetation. The trail detour would be closed and restored, and the trail routed back to its current location.

Construction would adversely affect all four qualities of wilderness character. Construction would increase human intervention in the landscape (trammeling); alter natural conditions (lake level, streamflow, vegetative cover); increase the area that appears developed; and affect the solitude of recreationists for an entire summer season, with the possibility of extending into a second season.

Construction Activities that Differ Among Action Alternatives

A larger staging area would be required to construct Alternative 2 than would be required for Alternatives 1 and 3, because Alternative 2 requires a larger quantity of concrete and materials. Figure 2-13 shows the staging area and possible trail relocation alignments. While blasting with explosives could occur with any action alternative, the likelihood of blasting may be slightly greater under Alternative 2 because the dam structure is larger and more excavation is required.

Potential construction impacts on wilderness character for all action alternatives are summarized in Table 3-2.

Table 3-2. Summary of the Effects of Dam Construction on Wilderness Character, by Alternative

Wilderness Quality	Alternatives 1 and 3	Alternative 2
Untrammeled	Lowering of lake level for the entire construction season.	Lowering of lake level for the entire construction season.
Natural	Removal of trees, stumps and ground cover for staging area and relocated trail. Leveling of staging area, some of which was previously modified to build the dam. Staging area up to 8,500 square feet in area. Tree and ground cover removal required for staging would have a minor effect on habitat. Lowering lake during dam construction would have a minor effect on habitat in Eightmile Creek. Approximately 20 to 25 trees (and stumps) removed.	Similar to Alternatives 1 and 3, but larger staging area (up to 10,000 square feet) means up to 30 trees removed and a larger area leveled.
Undeveloped	Eightmile Lake Trail would be temporarily moved, then restored after construction. Does not require any permanent improvement or habitation except that the 8,500-square-foot staging area would be leveled and remain so. Clearing for staging area could mean that the dam is more visible from the trail until vegetation grows back. Temporary cofferdam	Similar to Alternatives 1 and 3 but with a larger staging area (up to 10,000 square feet) and a longer duration of activities.

Wilderness Quality	Alternatives 1 and 3	Alternative 2
Undeveloped	would be visible from trail and lakeshore, including the campsites. Site restoration would remove all construction equipment and include replanting disturbed areas.	
Solitude or Primitive and Unconfined Recreation	Temporary and localized adverse effects on solitude due to noise intrusion from construction equipment, including helicopters (7 a.m. to 6 p.m.), excavators, and other equipment. Minor increase in human presence with construction staff camped near and working at the dam throughout construction. Recreationists would be prohibited from entering the dam area throughout construction. If blasting is required, the Eightmile Lake Trail would be closed for several hours, until the blasting has been completed. Noise would adversely affect solitude, and recreation would be restricted for the day of blasting.	Similar to Alternatives 1 and 3 but with a longer duration of activities due to larger scale of dam, but construction is not anticipated to last more than one season.

Helicopter Transportation Options

Most materials would be transported to a staging area at the project site by helicopter from a fly yard outside of the Alpine Lakes Wilderness. The size of the helicopter used would affect the number of trips and size of the staging area needed because the larger helicopter would deliver more materials to the site, initially requiring more on-site storage than the smaller helicopter, which would deliver materials throughout the course of construction. See Chapter 2, *Project Alternatives* for more details on the helicopter use options and their impacts on the size of the staging area. Regardless of the size of helicopters used, for the summer of construction, this would mean a substantial increase in helicopter trips as compared the current level of helicopter use. Two options for helicopter access are described below, and their impacts are summarized in in Table 3-3.

Option 1. Heavy-lift Helicopter with Limited Use of Small Helicopter Throughout Construction

Under this option, to minimize the total number of helicopter trips, a heavy-lift helicopter would be used. Most of the materials and all equipment needed would be transported over a 3– to 5-day period (8-hour days) in June or July as soon as snow conditions would allow. Between 70 and 105 round-trip flights to the site are anticipated (approximately 20 flights per day), with the larger number required for construction of Alternative 2. After the initial week, a smaller helicopter would be used for approximately 20 flights periodically throughout construction to transport supplies such as heavy materials that were not anticipated, and latrine servicing. A heavy-lift helicopter would be used again at the end of construction. The heavy-lift helicopter would conduct approximately 11 flights over a 2-day period to remove material and equipment. In total, approximately 5 to 7 full days of heavy-lift helicopter activity are anticipated with this option, along with up to 20 individual flights with the smaller helicopter (approximately two flights per week) over the construction period.

Because most materials would be brought in at once, this option requires the largest staging area (8,500 to 10,000 square feet, with the larger area required for Alternative 2). This would require the

removal of approximately 30 trees (for the largest staging area), which would be a minor effect on the natural quality and would not reduce ecological functions. Because the staging area would be conspicuous from the trail and contain materials and equipment, it would adversely affect the undeveloped quality of wilderness.

Helicopter noise would adversely affect the solitude quality of wilderness, not just at the site but through other portions of the Enchantment Permit Area, primarily in the Stuart and Colchuck Zones. The heavy-lift helicopter would cause louder noise than a small helicopter. This option would cause higher noise levels (affecting a larger area) but over a shorter duration that Option 2. Noise impacts are described in greater detail Chapter 9, *Noise*.

Option 2. Limited Use of Heavy-lift Helicopter with Small Helicopter Use for the Majority of Materials

Under Option 2, supplies would be brought to the site in stages as the project progresses, rather than all at once in the beginning. In the first 2 days, items that cannot be delivered by smaller helicopter (such as heavy equipment and a portion of the materials) would be delivered by heavy-lift helicopter, approximately 20 flights over two 8-hour days. The remainder of supplies would be delivered by smaller helicopter, spread out over the 4-month construction period–an additional 242 flights, over twelve 8-hour days (approximately 20 trips per day). A heavy-lift helicopter would be used again at the end of construction. The heavy-lift helicopter would conduct approximately 11 flights over a 2-day period to remove material and equipment. In total, approximately 4 full days of heavy-lift helicopter activity and 12 full days of small helicopter activity are anticipated with Option 2.

This option would allow a smaller staging area than Option 1 because materials would be brought to the site in stages, rather than having to be stored on-site from the beginning. The staging area for Option 2 would be approximately 15 percent smaller than the staging area needed for Option 1, as shown in Figure 2-13. An estimated 20–25 trees would be removed, fewer than under Option 1 and therefore less of an impact on the natural quality of wilderness. Being smaller than the staging area for Option 1, the staging area for Option 2 would also be less conspicuous and therefore less of an impact on the undeveloped quality.

Noise levels would not be as great under Option 2 as Option 1 (see Chapter 9, *Noise*). However, Option 2 would involve up to 9 more days of helicopter use than Option 1, which would be a greater impact on solitude.

Table 3-3. Comparison of the Effects of the Helicopter Transportation Options 1 and 2 on Wilderness Character

Wilderness Quality	Option 1. Heavy-lift Helicopter with Limited Use of Small Helicopter Throughout Construction	Option 2. Limited Use of Heavy-lift Helicopter with Small Helicopter Use for the Majority of Materials
Untrammeled	No effect.	No effect.
Natural	Requires the largest staging area and more tree and ground cover removal than Option 2. Minor impact on natural quality.	Similar to Option 1 but roughly 15% smaller staging area and less tree and ground cover removal.
Undeveloped	Staging area would larger than for Option 2 and be conspicuous from the trail. Minor impact on undeveloped quality.	Staging area would be smaller and less conspicuous from the trail than Option 1. Minor impact on undeveloped quality.

Wilderness Quality	Option 1. Heavy-lift Helicopter with Limited Use of Small Helicopter Throughout Construction	Option 2. Limited Use of Heavy-lift Helicopter with Small Helicopter Use for the Majority of Materials
Solitude or Primitive and Unconfined Recreation	Temporary and localized adverse effects on solitude due to noise intrusion. Higher noise level for initial transport of materials than for Option 2, but for only 3 to 5 days due to the larger size of the helicopter. An estimated 11 heavy lift helicopter trips will be required at the end of the project.	Similar to Option 1, but with lower helicopter noise level, and material transport lasting for 9 days more than Option 1, due to the smaller size of helicopter. An estimated 11 heavy lift helicopter trips will be required at the end of the project.

Summary of Construction Impacts

Construction of the project would adversely affect wilderness character. Clearing, grading, transporting materials using helicopters, and using heavy equipment and power tools would temporarily increase human intervention (trammeling), alter natural conditions, increase the area that appears developed, and affect the solitude of recreationists over one entire summer season. Blasting with explosives is not expected to be necessary and is not prohibited in the wilderness. It is covered in this analysis as a contingency because, if it occurs, it would further affect solitude and recreation.

None of the action alternatives would significantly impact wilderness qualities due to the limited scale and duration of the project. Alternatives 1 and 3 would have slightly fewer impacts than Alternative 2 because of the difference in staging area size, and the longer duration of construction for Alternative 2. Helicopter use under either option would be an increase from normal helicopter use in the wilderness, and would be noticeable by visitors during the construction season, but neither would constitute a substantial change in wilderness quality because of the limited duration.

3.5 Operational Impacts

As described in the introduction to this chapter, IPID has the right to maintain and operate the dam and exercise their water rights within their Special Warranty Deed Area within the Alpine Lakes Wilderness. Permanent changes to the dam itself and lake levels would be visible from locations outside of the Special Warranty Deed Area.

3.5.1 No Action Alternative

Under the No Action Alternative, the dam would be left as is and would continue to operate in its current state and manner. DSO currently requires IPID to leave the low-level outlet gate open during the winter and early spring to reduce the risk of a dam failure. DSO considers the dam to have a high risk of failure in the event of a large storm.

Under the No Action Alternative, the existing dam would be left as is (Figure 2-1), and it would continue to operate in its current state and manner, with no change to operating water levels (Figures 2-2 and 2-3). The DSO considers the dam vulnerable in the event of a large storm. Operation of the dam under existing conditions is not consistent with DSO regulations, so the DSO would eventually exercise enforcement action in accordance with WAC 173-175-620(3) to reduce the downstream risks. However, it is not possible to predict with certainty what that action or its effects would be. DSO currently requires IPID to leave the low-level outlet gate open during the winter and

early spring to reduce the risk of a dam failure. Consequently, for purposes of this EIS analysis, it is assumed that the existing state of the dam and its operation remains unchanged.

If the dam is not replaced and does not fail, there would be no change in wilderness character compared to existing conditions, until DSO took enforcement action in accordance with WAC 173-175-620(3). The dam has stood for nearly 4 years since it was repaired in 2018 and could stand for several more years without failing. However, if the dam is not replaced, it is certain that DSO would proceed with enforcement, and dam failure could occur before the dam is removed.

Should a dam failure occur, habitat downstream within the wilderness area would be damaged or destroyed, affecting the wilderness character. The degree of damage within the Alpine Lakes Wilderness would depend on the scale of the failure, but in the worst case, severe damage would occur to riparian vegetation downstream of the dam. Partial or total dam failure could result in debris torrents that cause severe channel scour (potentially to bedrock), denude riparian areas, deposit large volumes of sediment, cause widespread flooding, and potentially lead to debris jams and stream avulsions. In the worst case, if the entire dam and low-level outlet pipe were to fail, the lake level would fall by approximately 25 feet, dropping the high-water level approximately to the current low-water level. In summer months, the lake would likely dry out and shrink further. Substantial portions of Eightmile Lake and Little Eightmile Lake would likely become streambeds with no riparian cover until the ecosystem was able to recover, which could take years or decades. The worst-case failure would also likely leave dam debris such as the low-level outlet pipe scattered downstream.

Should IPID be required to remove the dam, the lake level would be lowered gradually, and the structure and low-level pipe would be excavated and removed. The resulting lake high-water level would fall by approximately 25 feet, dropping the high-water level approximately to the current low-water level. In summer months, the lake would likely dry out and shrink further.

Table 3-4 summarizes the effects on the qualities of wilderness character of each of these possible scenarios under the No Action Alternative.

The No Action Alternative would likely adversely affect wilderness character regardless of which scenario, failure or removal, occurs.

Table 3-4. Summary of the Effects of the No Action Alternative on Wilderness Character

Wilderness Quality	Failure Scenario	Removal Scenario
Untrammeled	Failure may or may not remove the entire dam structure, but any remaining parts would likely be required to be removed later by DSO. No further manipulation of water levels would occur, reducing trammeling.	With restoration of vegetation after removal, the dam site would appear less trammeled. No further manipulation of water levels would occur. The lowering of the lake due to dam removal may be seen as a trammeling, because the original lake level was higher. However, this scenario would also eliminate human intervention in lake levels, thus reducing trammeling.
Natural	Damage from initial failure to downstream habitats, and changes in lake shoreline due to lowering of lake level. Streamflows in summer would be lower.	Changes in lake shoreline habitats from lowering of lake level. Streamflows in summer would be lower.

Wilderness Quality	Failure Scenario	Removal Scenario
	Eventually, ecological equilibrium would likely return. Natural quality would not be substantially changed in the long term.	Eventually, ecological equilibrium would likely return. Natural quality would not be substantially changed in the long term.
Undeveloped	Failure may or may not remove all of the dam structure. Any remaining portions would be more conspicuous due to lower water level. Debris from the dam could be scattered downstream. Removal could improve the undeveloped quality, but dam remnants or debris would detract from this quality.	Reduced appearance of human manipulation since dam would be removed. Removal would improve the undeveloped quality.
Solitude or Primitive and Unconfined Recreation	No change or possible minor effect to the solitude or primitive and unconfined recreation quality.	No change or possible minor effect to the solitude or primitive and unconfined recreation quality.

Impacts from the No Action Alternative on wilderness character would not be significant. The No Action Alternative would have adverse impacts on the qualities of wilderness character. However, it would not substantially increase the degree of overall impact on the wilderness. If the dam were to fail or be removed, it would reduce trammeling, a benefit to wilderness quality.

3.5.2 **Alternative 1: Narrow Spillway with Gates**

Under Alternative 1, the dam would be replaced with a new, larger concrete dam with gates that could be raised and lowered mechanically using remote control. The gates would use a motor to inflate a bladder when they are raised and would deflate passively by opening a valve. The gate-bladders would be used to raise the lake water level during late spring with the last freshets. The high-water level with the gates up would make the lake approximately 81 acres in area, a 6 percent increase in size when compared to the existing lake full level. In an average year, the deeper lake and remote control would allow IPID to meet its water needs with more targeted and controlled releases than occurs under current management.

This alternative would also have an outlet that is 4 feet lower than the existing low-level outlet. Therefore, in drought years, the lake could be drawn down further than at present. At low WSEL without pumping, the lake could be approximately 2 acres (approximately 6 percent) smaller than the lake would be with the existing low-level outlet.

The dam would have 15-foot-wide concrete intermediate spillways on the north and south flanks of the primary spillway. There would also be a smaller secondary spillway to the south of the dam. The spillway would be armored and would be maintained clear of any trees for the life of the project.

Table 3-5 summarizes the effects on the qualities of wilderness character of the Narrow Spillway with Gates Alternative.

Table 3-5. Summary of the Operational Effects of Alternative 1 on Wilderness Character

Wilderness Quality	Alternative 1: Narrow Spillway with Gates
Untrammeled	Manipulation of water levels would continue in a similar manner as at present. The footprint of the dam would be similar to the existing dam including armored embankment but would also include the secondary spillway to the south of the dam (see Table 2-1).
Natural	Manipulation of water levels would continue in a similar manner as at present, with some benefit to downstream habitat. Change in wetland habitat at west end of lake with higher water level. These changes would not substantially change the natural quality.
Undeveloped	The dam structure would be more conspicuous, with prominent wing walls and not made with native stone as portions of the current dam are. Operation of the inflatable gates on the dam would require a motor. Trees would need to be suppressed on both spillways. These features would reduce the undeveloped quality near the dam.
Solitude or Primitive and Unconfined Recreation	Use of motor for inflatable gates would generate noise that could affect a sense of solitude if it occurred when people are present. Inflation of the gates is expected to occur at least once each year, but not likely more than once per year. No substantial change in solitude or primitive and unconfined recreation quality.

Impacts from this alternative on wilderness character would not be significant. Alternative 1 would have adverse impacts on all four qualities of wilderness character. However, all of these effects are similar to the effects of current operations and do not substantially increase the degree of overall impact on the wilderness.

3.5.3 Alternative 2: Wide Spillway without Gates

The dam would be operated in the same manner as described for Alternative 1: Narrow Spillway with Gates; therefore, impacts related to water level would be the same. Alternative 2 would include a 180-foot-wide spillway made of concrete, but it would be mostly obscured by an armored embankment on both sides. Vegetation on the downstream embankment would be allowed to grow but be kept clear of trees. Similar to Alternative 1, there would be a secondary spillway to the south of the dam that would be armored and be kept clear of trees for the life of the project.

Table 3-6 summarizes the effects on the qualities of wilderness character of the Wide Spillway without Gates Alternative.

Table 3-6. Summary of the Operational Effects of Alternative 2 on Wilderness Character

Wilderness Quality	Alternative 2: Wide Spillway without Gates Alternative
Untrammeled	Manipulation of water levels would continue in a similar manner as at present.
Natural	Manipulation of water levels would continue in a similar manner as at present, with some benefit to downstream habitat. Changes in wetland habitat at west end of lake with higher water level. The natural quality would not be substantially affected.

Wilderness Quality	Alternative 2: Wide Spillway without Gates Alternative
Undeveloped	Undeveloped quality would be reduced because the dam would be more conspicuous due to the wider dam and cleared area for the spillways. Trees would need to be suppressed on both spillways. The concrete portion would be more visible than the current condition but less conspicuous than under Alternative 1, because most of it would be covered with rock and earth.
Solitude or Primitive and Unconfined Recreation	No substantial change in solitude or primitive and unconfined recreation quality.

Impacts from Alternative 2 on wilderness character would not be significant. Like Alternative 1, Alternative 2 would have adverse impacts on the qualities of wilderness character. However, these effects are similar to the effects of current operations and do not substantially increase the degree of overall impact on the wilderness.

Alternative 2 would have a larger overall footprint than Alternative 1, but the armored embankment would obscure more of the concrete portion of the dam, with the result that the dam would blend in visually from a distance more than Alternative 1.

3.5.4 Alternative 3: Narrow Spillway without Gates

The dam would be operated in a similar manner as described for the other action alternatives, but this alternative would keep the maximum lake level the same as at present. Otherwise, impacts related to water levels would be the same.

Table 3-7 summarizes the effects on the qualities of wilderness character of the Narrow Spillway without Gates Alternative.

Table 3-7. Summary of the Operational Effects of Alternative 3 on Wilderness Character

Wilderness Quality	Alternative 3: Narrow Spillway without Gates Alternative
Untrammeled	Manipulation of water levels would continue in a similar manner as at present. The footprint of the dam would be similar to the existing dam including armored embankment but would also include the secondary spillway to the south of the dam.
Natural	Manipulation of water levels would continue in a similar manner as at present, with some benefit to downstream habitat. These changes would not substantially change the natural quality.
Undeveloped	The dam structure would be more conspicuous, with prominent wing walls and not made with native stone as portions of the current dam are. Trees would need to be suppressed on both spillways. These features would reduce the undeveloped quality near the dam. This alternative would not have inflatable gates and therefore would have slightly less impact on the undeveloped quality than Alternative 1.
Solitude or Primitive and Unconfined Recreation	No substantial change in solitude or primitive and unconfined recreation quality.

Impacts from Alternative 3 on wilderness character would not be significant. Like Alternative 1, Alternative 3 would have adverse impacts on the qualities of wilderness character. However, these

effects are similar to the effects of current operations and do not substantially increase the degree of overall impact on the wilderness.

The dam under Alternative 3 would cover the same area as Alternative 1.

3.5.5 Summary of Operational Impacts

Operation of the project in a manner similar to existing conditions would also adversely affect qualities of wilderness character, although none of the impacts would be significant. The degree of human intervention (trammeling) in the landscape would be similar to existing conditions, but the footprint of the dam and spillways would be larger than at present. Alternative 2 would have the largest human-made footprint. Natural conditions would largely be restored following construction to their present state and would not be further altered by operation, with the exception that trees would not be allowed to grow on the armored face of the secondary dam spillway. All action alternatives would add a human-made element that would be visible to trail users from the lake shore and campsites but not conspicuous, except to those who walk the spur trail to the dam. Alternative 1 would have the most conspicuous human-made elements, but Alternative 2 would have a larger spillway area that would need to be kept clear of trees.

Alternative 3 would be similar to Alternative 1 but would not have one of the more conspicuous mechanical components (gates). (See Chapter 11, *Visual Resources*, for additional information on visual impacts, including visual simulations.)

The No Action Alternative could also affect wilderness character. If the dam is not replaced, it would have to be removed or would likely fail. In either case, the result would be a much smaller lake than existed prior to the dam, but it would also end the trammeling effect of the dam, a benefit to wilderness quality.

3.6 Avoidance, Minimization, and Mitigation Measures

3.6.1 Construction

During construction, impacts on wilderness character can be minimized by the following, to be reflected in the construction plans where applicable:

- Minimize clearing area for staging and construction activities.
- Establish and maintain clear construction boundaries.
- Maintain detour trail around site during construction.
- After construction is complete, restore trail and cleared areas to Forest Service standards, consistent with the Wilderness and Backcountry Site Restoration Guide (Therrell et al. 2006).
- Coordinate with the Forest Service to forewarn visitors of potential disruption of wilderness experience due to construction activities, including notice to people seeking reservations through the lottery and to those awarded reservations.
- Provide signage to alert trail users regarding construction activity, including dates and hours of helicopter use, heavy equipment operation, and blasting.

- Provide a general description of work period and work impacts, including potential areas that will be closed to the public such as the staging and construction areas, prior to the Forest Service lottery for overnight permits in the Enchantment Permit Area.
- Design constructed features to match the natural environment to the extent feasible
- Provide alert of construction on the Forest Service Website for Alpine Lakes Wilderness: Okanogan-Wenatchee.
- Provide notification and signage at the Leavenworth Ranger Station and suggestions of other recreational opportunities in the area.
- Measures to reduce impacts from blasting with explosives include:
    - Minimize trail closure extent and duration.
    - Use blasting mats to reduce noise and dust and prevent flyrock.
    - Limit the Eightmile Lake Trail closure to the segment from the Caroline Lakes Trail Junction westward to the minimum safe distance from the blast location.
    - Identify extent of blast safety zone on a map.
    - Identify camping areas outside of safety zone that can be used during blasting if desired.
    - Provide personnel at Eightmile Lake Trailhead, Caroline Lakes Trail junction, and upper limit of safety area on trail, on the day of blasting.
    - Schedule blasting to minimize impact on trail users:
        - Schedule for midweek (Tuesday through Thursday), and non-holiday (if July 4th falls on a mid-week day).
        - Avoid full-day trail closure by scheduling blasting to occur between 11:00 a.m. and 2 hours before sunset.
    - Allow trail users to use the trail in the morning before blasting or in the evening after blasting.
    - Providing a general description of work period and work impacts, including potential for closure for blasting, prior to the Forest Service lottery for overnight permits in the Enchantment Permit Area (by October 1).
    - Providing description of closure area and timing to Forest Service once known, at least 10 days prior to blasting.
    - Posting notices at Eightmile, Caroline Lake, and Jack Creek trailheads. These notices should be pre-approved by the Forest Service prior to posting.
    - Notifying occupants of campsites on Eightmile Lake the day before blasting that there will be a temporary trail closure.
    - Providing notice, such as a press release, to organizations such as Washington Trails Association, The Mountaineers, Sierra Club, and Alpine Lake Protection Society once schedule is known. The notice should be pre-approved by the Forest Service prior to sending.

3.6.2 Operation

During operation, impacts on wilderness character can be minimized by the following:

- The dam's materials and colors that will visually blend with the landscape around the dam, to the extent feasible, to minimize visual impacts.
- Use the quietest available motor for the inflatable gates.
- Avoid using the motor to inflate the gates at night and on weekends or holidays, to the extent feasible.

3.7 Significant Unavoidable Adverse Impacts

None of the action alternatives would have significant unavoidable impacts on wilderness character when compared to existing dam operations/conditions.

CHAPTER 4: SURFACE WATER RESOURCES

This chapter describes the environmental setting of Eightmile Lake and waterbodies within its area of influence that may be affected by the project. The organization of this chapter addresses each environmental resource separately, including:

- Surface Water Quantity
- Surface Water Quality
- Climate Change, which is a factor that affects both surface water quantity and quality.

For each environmental resource, discussion is provided for the methodology, regulatory context, and impacts associated with the project alternatives as described in Chapter 2. Issues and considerations related to water rights, which are closely tied to surface water resources, are included in Chapter 6, and groundwater resources are described in Chapter 5.

Key Findings for Water Resources

- Given the increased ability to manage reservoir storage and outflow during both drought and non-drought years, the project would improve IPID's ability to adaptively operate the reservoir in response to changes in inflow timing and magnitude, including seasonal drought and adaptive response to climate change.
- Under the action alternatives:
  - Maximum summer flow releases may be increased over 10 percent.
  - Useable storage will increase over 30 percent.
  - A 15 percent increase in drawdown volume would be available.
  - Summer minimum flows would not change without further investigation of leakage from the lake.

4.1 Methodology

Water resources were characterized by reviewing existing studies and data that describe water quantity, water quality, and climate associated with the study area. The Icicle Creek Water Resource Management Strategy FPEIS (Ecology 2019a) is referenced for much of the background information described in this chapter. Additional information sources include published environmental planning documents and design reports by technical experts.

The project site is in the Alpine Lakes area of the Eightmile Creek watershed (Hydrologic Unit Code [HUC] #170200110405) and the Icicle Creek watershed (HUC #170200110406) (**Figure 4-1**). The study area extends between the Eightmile Lake watershed to the confluence with the Wenatchee River (**Figure 4-2**).

Figure 4-1. Alpine Lakes Region and the Eightmile Creek Watershed and Lower Icicle Creek Watershed 12-digit HUC Boundaries

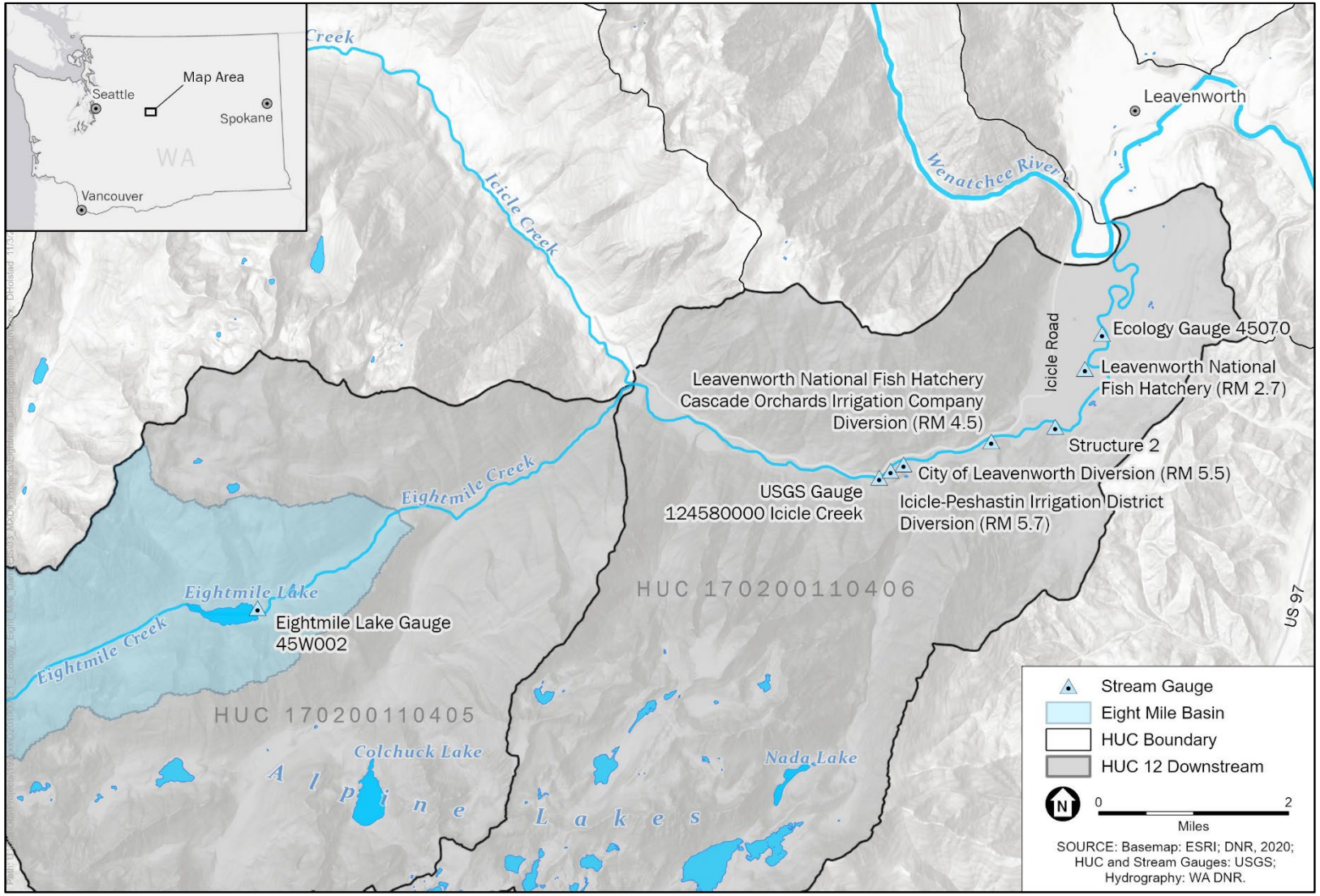
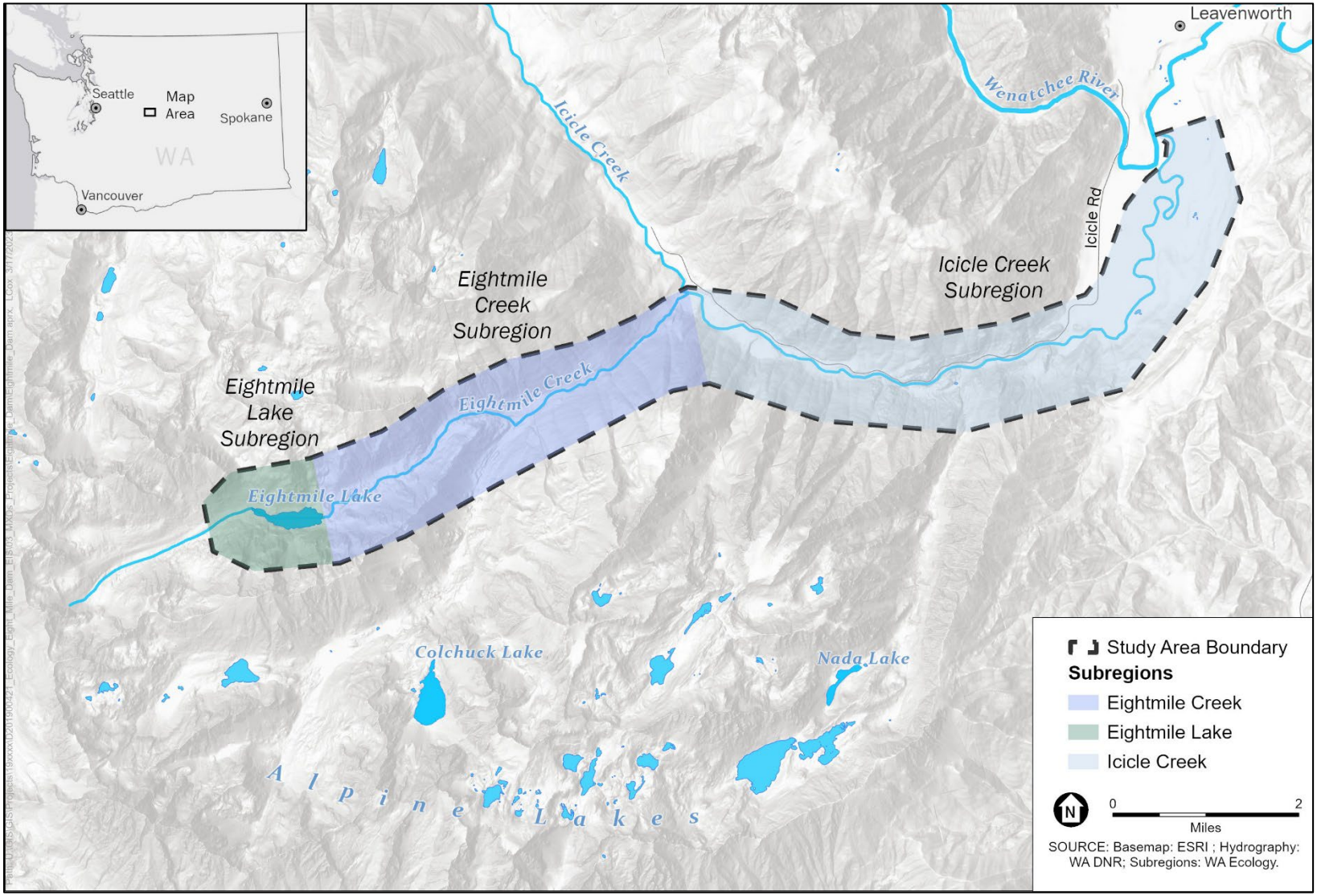


Figure 4-2. Study Area and Subregions for the Surface Water Analysis



The Wenatchee River corridor is not included as part of the surface water study area due to the small relative size of the Eightmile Creek watershed (31 square miles) compared to the Wenatchee River watershed upstream of the Icicle Creek confluence (910 square miles). Potential impacts in the Wenatchee River attributed to changes in surface water hydrology from the Eightmile Lake watershed would be relatively minor, as the contributing streamflow of Eightmile Creek is approximately 1 percent of the total streamflow in the mainstem Wenatchee River. Surface water resources in the watershed above the Eightmile Lake shoreline and Icicle Creek above the confluence with Eightmile Creek would not be affected by the project and are not considered part of the study area for surface water resources.

Resources were evaluated using different spatial extents (subregions) depending on the character of the resource and the extent of reasonably foreseeable project-related impacts (Figure 4-2). The subregions included in this chapter are described below.

- The Eightmile Lake and shoreline subregion encompasses the immediate mountainous region, part of the Alpine Lakes Wilderness, surrounding Eightmile Lake.
- The Eightmile Creek subregion consists of the mainstem of Eightmile Creek from the mouth Eightmile Lake to the confluence with Icicle Creek.
- The Icicle Creek subregion consists of the mainstem Icicle Creek floodplain and valley walls from the confluence with Eightmile Creek at River Mile (RM) 9.0 to the confluence with the Wenatchee River.

Potential impacts from the project alternatives include both short-term impacts related to construction of the action alternatives, and long-term impacts from operation of the dam under the No Action and action alternatives. When federal and state regulations directly relate to the analysis of impacts, the resource sections include a description of the regulatory setting. Section 4.2 includes a summary of federal, state, and local regulations and policies that relate to the project.

Potential significant impacts are defined below; impacts that do not reach these thresholds are considered less-than-significant.

Criteria for Construction Impacts on Surface Water Quantity:

Construction impacts would be significant if a temporary change from typical reservoir storage and release substantially reduced the magnitude and duration of downstream flow within the construction year that would reduce instream flows to levels that are detrimental to aquatic life and/or reduce the ability of water rights holders to make withdrawals.

Criteria for Operational Impacts on Surface Water Quantity:

Operational impacts would be significant if a permanent change from existing reservoir operation and release substantially reduced reservoir storage and streamflow during the months of June through October of each year. Substantial reductions in storage and streamflow during these months would reduce instream flows to levels that are detrimental to aquatic life and/or reduce the ability of water rights holders to make withdrawals.

Criteria for Construction and Operational Impacts on Surface Water Quality:

Construction and operational impacts would be significant if water quality conditions are predicted to be out of compliance with Washington surface water quality standards and if existing background conditions are predicted to be degraded beyond variations allowed by Washington State standards for fresh waters (WAC 173-201A). Allowable variations in background water quality conditions due to human activity per Washington State standards (WAC 173-201A) are:

- **Temperature:** up to 0.3 °C increase.[1]
- **Turbidity:** 5 Nephelometric turbidity units (NTUs) over background.
- **Dissolved Oxygen (DO)**: decrease of no more than 0.2 milligram per liter.[1]
- **pH:** variation of no more than 0.2 Standard Units.

Minor-to-Moderate Benefits

A minor-to-moderate benefit would be achieved if the alternative increases IPID's ability to manage reservoir storage and streamflow during non-drought, typical water years for the benefit of fish use and recreation, without reducing water supply to existing water rights.

Substantial Benefits

A substantial benefit would be achieved if the alternative increases IPID's ability to manage reservoir storage and streamflow during drought years as it relates to fish use, recreation, or water rights. This would include increased resilience and adaptive capacity with climate change (increased ability to adaptively manage the system).

4.2 Regulatory Context

Several federal and state regulations apply to water resources for the Eightmile Lake Rebuild and Restoration Project. Table 4-1 summarizes the programs, policies, and regulations that apply to water quantity, water quality, and climate change in the study area. Regulations relating to water rights are described in Chapter 5.

Table 4-1. Regulations and Guidelines Applicable in the Study Area

Regulation, Policy, or Guideline	Description
Executive Order 11988: Floodplain Management	Executive Order 11988 requires federal agencies to reduce the risk of floodplain loss, minimize the adverse impacts of floods, and restore and preserve the natural functions provided by floodplains. Individual projects involving federal permits or approvals will further ensure consistency with this executive order.
U.S. Forest Service Authorization	A Forest Service authorization is a legal document, such as a permit, lease, or easement, that allows occupancy, use, rights, or privileges on National Forest land. The authorization is granted for a specific use of the land for a specific period of time. The Alpine Lakes Wilderness is jointly administered by the Okanogan-Wenatchee National Forest and the Mt. Baker-Snoqualmie National Forest. IPID has an agreement with the Forest Service that grants IPID limited privileges, including the ability to maintain and repair its reservoirs within the Alpine Lakes Wilderness. IPID currently inspects and maintains the dam in accordance with Ecology DSO requirements.

[1] These criteria for temperature and dissolved oxygen are not currently in effect for Clean Water Act purposes as a result of EPA's 2021 reconsideration and disapproval of Washington's natural conditions criteria in the water quality standards. These criteria remain in effect for other statewide water quality actions. Ecology has initiated rulemaking to revise the natural condition provisions that will respond to EPA's concern and will again meet Clean Water Act approval. For more information, please visit Ecology's website (https://ecology.wa.gov/Regulations-Permits/Laws-rules-rulemaking/Rulemaking/WAC-173-201A-Natural-Conditions).

Regulation, Policy, or Guideline	Description
WDFW Hydraulic Project Approval (HPA)	The WDFW administers the Hydraulic Project Approval (HPA) program under the State Hydraulic Code (WAC 220–660), which is specifically designed to protect fish life. Construction projects or other activities in or near state waters require an HPA. Individual projects with the potential to affect state waters and fish require an HPA.
Washington State Department of Natural Resources Aquatic Use Authorization	An Aquatic Use Authorization is required from the Washington State Department of Natural Resources (WDNR) for use of use of state-owned aquatic lands. State-owned aquatic lands are navigable lakes, rivers, streams, and marine waters. WDNR may also require surveys or a legal description of the property, a plan of development/operations, bonds, and insurance. SEPA approval and the HPA need to be completed prior to WDNR issuing the Aquatic Use Authorization.
Shoreline Management Act Permit	Compliance with the Shoreline Management Act (Chapter 90.58 RCW) is required for development in proximity to waterbodies of a certain size. In Chelan County, these waterbodies include lakes greater than 20 acres and streams and rivers over 20 cfs. Shoreline Management Act jurisdiction also includes upland areas associated with these waterbodies—specifically lands within 200 feet of ordinary high-water mark, floodways, some floodplains, and associated wetlands. Shoreline permitting applies to new structures (buildings, docks, etc.), grading, and other activities.
Instream Flow Rule	Washington State relies on notice-and-comment rulemaking related to instream flows. Chapters 90.22.010, 90.22.020, and 90.54 RCW provide the framework for establishing or modifying instream flows. Prior to modifying instream flow rules, Ecology must provide public notice and conduct a public hearing in the same county where the waterbody is located.
Clean Water Act	
Clean Water Act (33 U.S. Code 1251 et seq.)	The Clean Water Act establishes the basic structure for regulating pollutant discharges into waters of the U.S. and makes it unlawful to discharge any pollutant from a point source into those waters without a permit. The following rows identify key sections of the Clean Water Act relevant to water quality standards and permitting facilities for which construction or operation would result in a discharge into waters of the U.S.
Clean Water Act Section 303(c)	Section 303(c) directs states to adopt water quality standards for their waters subject to the Clean Water Act. Ecology's surface water quality standards are the basis for water quality protection in Washington and are documented in WAC 173-201A. The standards specify designated uses for waters and establish numeric and narrative water quality criteria protective of those uses.
Clean Water Act Sections 303(d) (Impaired Waters and Total Maximum Daily Loads; TMDLs) and 305(b) (Water Quality Assessment Report)	Section 303(d) establishes a process to identify and clean up polluted waters, and Section 305(b) requires states to submit a report on the water quality status of waters to the U.S. Environmental Protection Agency (EPA) every 2 years. In Washington, Ecology performs the Water Quality Assessment, develops the 303(d) list of impaired waters, and leads TMDL development.

Regulation, Policy, or Guideline	Description
Clean Water Act Section 401 (Water Quality Certification)	Section 401 provides states the authority to ensure that federal agencies do not issue permits or licenses that violate state water quality standards or other protections of the Clean Water Act.
Clean Water Act Section 402 (National Pollutant Discharge Elimination System [NPDES])	Section 402 establishes the NPDES program, requiring pollutant discharges to surface waters be authorized by a permit. NPDES permit requirements initially applied to point source discharges, but the program was expanded in 1987 to explicitly include stormwater discharges, including construction stormwater discharges. Ecology administers the NPDES permitting program in Washington for non-federal operators for projects that have the potential to discharge stormwater to surface waters.
Clean Water Act Section 404 (Dredged/Fill Material Discharge Permits)	Section 404 establishes a program to regulate the discharge of dredged or fill material into waters of the U.S., including wetlands. The U.S. Army Corps of Engineers issues Section 404 permit decisions.
Dam Safety	
WA Ecology Dam Safety Office (DSO) Construction Permit	Ecology's DSO requires a construction permit before repair, modification, or construction of a dam storing 10 or more acre-feet of water. Permits may require dams to be designed to withstand a 1 million year storm event. Dams must also include outlet facilities that provide controlled releases of water and limit seepage or uncontrolled releases. A minimum freeboard of 0.75 foot is required at spillways under design inflow conditions.
Climate Change	
Chelan County Climate Resilience Strategy	Chelan County establishes and evaluates progress toward climate resilience goals in the recently released Climate Resilience Strategy. This document summarizes climate-related vulnerabilities in the region and outlines climate resilience initiatives. Many of the outlined climate strategies relate to water resources, including increasing water storage solutions for agricultural producers, drought planning, rural water management, flood risk reduction programs, and instream flow protection.
North Cascadia Adaptation Partnership (NCAP)	NCAP is a National Park Service – Forest Service collaboration that focuses on vulnerability assessment and adaptation planning for federal lands in the North Cascadia region.
Guidance for NEPA and SEPA Project-Level Climate Change Evaluations	This guidance document produced by Washington State Department of Transportation (WSDOT) outlines recommended procedures for evaluating climate change risks for proposed infrastructure projects.

4.3 Affected Environment

4.3.1 Surface Water Quantity

This section summarizes the surface water quantity in the study area (Figure 4-2) and describes the overall water budget pertaining to the study area. This review includes discussion of reservoir storage, release, and withdrawal as it pertains to the short-term and long-term impacts associated with the project. This analysis does not include a review of the validity and extent of surface water rights, and does not determine the validity of quantities of water that are authorized for use under such water rights. For information on water rights, see Chapter 6, *Water Rights.*

General Hydrology in the Study Area

The hydrology of the study area is typical of largely undisturbed, subalpine forest sites. The Alpine Lakes and their outlet streams within the study area are primarily snow-fed systems. Snow accumulates within the basin typically between September and April of each year. Peak snowmelt occurs in June, and melt continues well into summer. Although the basin is snow-dominated, design storm flows are based on major rainfall events (e.g., the 100-year, 6-hour duration storm), which are typically associated with thunderstorms in eastern Washington. Rain-on-snow events can cause high peak runoff volumes in the small, steep catchment areas.

The only hydrologic input to the study area is in the form of precipitation. Mean annual precipitation is 65.1 inches of water equivalent (Anchor QEA 2019). Outflows from the basin include evapotranspiration, discharge from Icicle Creek to the Wenatchee River, and several water diversions that occur within the lower reaches of Icicle Creek.

As described in Chapter 6, *Water Rights*, IPID holds several water rights on Icicle Creek for irrigation use, only one of which specifies an annual quantity limit. The combined diversion right is approximately 118 cfs, and IPID generally diverts the full authorized amount at its diversion structure. The IPID diversion is located at Icicle Creek RM 5.7. The City of Leavenworth municipal diversion is located slightly downstream at RM 5.5. The City has a combined water right of approximately 4.7 cfs at this diversion point, and its water rights primarily authorize the use of water for municipal supply purposes. Further discussion of diversions and water right is included in Chapter 6.

A diversion at RM 4.5 serves both the Leavenworth National Fish Hatchery (LNFH) and the Cascade Orchards Irrigation Company (COIC). The hatchery, owned and operated by the U.S. Fish and Wildlife Service (USFWS), has a diversion right of 42.0 cfs with an annual limit of 27,482 acre-feet per year. A second contingency diversion structure for the hatchery is located at RM 2.8. The water use at LNFH is considered non-consumptive, and the water is discharged back to Icicle Creek at RM 2.6. COIC's water right at the joint diversion structure allows for a diversion of 11.9 cfs for irrigation. LNFH maintains the joint LNFH–COIC diversion structure at RM 4.5.

Eightmile Lake and Shoreline

Eightmile Lake is one of four lakes in the Alpine Lakes Wilderness managed by IPID to provide storage for diversion and irrigation. The lake captures water from approximately 3,822 acres of surrounding hillslope (approximately 6 square miles), and the drainage basin is predominantly covered with rocky outcrops and exposed bedrock. The lake has a surface area of approximately 41.2 acres at the low lake level and 6,400 linear feet of shoreline. The average reservoir depth is 91.3 feet, estimated between the crest of the existing spillway and the bottom of the lake (Anchor QEA 2019). Sub-alpine forest covers approximately 30 percent of the watershed; however, much of the forest was burned down to the waterline in the Jack Creek Fire during August 2017.

Two Special Warranty Deed parcels were established on the shore of Eightmile Lake that preserve IPID's rights to maintain and operate the dam and exercise their water rights. These warranty deeded parcels consist of approximately 0.72 mile of shoreline and include approximately 120.5 acres of land (see Figure 1-2).

The lakes in the Alpine Wilderness generally begin to fill by the beginning of the water year (October) and continue filling through spring, even in dry years. For lakes with dams, once Eightmile Lake is full to the designed spillway or overflow elevation, water is released over the spillway to Eightmile Creek. Controlled releases from the alpine lakes typically begin in July or early August in response to seasonal flow triggers in lower Icicle Creek, to offset diversions by IPID and the USFWS. Water is released through a low-level outlet system, a gated pipeline that extends under the existing spillway that is located immediately south of the earthen embankment.

IPID currently manages Eightmile Lake and holds a water right that authorizes 25 cfs of water for storage in the lake (with no maximum annual quantity specified on their water right certificate). Due to the large size of the drainage basin relative to the storage volume in the lake, Eightmile Lake retains a high potential for annual refill during both wet and dry years. A hydrologic analysis was performed as part of the *Appraisal Study, Alpine Lakes Optimization and Automation* (Aspect Consulting and Anchor QEA 2015) to approximate a mean annual watershed yield of approximately 19,686 acre-feet; the annual volume typically stored within the lake is a small percentage of the total watershed yield, even under drought conditions. IPID further describes their refill practices at the lake during the summer in the Eightmile Lake multi-fill analysis (Aspect 2022a).

The existing facility controlling reservoir operations from Eightmile Lake includes an earthen dam, low-level outlet pipe, and a slide gate to regulate the release of stored water to increase water supply within Icicle Creek during periods of low flow. The original spillway crest was set at elevation 4,671.3 feet, and the 30-inch diameter low-level outlet pipe provided drawdown to elevation 4,648.7 feet based on a revised topographic survey conducted in 2016. These elevations represent an operation range of approximately 23 feet. Table 4-2 summarizes historic reservoir operational elevation and associated storage volumes at Eightmile Lake (Anchor QEA 2019; Aspect 2022a).

Table 4-2. Eightmile Lake Volume and Operation Summary (adapted from Anchor QEA 2019)

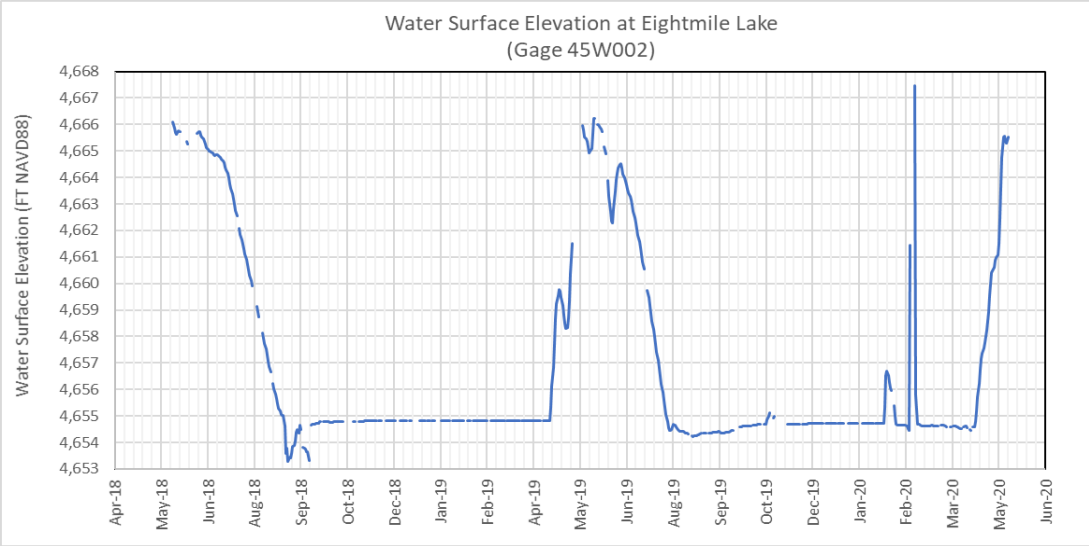
	Water Surface Elevation (feet)	Water Surface Area (ac)	Total Storage Volume (ac-ft)	Active Storage Volume (ac-ft)	Useable Storage Volume (ac-ft)
Low Lake Level	4,644.0	44.1	1,331		
Low-Level Outlet	4,648.7	47.9	1,547	1,151[1]	1,600[2]
Top of Weir	4,664.6	73.7	2,514		
Existing High Water Surface	4,667.0	76.6	2,698		
Spillway Crest	4,671.3	81.7	3,035		

1. Active storage between the low-level outlet and the invert of spillway (no stop logs) (Aspect 2022a).
2. Seepage below the low-level outlet pipe continues to draw the lake below the low lake level of 4,644 feet. IPID estimates that the total usable storage including the additional seepage is approximately 1,600 acre-feet, measured between the low-level outlet and the existing high water surface.

Currently, the embankment has partially eroded to elevation 4,667 feet (the elevation of the existing emergency spillway). Damages have reduced the capacity of the lake to store water, which limits the rate at which IPID can release water to Icicle Creek. The dam is currently unable to impound water to the full level at which it was designed and presumably historically operated, due to partial erosion of the embankment. Total potential storage volume, measured from the top of the stop logs, has been reduced by approximately by 320 acre-feet to less than 1,400 acre-feet. The low-level outlet pipe, previously damaged, was repaired in the summer of 2018.

In May 2018, Ecology installed a telemetry gage, ID 45W002, to measure water surface elevation at the outlet of Eightmile Lake. A review of available data indicates that the water surface elevation remains below the minimum measurable gage elevation for most of the year, near elevation 4,655 feet, while IPID drains the lake in anticipation of spring snowmelt. Water surface elevation is observed to rise to a maximum storage elevation of near 4,667 feet during the summer. A summary graph of available water surface elevation data between October 2018 and June 2020 is provided in Figure 4-3.

Figure 4-3. Recorded Reservoir Elevation, October 2018 – June 2020



Source Data: Ecology (2022a) – The data presented are considered preliminary and have not been validated for accuracy.

Eightmile Creek

Eightmile Creek spans approximately 5 miles between Eightmile Lake and the confluence with Icicle Creek at approximately RM 9.0. The Eightmile Creek watershed covers approximately 31 square miles. The creek parallels FSR 7601 for approximately 12,000 linear feet in the lower portion of the watershed (between the confluences with Icicle Creek and Mountaineer Creek). Mountaineer Creek is the largest tributary to Eightmile Creek with a drainage area of approximately 15 square miles. Upstream of Mountaineer Creek is Colchuck Lake, with an outlet structure and active storage volume of 1,480 acre-feet. Colchuck Lake regulates approximately 15 percent of the contributing area to Mountaineer Creek.

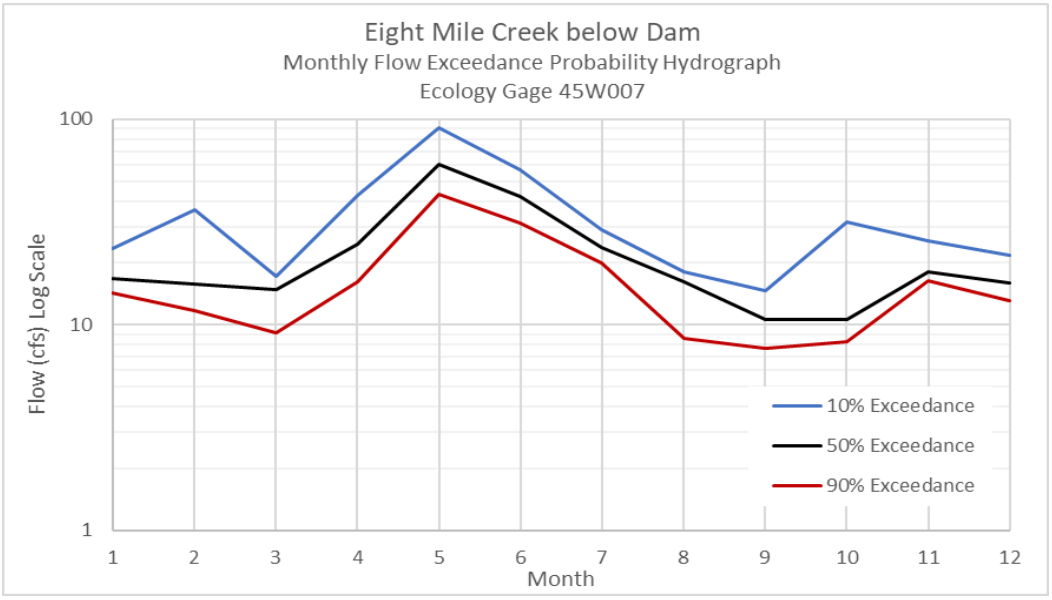
Discharge immediately downstream of Eightmile Lake is dependent on reservoir level and gate operation. An Ecology telemetry gage, ID 45W003, measuring discharge and water surface elevation was installed at Eightmile Creek below the dam in May 2018. The gage is downstream of the existing outlet pipe for Eightmile Dam. A review of available streamflow data indicates a minimum discharge no less than 7.6 cfs occurring annually during summer months (Figure 4-4). Maximum streamflow below the dam is observed to be 102 cfs in early June, which coincides with the maximum storage elevation observed following snowmelt. To describe the seasonal variation of flow as measured at the gaging station, monthly flow exceedance values are summarized in Table 4-3 and shown in Figure 4-4. These exceedance discharge values describe the percentage of time an observed streamflow is greater than or equal to the indicated discharge. No other gages are located within the Eightmile Creek watershed.

Table 4-3. Flow Exceedance Values (cfs) at Eightmile Creek, Water Year 2018 to 2020

Exceedance (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
90%	14.3	11.7	9.1	16.3	43.3	31.4	20.1	8.6	7.7	8.3	16.3	13.2
50%	16.9	15.8	14.8	24.6	60.3	41.9	23.7	16.2	10.6	10.6	18.2	15.9
10%	23.6	36.3	17.2	42.5	91.1	56.5	28.9	18.0	14.6	31.7	25.7	21.8

Source data: Ecology 2022a

Figure 4-4. Flow Exceedance Values (cfs) at Eightmile Creek, Water Year 2018 to 2020



Source data: Ecology 2022a

Icicle Creek

Icicle Creek extends from the headwaters at Josephine Lake near RM 32 to the confluence with the Wenatchee River. Icicle Creek drains approximately 213 square miles in the Alpine Lakes Wilderness and is the largest subbasin in the Wenatchee River watershed. Major tributaries of Icicle Creek include Leland, French, Eightmile, and Snow creeks. Eightmile Creek enters the mainstem of Icicle Creek near RM 9.0, contributing less than 10 percent of the mean daily flow. The mainstem of Icicle Creek has been divided into five distinct reaches based on major infrastructure and operation (Ecology 2019a). The confluence of Eightmile Creek at Icicle Creek is located within Reach 1. This reach tends to have higher flow than downstream reaches, with significant inflow and few outputs (diversions and withdrawals). Reach 1 ends at the IPID diversion at RM 5.7 where flows become diminished by IPID during the irrigation season (April through September).

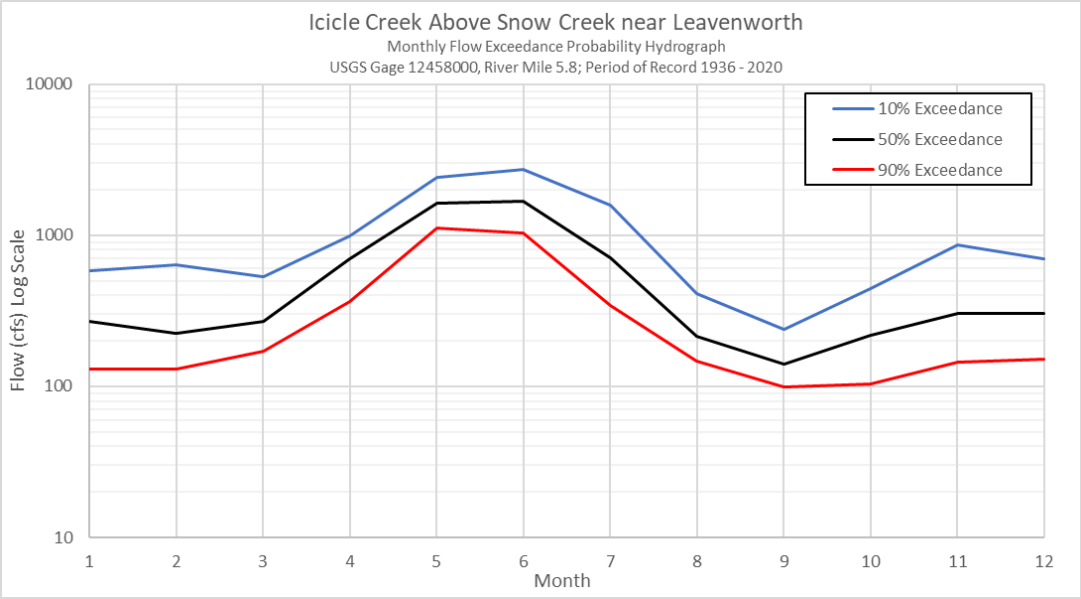
A U.S. Geological Survey (USGS) gaging station (#12458000) is located approximately 3.2 miles downstream of the confluence of Eightmile Creek and Icicle Creek at RM 5.8, which is upstream of any significant flow diversion or withdrawal. Review of the available gage data shows that streamflow peaks in June with snowmelt and steadily declines throughout the rest of summer. Typical low flow occurs by September through early October, until streamflow begins to rise in response to fall precipitation. To describe the seasonal variation of flow as measured at the gaging station, monthly flow exceedance values are summarized in **Table 4-4** and shown in **Figure 4-5**. Flow within Icicle Creek is partially dependent on storage and release of water in the Eightmile Lake and the surrounding Alpine Lakes Wilderness.

Table 4-4. Flow Exceedance Values (cfs) at USGS Gage 12458000 (1936 – 2021)

Exceedance (%)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
90%	579	634	534	988	2428	2714	1573	411	238	443	866	697
50%	271	224	269	695	1639	1677	706	216	141	216	303	304
10%	131	131	171	361	1122	1036	343	148	99	104	146	152

Source data: USGS 2022

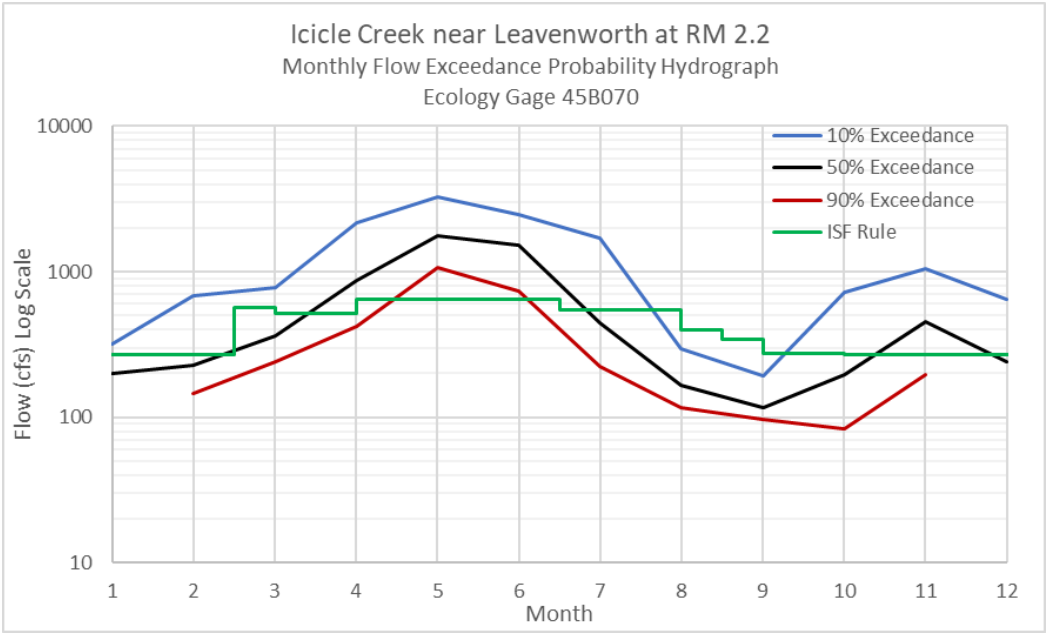
Figure 4-5. Flow Exceedance Values (cfs) at USGS Gage 12458000 (1936 – 2021)



Source data: USGS 2022

An additional stream gage, owned and operated by Ecology (45B070), is located at RM 2.2 within Icicle Creek downstream of the USGS gage. The Ecology gage provides record beginning in May 2007 (Figure 4-6). Streamflow within Icicle Creek at RM 2.2 is subject to multiple diversions and withdrawals compared to the upstream USGS gage previously described. Furthermore, Snow Creek enters the mainstem of Icicle Creek between the USGS gage and Ecology gage. Included in Figure 4-6 is the monthly minimum instream flow (ISF) rule specified within WAC 173-545-030. The ISF guides water resource decision-making and management as it relates to minimum surface water flows for ecological resources and communities.

Figure 4-6. Flow Exceedance Values (cfs) at Ecology Gage 45B070 (2007 –2021)



Source data: Ecology 2022a

The Ecology gage is useful for understanding how water management within the Eightmile Creek watershed affects surface water quantity in the lower watershed. A discussion on ISF rules and other water rights that affect flows in Icicle Creek can be found in Chapter 6 of this EIS, including diversions and withdrawals of water.

4.3.2 Water Quality

This section describes water quality conditions for surface waters in the study area, which includes Eightmile Lake, Eightmile Creek to the confluence with Icicle Creek, and Icicle Creek from its confluence with Eightmile Creek downstream to the Wenatchee River (Figure 4-3). In general, the available data and the relatively pristine and undeveloped condition of the contributing watershed suggest generally good water quality conditions in Eightmile Lake and Eightmile Creek. Neither Eightmile Lake nor Eightmile Creek has ever been identified on Ecology's EPA-approved 303(d) list as impaired for any parameter (Ecology 2018a). Ecology's currently approved 303(d) list is from the 2018 Water Quality Assessment, which received final EPA approval on August 26, 2022.

The lower portion of Icicle Creek is identified as impaired for dichlorodiphenyldichloroethylene (4,4'-DDE) and polychlorinated biphenyls (PCBs) in Ecology's current EPA-approved 303(d) list (Ecology 2018a). Portions of Icicle Creek have also been identified in historic 303(d) lists as impaired for parameters including temperature, dissolved oxygen (DO), and pH. The Wenatchee River Watershed Temperature TMDL (Ecology 2007b) and the Wenatchee River Dissolved Oxygen and pH TMDL (Ecology 2009) were developed in response to listings for those parameters in the Wenatchee River and its tributaries, including Icicle Creek.

Water Quality Standards

Based on the nature of the construction activities and water management operations considered in this EIS, and on the status of the receiving waters, the water quality parameters most relevant to assessing the effects of the project alternatives are temperature, DO, turbidity, and pH. Water quality standards for each of those parameters are identified below, to establish a basis for evaluating the significance of effects on water quality.

Temperature

Washington's temperature standards are established to protect aquatic life, and the criteria that apply to a specific stream are based on designated fish uses of that stream. The applicable criteria for surface waters in the study area are summarized in Table 4-5 and in the following text.

In addition to the numeric temperature criteria shown in Table 4-5, Ecology's surface water quality standards contain other narrative criteria and guidelines for temperature, including the following:

- Moderately acclimated (16°C to 20°C) adult and juvenile salmonids will generally be protected from acute lethality by discrete human actions maintaining the 7-day average of daily maximum (7-DADMax) temperature at or below 22°C and the 1-day maximum (1-DMax) temperature at or below 23°C (WAC 173-201A-200(1)(c)(vii)(A)).
- When a waterbody's temperature is warmer than the criteria (or within 0.3°C of the criteria) and that condition is due to natural causes, then human actions considered cumulatively

may not cause the 7-DADMax temperature of that waterbody to increase more than 0.3°C (WAC 173-201A-200(1)(c)(i))[2].

- For lakes, human actions considered cumulatively may not increase the 7-DADMax temperature more than 0.3°C above natural conditions (WAC 173-201A-200(1)(c)(v)).

Table 4-5. Designated Aquatic Life Uses and Temperature Criteria

Stream Segment	Designated Aquatic Life Uses	Criteria (7-DADMax)
Icicle Creek: Upstream from the mouth to the National Forest boundary, including tributaries	Core summer salmonid habitat	16°C*
	Supplemental spawning and incubation (August 15 to July 15)	13°C
Icicle Creek: Upstream from the National Forest boundary to confluence with Jack Creek (approximately 8 miles upstream from the Icicle-Eightmile Creek confluence), including tributaries	Core summer salmonid habitat	16°C
Eightmile Lake and Eightmile Creek	Core summer salmonid habitat**	16°C

Notes:
7-DADMax: 7-day average of daily maximum temperature.
* Applies year-round except when superseded by supplemental spawning and incubation criteria.
** All surface waters within National Parks, National Forests, and/or wilderness areas are to be protected for the designated use of core summer salmonid habitat (WAC 173-201A-600(a)(i)).

Dissolved Oxygen

DO is an important water quality parameter because many aquatic species, including fish, need it to survive. Water's capacity to hold DO decreases with increasing temperature, and DO levels are generally lower in summer when flows are lower and temperatures and biological activity are higher.

Similar to temperature, Washington's water quality criteria for DO are based on designated aquatic life uses. The criterion for core summer salmonid habitat is a 1-day minimum of 10.0 milligrams per liter (mg/L) or 95 percent saturation; this applies to Eightmile Lake, Eightmile Creek, and Icicle Creek within the study area.

Washington's water quality criteria for DO state that when DO levels in a stream are lower than the criteria, and that condition is due to natural causes, then human actions considered cumulatively may not cause the DO level of that waterbody to decrease more than 0.2 mg/L (WAC 173-201A-200(1)(d)(i))[2]. For lakes, human actions considered cumulatively may not decrease the DO concentration more than 0.2 mg/L below natural conditions (WAC 173-201A-200(1)(d)(ii)).

Turbidity

Turbidity is a measure of water clarity that is largely influenced by suspended sediments, with higher total suspended solids (TSS) levels generally associated with higher turbidity levels. Algae can also

[2] These criteria are not currently in effect for Clean Water Act purposes as a result of EPA's 2021 reconsideration and disapproval of Washington's natural conditions criteria in the water quality standards. These criteria remain in effect for other statewide water quality actions. Ecology has initiated rulemaking to revise the natural condition provisions that will respond to EPA's concern and will again meet Clean Water Act approval. For more information, please visit Ecology's website (https://ecology.wa.gov/Regulations-Permits/Laws-rules-rulemaking/Rulemaking/WAC-173-201A-Natural-Conditions).

contribute to elevated turbidity levels. Excessive instream turbidity and suspended sediment can adversely affect fish and aquatic habitat in several ways, including by reducing the amount of light available for aquatic plants, interfering with fish feeding behavior, clogging gills, and silting in spawning gravels. Instream turbidity levels are naturally highly variable. Levels are typically highest in winter months during periods of heavy precipitation and high runoff rates, and lowest in summer when precipitation and runoff are low.

The aquatic life turbidity criteria of WAC-173-201A-200(e), which are applicable to Eightmile Lake, Eightmile Creek, and Icicle Creek in the study area, state that turbidity shall not exceed 5 NTUs over background when the background is 50 NTUs or less, or exceed a 10 percent increase in turbidity when the background is more than 50 NTUs.

The water quality standards of WAC-173-201A-200(e) allow temporary areas of mixing during and immediately after in-water construction activities that disturb sediments, where the turbidity criteria compliance point is some distance from the activity. For construction within or along lakes or other non-flowing bodies of water, the point of compliance is at a radius of 150 feet from the activity. For streams up to 10 cfs flow at the time of construction, the point of compliance is 100 feet downstream. For streams above 10 cfs up to 100 cfs (typical flow conditions in Eightmile Creek below the dam), the point of compliance is 200 feet downstream of the activity.

pH

Water pH is a measure of acidity or basicity, with lower pH values (below 7 Standard Units [SUs]) more acidic and higher pH values more basic. In surface waters, pH is influenced by chemical interactions between water and sediments as well as photosynthesis by aquatic plants and algae. Pollutant discharges that change water chemistry and aquatic biological functions can lead to excessively low or high instream pH, which can be harmful to aquatic organisms that require a limited pH range to survive.

Washington's water quality criteria state in WAC-173-201A-200(g) that freshwater pH should be within the range of 6.5 to 8.5 SUs. Allowable human-caused variation to the standard is limited to 0.2 SUs in areas protected as core summer salmonid habitat.

Eightmile Lake

Published water quality monitoring data for Eightmile Lake are limited. Ecology's Washington State Lakes Environmental Data portal, which includes available information from Ecology's lake water quality monitoring reports and data from Ecology's Environmental Information Management (EIM) database, contains no records for Eightmile Lake (Ecology 2022b).

The USGS monitored water quality in Eightmile Lake on a single date in summer 1974 and a single date in summer 1978. For both monitoring events, samples were collected from two depths: a near-surface sample at 1-meter depth and a deeper sample at 20+ meter depth (23 meters in 1974 and 20 meters in 1978). Overall, the monitoring data showed low nutrient (nitrogen and phosphorus) concentrations, low fecal coliform bacteria levels, low conductivity, high water clarity, and temperature and dissolved oxygen concentrations that reflected warmer summer water temperatures at the lake surface and cooler water temperatures at depth.

Table 4-6 summarizes the monitoring data from the USGS reports for the 1974 and 1978 monitoring events (Dion et al. 1976; Dethier et al. 1979). While these data were not collected recently, they are the best available for the lake and remain relevant because lake operations and the management of the surrounding lands have not changed substantially since the 1970s.

Table 4-6. USGS Monitoring Data for Eightmile Lake

Sample Date	July 31, 1974		August 10, 1978	
Sample Time	1430	1435	1800	1805
Sample Depth (m)	1	23	1	20
Total nitrite plus nitrate (mg/L)	0.01	0.01	--	--
Total kjeldahl nitrogen (mg/L)	0.08	0.11	0.10	0.12
Total ammonia (mg/L)	0.05	0.03	0.02	0.02
Total organic nitrogen (mg/L)	0.03	0.08	0.08	0.10
Total phosphorus (mg/L)	0.003	0.005	0.007	0.012
Specific conductance (micromhos)	18	18	20	24
Water temperature (°C)	11.8	4.7	16.0	5.4
Secchi-disc visibility (m)	11		--	
Dissolved Oxygen (mg/L)	9.8	10.2	8.2	9.0
Fecal coliform, min., max., and mean (col./100mL)	<1	--	--	--

Source: Dion et al. 1976; Dethier et al. 1979

As shown in Table 4-6, the highest water temperature (16.0°C) and lowest DO concentration (8.2 mg/L) were both recorded in the near-surface sample on August 10, 1978, and the lowest temperature (4.7°) and highest DO concentration (10.2 mg/L) were both recorded in the deep sample (23 meters) on July 31, 1974. Temperature differences between near-surface and deeper samples ranged from 7.1°C for the 1974 sampling and 11.6°C for the 1978 sampling. The datasheet for the 1974 monitoring event included a note stating "*the DO concentration was high throughout the entire water column,*" and the reports for both years noted little to no coverage of the lake surface or shoreline by emersed plants.

Lake operations for water storage and the surrounding land management (as a National Forest with Wilderness designation established in 1976) are similar today to when the USGS conducted water quality monitoring in the 1970s. Because of the lake's remote location and wilderness protections, the potential for pollutant problems is generally low and limited to the recreational use of the area, which can contribute pollutants including bacteria, nutrients, and sediment to the lake. There are no NPDES-permitted outfalls or other point source discharges to the lake, and no pollution-generating impervious surface (PGIS) contributing stormwater runoff to the lake.

In August 2017, the Jack Creek Fire burned much of the Eightmile Basin adjacent to and upstream of Eightmile Lake, with a substantial portion of the burned area (64 percent) experiencing moderate to high soil burn severities (USFS 2021g). The rates of soil erosion and sediment delivery to Eightmile Lake and Eightmile Creek were likely higher from those areas of moderate and high soil burn severity following the fire and may have contributed to temporarily elevated turbidity levels during periods of heavy precipitation and/or runoff. The erosion potential of the burned areas may remain higher than the pre-fire condition, but the natural re-establishment of vegetation since the fire has reduced erosion potential over time and is expected to continue to reduce the potential for excessive sediment delivery and turbidity in Eightmile Lake and Eightmile Creek, as vegetation continues to mature and vegetation coverage continues to increase.

Ecology has not identified Eightmile Lake as impaired or a water of concern for any parameter on the current EPA-approved Water Quality Assessment or in past assessments (Ecology 2018a).

Eightmile Creek

There are no permanent Ecology water quality monitoring stations on Eightmile Creek, but monitoring data have been collected as part of previous studies documented in Ecology's EIM database. Continuous water temperature monitoring was conducted on Eightmile Creek at two locations in summer 2002. One location (Location ID 45EC02.7) was at RM 2.7 just upstream of the confluence with Mountaineer Creek, and one location was near the mouth, just upstream of the Icicle Creek confluence (Location ID 45EC00.1). Data collected from both stations showed no exceedances of the 16.0°C standard for core summer salmonid habitat for the summer 2002 monitoring period (Ecology 2022b).

Monitoring at the Eightmile Creek station located near the mouth also included periodic sample collection for other parameters from June 2002 to January 2003. Sample parameters included DO, turbidity, pH, nutrients, and others. Sample results indicated good water quality conditions on all sample dates, with high DO concentrations ranging from a low of 9.7 to a high 13.6 mg/L, low stream turbidity (1.4 NTUs or lower for all samples), pH within standards in a range of 7.4 to 8.1 SU, and low levels of nitrogen and phosphorus (Ecology 2022b).

Ecology's current EPA-approved Water Quality Assessment identifies the lower portion of Eightmile Creek (where water quality data have been collected) as a "Category 1" water, which means that it meets water quality standards. Eightmile Creek has no listed impairments on the current or historic Water Quality Assessment and 303(d) lists (Ecology 2018a).

There are no NPDES-permitted outfalls to Eightmile Creek (Ecology 2022c, EPA 2022).

Icicle Creek

Monitoring data for Icicle Creek have indicated exceedances of water quality criteria for temperature, DO, and pH. Ecology has documented temperature criteria exceedances in sections of Icicle Creek both upstream of the Eightmile Creek confluence as well as within the study area between Eightmile Creek and the Wenatchee River. Documented DO and pH criteria exceedances have been limited to the lower portion of the Icicle Creek near the confluence with the Wenatchee River (Ecology 2018a).

The temperature listings are addressed in the Wenatchee River Watershed Temperature TMDL, which was approved by EPA in August 2007. The temperature TMDL establishes load allocations for effective shade targets for Icicle Creek and other streams in the watershed. The load allocation for effective shade for all perennial streams in the watershed is the potential shade that would occur from mature riparian vegetation (Ecology 2007b). The temperature TMDL also establishes wasteload allocations for selected NPDES-permitted point source dischargers, including the Leavenworth Wastewater Treatment Plant (WWTP) and the LNFH, both of which discharge to Icicle Creek.

The DO and pH criteria exceedances are addressed in the Wenatchee River Watershed Dissolved Oxygen and pH TMDL: Water Quality Improvement Plan, which was approved by EPA in August 2009. The Water Quality Improvement Plan identifies the need for large reductions in point sources and non-point sources of phosphorus loading in the Wenatchee River and Icicle Creek to achieve DO and pH targets. Point sources include NPDES permitted discharges and fish hatcheries, and the TMDL established wasteload allocations for the Leavenworth WWTP and the LNFH (Ecology 2009). Non-point sources of phosphorus loading include leaking septic systems.

Ecology's current EPA-approved 303(d) list identifies a portion of lower Icicle Creek in the vicinity of the East Leavenworth Road Bridge as impaired for 4,4'-DDE and PCBs. 4,4'-DDE is an organochlorine pesticide and a breakdown product of DDT. PCBs are a class of chlorinated hydrocarbons that were historically used in various commercial and industrial applications (e.g., electrical transformers and other electrical equipment, fluorescent light ballasts, plasticizers), prior to the banning of their manufacture in the U.S. in 1979. The 303(d) listings for 4,4'-DDE and PCBs in lower Icicle Creek are based on results of tissue samples from mountain whitefish (*Prosopium*

williamsoni) that showed fish tissue equivalent concentration (FTEC) exceedances (Ecology 2018a). The sampled fish were collected from lower Icicle Creek approximately 2.6 miles upstream of the confluence with the Wenatchee River.

Ecology conducted a source assessment of DDT and PCBs in the Wenatchee River watershed (Hobbs and Friese 2016) in response to their detected presence in fish tissue samples in multiple locations in the watershed, including the Icicle Creek location noted above. The investigation identified two distinct sources of PCBs in the Wenatchee River, both of which are in the lower river downstream of Cashmere and outside of the study area for this EIS. Ecology determined that the main known sources of DDT–which was widely applied to orchard crops in the Wenatchee River watershed prior its federal ban in 1972–are within the Mission and Chumstick Creek sub-basins. The study concluded that the diet of mountain whitefish is selective (caddis flies and mayflies) and the location of the contaminated food source is confined to the lower Wenatchee River. The source assessment specifically noted that the source of PCBs to the Wenatchee River is approximately 10 miles downstream of where the fish tissue samples were collected in Icicle Creek (Hobbs and Friese 2016).

4.3.3 Climate Change and Surface Water

Climate change represents a challenge for planning, usage, and protection of surface water and associated surface water resources in the Icicle–Eightmile Creek Watershed. During the past 100 years, the Pacific Northwest has become warmer and wetter (Mote et al. 2005), and models predict a continuation in this trend. These changes may result in increased uncertainty in the timing, form, and distribution of precipitation and water demand. This section provides a regional context of the Eightmile Lake climate and changes anticipated based on available research and collected data.

The study area is in Climate Region 14 as documented by the Technical Note 3 of the Department of Ecology Dam Safety Guidelines (Ecology 1993). Eightmile Lake and the surrounding Alpine Lakes Wilderness are east of the Cascade crest, where the climate is generally warmer and drier in contrast to valleys surrounding the Puget Sound. The Cascade crest creates a regional dichotomy in climate, with rain-shadow effects driving drier conditions and creating a barrier between the maritime low pressure and continental high pressure. This pattern holds true for the lower Icicle Creek watershed. The low-level outlet pipe at Eightmile Lake is at an elevation of approximately 4,648.7 feet with the basin extending up to 7,780 feet, where considerable precipitation in the upper watershed falls as snow, while precipitation in the lower watershed comes predominantly as rain. Because of its location and elevation, the Eightmile Lake watershed receives approximately 65 inches of precipitation, primarily as snowfall (Anchor QEA 2019). In the eastern lowlands below Eightmile Lake, average annual precipitation is generally less than 20 inches, with some areas receiving as little as little as 7 inches (Ecology 2019a).

The Climate Impacts Group (CIG) at the University of Washington made regionalized climate projections as part of their *2009 Washington Climate Change Impacts Assessment* (CIG 2009). The CIG projected that probable climate impacts within the Pacific Northwest include a decreased April 1 snowpack by as much as 40 percent in the 2040s and an average annual temperature warming rate of approximately +0.5°F per decade in the 21st century (CIG 2009). The conclusions of the assessment include a shifting seasonality for the onset of snowmelt earlier in the water year, driven by more transient precipitation occurring as rainfall. The combination of reduced snowpack and shifting seasonality earlier in the water year will result in reduced reservoir storage refill in the late spring and early summer months, and therefore less water available for supply and irrigation during critical months toward the end of the water year.

Climate modeling indicates that the changes described will have substantial impacts on streamflow in Icicle Creek (Mauger et al. 2017), which includes smaller tributaries such as Eightmile Creek. Within Icicle Creek, climate modeling predicts that the minimum average flow will decrease by as

much as 75 percent by 2050 for a 2-year return period. In contrast, an increase in peak flow is predicted by up to 58 percent, which suggests that surface waters will generally become flashier with lower baseflow and a higher peak flow. Table 4-7 provides the average monthly change in streamflow. Although these changes in streamflow were calculated for Icicle Creek, a similar percent change in streamflow can be assumed for Eightmile Creek, which is a tributary to Icicle Creek. Eightmile Creek is subject to the same climatic changes as Icicle Creek and therefore will likely experience similar percent changes in streamflow, not considering dam operations.

Climate predictions are based on Global Climate Models (GCMs). To obtain localized projections of climate change and resulting impacts, statistical downscaling is applied to GCMs using empirical relationships between observed, site-specific climatology and coarser-scale modeling. Downscaling is the process of extracting localized data from global or regional climate models. Specific to the study area, downscaling was performed in 2017 as part of the Icicle Work Group (IWG) *Changing Streamflow in Icicle, Peshastin, and Mission Creeks* to inform water management decision-making. Downscaling is based on 1/16-degree gridded historic observed temperature and precipitation (Mauger et al. 2017).

Table 4-7. Average Streamflow Percent Change In Icicle Creek from Climate Change Modeling for 2050 (Mauger et al. 2017)

Month	Low	Mid	High
October	5	8	9
November	27	32	55
December	16	63	106
January	14	63	201
February	32	57	206
March	41	67	244
April	9	102	143
May	-7	4	35
June	-50	-28	9
July	-71	-41	-28
August	-75	-62	-31
September	-41	-39	-20

A summary of anticipated hydrologic changes specific to the study area is provided based on the GCM 2050 low greenhouse gas modeling scenario, known as Relative Concentration Pathway (RCP) 4.5. For both Eightmile Lake and Icicle Creek, results of climate change modeling indicate a reduction in peak flow of approximately 15–20 percent and a shift in peak flow timing from June to May in 2050. Winter flows were observed to increase approximately 40–60 percent because of a greater amount of precipitation occurring as rainfall. Changes become more significant moving downstream in the watershed and further in time through the 2080 modeling scenario. Under medium and high greenhouse gas emission modeling scenarios (Scenario A1B and RCP 8.5), the results become accelerated and exaggerated.

Figure 4-7 and Figure 4-8 show the 2050 projection for monthly streamflow under a low greenhouse gas emissions scenario for both Eightmile Lake and Icicle Creek. In Figure 4-7 the historical streamflow is shown in orange, with peak streamflow occurring around late June and exceeding 90

cfs. Throughout most of the late-summer through early spring, flows are low, less than 10 cfs. Under the various climate models shown in light blue (with dark blue representing the average of the ensembled models), the peak streamflow shifts forward to early May with a decrease in peak streamflow rate. The flows in winter and spring are considerably higher than under historical conditions, averaging around 15 cfs. Mid- and late-summer flows are considerably lower under the climate change conditions, primarily because the falling limb of the hydrograph has shifted forward in the year. This means that in June, July, and August, streamflow will be much lower than under historical conditions. These mid- to late-season flows in the upper Eightmile watershed contribute to Eightmile Lake reservoir refill.

Figure 4-8 shows a similar trend for Icicle Creek, with an even more pronounced shift and drop in peak streamflow timing and magnitude. In mid- to late-summer, flows in Icicle Creek are predicted to decrease substantially to flow rates less than 300 cfs. This has major implications for water users and water withdrawals from Icicle Creek.

Figure 4-7. Eightmile Lake Modeled 2050 Flows (Low Greenhouse Gas Emissions) (Mauger et al. 2017)

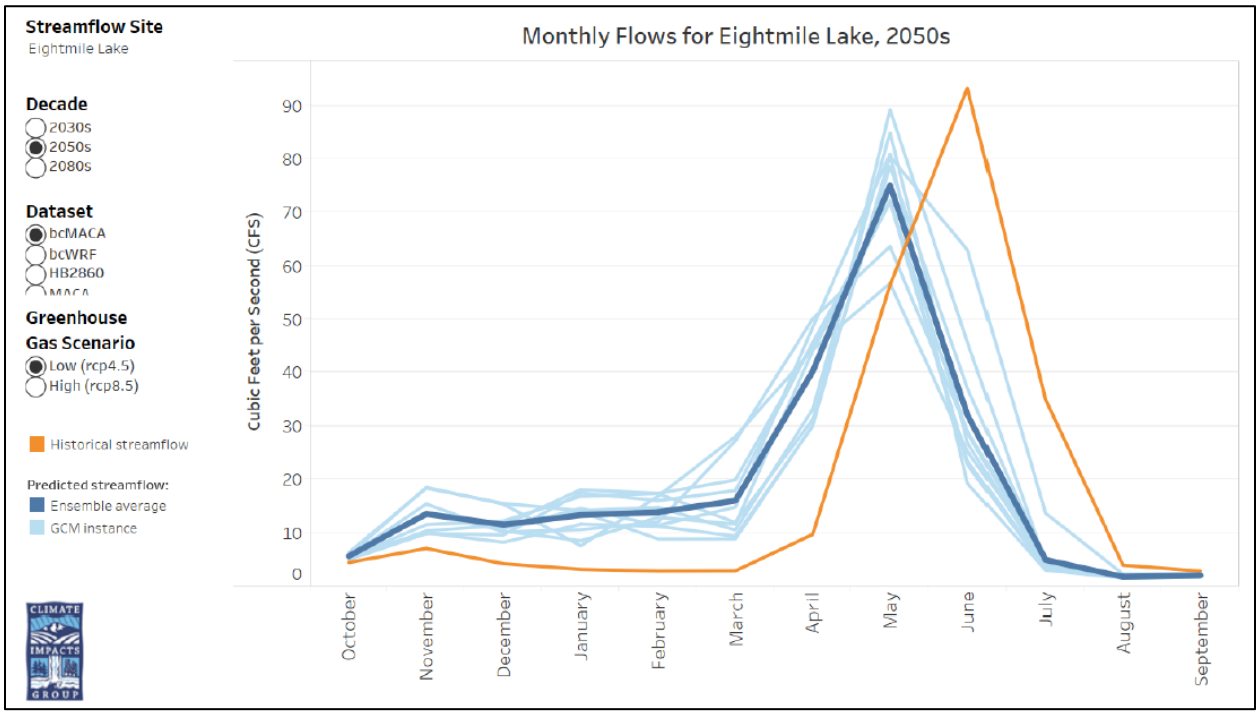
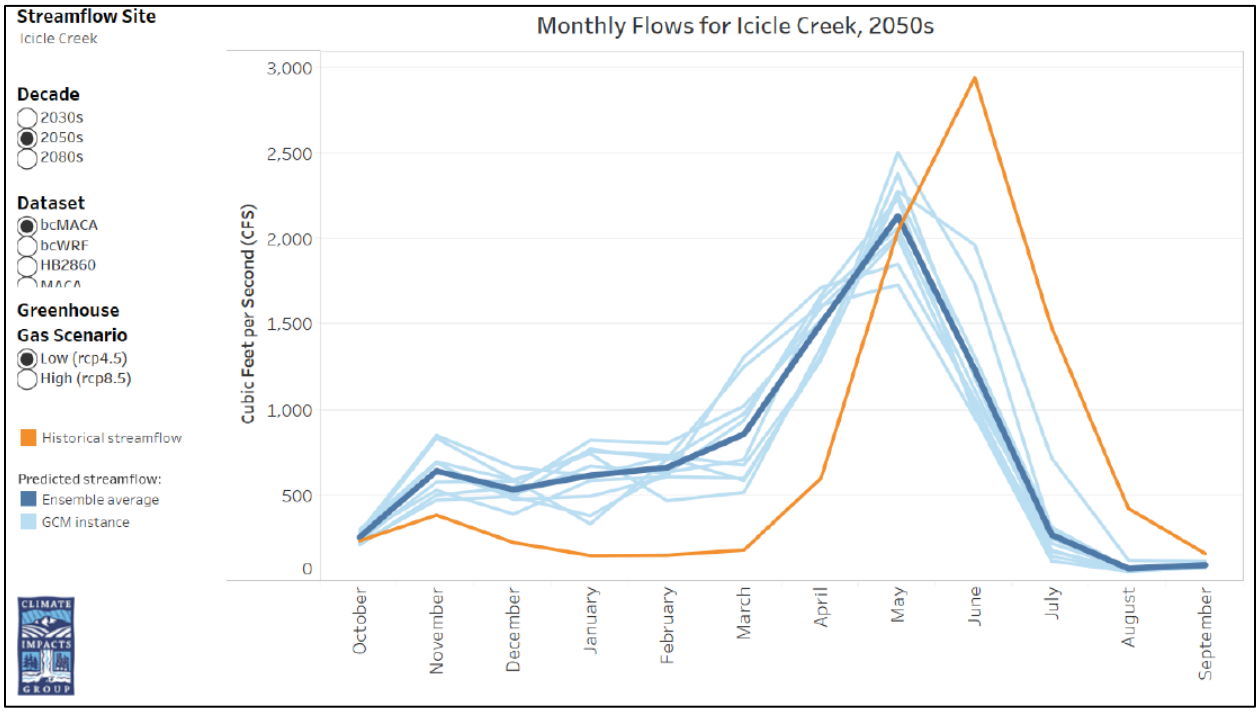


Figure 4-8. Icicle Creek Modeled 2050 Flows (Low Greenhouse Gas Emissions) (Mauger et al. 2017)



4.4 Construction Impacts

Project-related impacts during construction are described below for both surface water quantity and surface water quality, organized by alternative. Construction methods such as the helicopter access options are not specifically addressed in this chapter as they have no effect on surface water quantity or quality.

4.4.1 No Action Alternative

Surface Water Quantity and Quality

Under the No Action Alternative, no construction would occur; therefore, there would be no construction impacts on surface water quantity and quality. There would be a risk of dam failure, which could lead to additional emergency repairs. In addition, if DSO were to exercise enforcement action in accordance with WAC 173-175-620(3), impacts like those described below for construction would occur. The duration of removal activities would be substantially shorter than for construction of any of the action alternatives.

4.4.2 Impacts Common to All Action Alternatives

There is no anticipated variation in construction impacts among the action alternatives because all action alternatives require the lake level to be lowered to approximately the same elevation for approximately the same duration of time during project construction. Lake level lowering, dewatering pumping, and restriction of releases are the primary construction actions that affect water resources.

Surface Water Quantity

The primary impact on surface water quantity is that the lake and creek would have less water than usual throughout construction; however, these reductions would not be reduced in magnitude and duration to a point that would be detrimental to aquatic life, or the ability of water rights holders to make withdrawals.

Construction activities would begin in mid-June or as soon as the snow conditions allow. The work at the lake would need to be completed after the lake has been drawn down well below the existing low-level outlet pipe so that work can be completed "in the dry." Excavation would start as soon as the lake water level was below elevation 4,661 feet. When the lake level is at 4,661 feet, the creek bed at the lake would be dry. Once the lake elevation drops below 4,650 feet, the new low-level outlet pipe would be installed. Water would exit the lake via the newly installed low-level outlet pipe throughout construction. Once the new low-level outlet pipe is installed, cofferdams would be installed, and the existing dam structure and low-level outlet pipe would be removed. Pumps would be used to dewater work areas as needed. Cofferdams would be constructed using large bulk bags, which would also be used to transport items up to the lake.

When the reservoir was actively operated to provide storage for IPID, the lake was not typically drawn down until summer, when IPID opened the gate to releases water to maintain irrigation water supply downstream. More recently, to address concerns expressed by Ecology's DSO, IPID has left the gate open on the outlet, which has resulted in the lake being drawn down below the outlet earlier in the year and for a longer period each year. This is the proposed mode of operation during the year that the improvements are constructed. Early drawdown has resulted in up to approximately 40 cfs less streamflow being discharged to Eightmile Creek in mid- to late summer. During the year that the improvements are constructed, temporary pumping equipment and the newly constructed low-level outlet pipe may be used, if needed, to divert water from the lake through the work area, to keep the lake level low until construction is completed. This could increase streamflows in Eightmile Creek during the fall, likely on the order of 5 to 10 cfs above normal flow rates; however, the increased flow rate would depend on precipitation during the construction year and the resulting need to pump or divert water from the lake through the work area during construction. If the lake is drawn down at the beginning of construction and there is little precipitation during construction, there may be no need to pump or divert water from the lake through the work area during construction.

The expected changes in the timing and magnitude of flow into Eightmile Creek represent **less-than-significant impacts** on water quantity because these streamflow volumes and timing are within the typical range of current reservoir operation, considering the year-to-year variation in the hydrologic cycle.

Surface Water Quality

Construction activities could temporarily affect surface water quality through in-water work for the excavation and installation of the new low-level outlet pipe and the installation of the cofferdams to isolate the dam work area from Eightmile Lake and Eightmile Creek. Related disturbance of sediments would likely result in short-term, localized increases in turbidity, which could result in short-term increases in water temperature since suspended sediments absorb heat from solar radiation more efficiently than water. A temporary increase in water temperatures would result in a corresponding temporary decrease in DO levels.

Upland construction activities in areas adjacent to Eightmile Lake and Eightmile Creek also present a potential to affect surface water quality. Vegetation clearing, excavation, and fill placement for staging areas and dam construction would expose soils and temporarily increase the potential for soil mobilization and transport to surface waters in stormwater runoff, until vegetation in disturbed areas is re-established through planting after construction. The trail rerouting, road improvement work, and installation of the repeater station could also pose a risk for sediment mobilization.

Drawing down the lake earlier than normal to facilitate construction would also temporarily increase the potential for erosion and sediment mobilization along the shoreline by exposing normally submerged soils/sediments to precipitation (summer storms) earlier than normal. All activities that may mobilize sediment will be accompanied by appropriate sediment best management practices (BMPs), including installation of silt fences, coir logs, and turbidity curtains. These temporary sediment control measures would prevent significant turbidity and sediment accumulation in the lake and in the stream until the site is permanently stabilized through planting after construction.

The use of construction equipment on-site would increase the potential for pollutants (e.g., fuel, oil and grease, hydraulic fluid) to enter surface waters from accidental releases. The construction of all action alternatives would also include concrete pouring to construct a new spillway. Wet or curing concrete can raise pH in surface waters that come into contact with it. However, the concrete pours for the spillway would be performed in the dry, at low lake levels and isolated from the lake and creek by a cofferdam. Surface water contact with curing concrete is therefore not expected.

Construction would take approximately 4 months to complete starting in approximately mid-June, with the potential for water quality impacts from in-water work associated primarily with the early portion of the construction period, until the dam work area is fully isolated by the cofferdams. The potential for water quality impacts from in-water and upland construction activities would generally be similar for all three action alternatives. Alternative 2 (wide spillway without gates) would involve construction of a longer dam and require more earthwork and a larger construction footprint–including a larger staging area–than Alternatives 1 and 3, presenting a potential for a greater extent and duration of water quality impacts than the other action alternatives.

Construction activities within and adjacent to Eightmile Lake and Eightmile Creek would be performed under the regulation of federal and state permits, including a Corps Section 404 permit, an Ecology 401 Water Quality Certification, a WDFW HPA, and an NPDES Construction Stormwater Permit. Those permits would require the implementation of erosion, sediment, and pollution control measures during and after construction. The 401 Certification would include additional conditions related to water quality protection such as requirements for monitoring turbidity during in-water work to ensure that water quality standards are met at the mixing zone compliance points and that work is stopped if permitted threshold are exceeded, until problems are addressed.

After construction is completed, all supplies, construction waste, and equipment would be removed by helicopter. The area around the site disturbed by the work or used for construction staging would be restored. The staging area would be returned to natural looking contours. Native vegetation would be replanted in disturbed areas, following a plan approved by the Forest Service.

With appropriate control measures and monitoring programs in place as required by permits, construction-related short-term variations in stream turbidity, temperature, dissolved oxygen, and pollutant discharges are expected to be within limits allowed by water quality standards, and therefore would represent **less-than-significant** adverse impacts on water quality.

4.5 Operational Impacts

The section describes the long-term operational impacts associated with the project alternatives, including the No Action Alternative. Operational impacts include improvements and deficiencies to reservoir storage, control, and telemetry. Impacts that do not rise to the level of significance described in Section 4.1 are considered less-than-significant.

Table 4-8 summarizes the relevant elevations, areas, volumes, and flow rates described throughout this section for the No Action Alternative and the three action alternatives.

Table 4-8. Summary of Operational Conditions for Eightmile Dam, by Alternative

Eightmile Lake Consideration[1]	No Action Alternative[2]	Action Alternatives		
		Narrow Spillway with Gates (Alternative 1)	Wide Spillway Without Gates (Alternative 2)	Narrow Spillway without Gates (Alternative 3)
Automation	None	Automated primary spillway control gate and automated low-level outlet pipe	Automated low-level outlet pipe	Automated low-level outlet pipe
Max. Lake WSEL (feet)	4,667	4,671	4,671	4,667
Min. WSEL Without Pumping (feet)[4]	4,640	4,636	4,636	4,636
Max. Lake Area (acres)	76.6	81.4	81.4	76.6
Min. Lake Area (acres)	~41.2	38.7	38.7	38.7
Max. Lake Volume (acre-feet)	2,698	3,010	3,010	2,698
Min. Lake Volume (acre-feet)	~1,158	1,010	1,010	1,010
Active Storage Volume (acre-feet)	~1,540	2,000	2,000	1,698
When would lake be full?	Annually; Mid May-Late July	Annually; Mid May-Late July	Annually; Mid May-Late July	Annually; Mid May-Late July
When would Lake be drawn down to lowest level?	Almost Every Year; Late Sept-Early Oct	Only Drought Years; (~1 in 5 Years); Late Sep-Early Oct	Only Drought Years; (~1 in 5 Years); Late Sep-Early Oct	Only Drought Years; (~1 in 5 Years); Late Sep-Early Oct
Typical summer flow release from outlet pipe	20 to 35 cfs Jul 1 - Late Aug	Estimated 20 to 40 cfs Jul 1 - Late Aug	Estimated 20 to 40 cfs Jul 1 - Late Aug	Estimated 20 to 40 cfs Jul 1 - Late Aug
Typical 50% Exceedance Flow in Eightmile Creek[3]	23.7 cfs – July 16.2 cfs - August	Estimated 28.7 cfs – July Estimated 21.2 cfs - August	Estimated 28.7 cfs – July Estimated 21.2 cfs - August	Estimated 28.7 cfs – July Estimated 21.2 cfs - August
Summer minimum flow release from outlet pipe	0 cfs	0 cfs	0 cfs	0 cfs

[1] Physical attributes of Eightmile Lake and associated operational estimates do not include climate change considerations discussed in Chapter 4.

[2] No change to the existing dam or operations (same as existing conditions), until dam failure or the DSO requires removal.

[3] Exceedance values were calculated from existing flow rate data at the Ecology gage 45W003 between May 2018 and June 2020. A longer record of flow rates will provide more-representative exceedance flow rates.

[4] This elevation represents the lowest drawdown that would occur without pumping. Under existing conditions, the lake is typically drawn down to the low-level outlet pipe invert elevation (4,648.7 feet) during the late summer. The lake level continues to drop during the late summer due to seepage through the landslide deposits that underlie the dam until precipitation begins to refill the lake. The lowest observed drawdown in recent years is estimated to be approximately 4,640 feet. Under each of the action alternatives, IPID will monitor and manage the lake WSEL and drawdown so that the lake WSEL does not fall lower than 4,636 feet, as shown in the table.

4.5.1 No Action Alternative

Surface Water Quantity

Under the No Action Alternative, reservoir storage would remain limited to the current active storage volume of approximately 1,151 acre-feet, roughly 540 acre-feet less than the lake's historical maximum potential operational capacity of 1,698 acre-feet, at least in the short term while the existing dam remains functional and authorized for use. Gate operation controlling reservoir drawdown requires IPID personnel to use a come-along tool (a type of winch) to open and close the gate, making opening and closing the gate difficult. In the short term, the lake would continue to be drawn down to elevation 4,648.7 feet annually by late September, until fall precipitation begins to refill the reservoir. Due to embankment damage, storage capacity is reduced and a lower lake level has the potential to impact groundwater processes that may support hyporheic exchange into Eightmile Creek and adjacent wetlands.

Water released from the reservoir into Eightmile Creek between July and September would follow existing operational patterns (release of between 20 and 35 cfs over an approximate 6- to 8-week period), unless operational restrictions are met (e.g., flows in Icicle Creek are below the water rights that are senior in priority to the Eightmile Lake storage right). Historical release rates from Eightmile Lake are in the range of 40 to 50 cfs (Aspect 2022a). Therefore, in the short term, the No Action Alternative represents a continuation of the current practice of 30 to 50 percent reduction in maximum release rates relative to historical conditions.

According to the Ecology's DSO, the hazard classification for the dam has been changed from "Low" to "High." Under the No Action Alternative, the dam would be left in its current condition, vulnerable to failure, which has the potential to threaten human lives and create economic hardship for the IPID. Should a dam failure occur, downstream residences, public infrastructure, and wildlife habitat may be damaged or destroyed. Uncontrolled erosion from a dam failure could cause major channel change in Eightmile Creek. If a catastrophic dam failure occurred, it would release up to 15,000 cfs of flow into Eightmile Creek during a natural high-flow event (approximately 10,000 cfs) (Anchor QEA 2018b). Additional details on the impacts of dam failure are provided in Chapter 12, *Public Safety*. Currently, DSO requires IPID to leave the low-level outlet pipe open during the winter and early spring to reduce the risk of a dam failure; IPID has currently removed all of the stop logs that allow for a maximum elevation of 4,667-feet. The long-term operation of the dam in this manner is not consistent with DSO regulations, does not meet the DSO's safety requirements for a High Hazard dam, and ultimately may result in enforcement action by the DSO, which could include removal of the dam.

Were an enforcement action to be taken by DSO, the lake outlet elevation would likely be lowered to at least an elevation of 4,648 feet. This would likely also cause erosion and potentially a complete loss of the natural outlet of Little Eightmile Lake, which currently offers a limited amount of water storage within the Eightmile Creek System. Under either of these scenarios, the dam and low-level outlet pipe would likely no longer be operable. Lake area and volume at maximum WSEL would be substantially less than under existing conditions (particularly in the event of a catastrophic dam failure), and flows would overtop the lake outlet without passing through the low-level outlet pipe and control gate.

If the control gate and low-level outlet pipe no longer operate, flows in Eightmile Creek would generally match inflows to Eightmile Lake in a "run-of-river" manner (i.e., flows into the lake equal flows out) for much of the year, except during fall periods of initial lake refill where flows in Eightmile Creek would remain low or dry until the lake refills to the channel outlet elevation. This would mean that during the summer dry season (when inflows to the lake and streambed from snowmelt, precipitation, and groundwater are small), the flow within Eightmile Creek would be small or potentially dry in the upper reaches of the creek. Existing and historic operations practices of the

dam have supplemented 20 to 35 cfs of flow to Eightmile Creek from the low-level outlet pipe during the first 6 to 8 weeks of the summer season, typically beginning July 1 of each year. These contributions of stored water to supplement streamflow would no longer be possible under an enforcement action or dam failure. Instead, flows in the creek would entirely depend on the direct inflow from the surrounding basin. Assuming no change in operation of Colchuck Lake or other water control structures on Icicle Creek, the loss of these Eightmile Lake contributions could reduce flows in Icicle Creek in July and August by up to approximately 3 to 15 percent during normal conditions and by approximately 6 to 24 percent during drought conditions. Due to climate change, summer streamflow in the study area is predicted to be further reduced by up to 75 percent in Icicle Creek and likely within its tributaries (including Eightmile Creek). This would further reduce summer flows within Eightmile and Icicle creeks if a dam failure or enforcement action were to remove the ability to adaptively manage flows from Eightmile Lake.

The loss of the ability to control stored water releases would make it more difficult to predict flows in Eightmile Creek for downstream water users and to adaptively manage releases during the summer to meet water needs. A potential massive erosion event following a dam failure has the potential to cause large-scale channel change and damage to structures throughout Eightmile Creek and lower Icicle Creek. These changes would result in **significant impacts** on lake storage and flow releases relative to existing conditions, as there would be a permanent change in releases that would be detrimental to aquatic life and reduce IPID's ability to make withdrawals. The No Action Alternative provides no benefits to the management of surface water resources within the study area.

Surface Water Quality

Under the No Action Alternative, assuming the dam continues to operate as it does currently, there would be no changes in water quality relative to existing conditions. However, two potential scenarios could result from the No Action Alternative that would affect water quality conditions in the lake and downstream: (1) the DSO requires removal of the dam due to safety concerns, or (2) the dam fails.

Removal of the existing dam could be designed and constructed in a planned way that would limit the potential for significant construction-related water quality impacts. However, as described in the *Water Quantity* section above, dam removal would lower the lake's outlet elevation, reduce lake storage, and reduce cool-water lake contributions to streamflow during summer low-flow periods downstream in Eightmile Lake and Icicle Creek. Such changes in hydrology, which could reduce flows in Icicle Creek in July and August by up to approximately 24 percent during drought conditions, could result in **significant impacts** on summer stream temperature and DO levels relative to existing conditions.

A catastrophic dam failure would ultimately result in similar long-term impacts on stream temperature and DO as the dam removal scenario described above, by reducing lake storage and contributions to downstream flows during the summer low-flow period. A catastrophic dam failure and the resultant release of stored water could also result in substantial downstream erosion, sediment transport, and flooding in Eightmile Creek and Icicle Creek to the confluence with the Wenatchee River. In addition to long-term impacts on water temperature and DO, a catastrophic dam failure would result in **significant impacts** from substantially increased turbidity from suspended sediment. Additionally, significant water quality impacts could result from mobilization of pollutants–including bacteria, nutrients, pesticides, and hazardous materials–from floodplain areas subject to sudden inundation by floodwaters.

Climate Change and Surface Water

With climate change, summer streamflow in the study area is predicted to be reduced by up to 75 percent in Icicle Creek and likely within its tributaries (including Eightmile Creek) compared to present-day flows. This will further reduce summer flows within Eightmile and Icicle creeks, and if a

dam failure or enforcement action were to occur, there would be extremely limited ability to manage flows in Eightmile Creek for instream use or for downstream water users (i.e., release water stored during the wet season to supplement dry season flow rates). Given the limited ability to manage reservoir storage and outflow, the ability for IPID to adaptively operate the reservoir in response to changes in inflow timing and magnitude is limited. This represents a **significant impact** as there would be a substantial reduction in the ability to manage instream flows to support aquatic life and allow water rights holders to make withdrawals.

The No Action Alternative provides no benefits to future management for surface water resources with consideration of climate change within the study area.

4.5.2 Alternative 1: Narrow Spillway with Gates

Surface Water Quantity

Alternative 1 includes replacement of the existing dam with an earthen embankment and reinforced concrete dam structure equipped with automated control gates over the primary spillway. The gates would allow IPID to control the water level within the top 4 feet of the lake, up to a maximum elevation of 4,671.0 feet. Water would be released from the lake through a new 30-inch diameter low-level outlet pipe/siphon. This would allow the lake to be drawn down to a low-water surface elevation of 4,636 feet, which would allow access to stored water without pumping. IPID would release water during the late summer to maintain the water supply available for authorized diversions and instream flows in Icicle Creek. Releases through the low-level outlet pipe would be controlled by an automated plug valve at the downstream end of the pipe. IPID would have the ability to adjust the valve remotely to release the flows needed to meet downstream water supply and instream flow needs.

Alternative 1 provides an operational drawdown of up to 35 feet and up to 2,000 acre-feet of storage without pumping. The increased storage would provide additional instream flow based on releasing up to an additional 600 acre-feet of water. Releases from the reservoir would be managed remotely by IPID and would be between 20 and 35 cfs from June through August. Release rates would be within limits of trust donation quantities and in accordance with terms of agreement; release rates would continue to vary depending on seasonal hydrology, instream flow rules, and irrigation needs. Additional storage capacity would allow IPID to release increased flow rates and/or increase the duration of flow releases (i.e., potentially release for more than 8 weeks or at maximum flow rates exceeding 35 cfs). During the winter months, additional inflow would be captured and stored within the reservoir rather than conveyed downstream. This would result in a minor reduction (less than 1 cfs on average) in wet season flow rates. Wet season flow rates are typically between 15 and 60 cfs (see Table 4-3), so a reduction in 1 cfs on average would be less than significant.

Alternative 1 would allow the lake to fill to a level that provides up to 4.8 acres more lake surface area than existing conditions (a 6 percent increase over existing conditions), and would also allow the lake to be drawn down to a level to provide a lake area of 2.5 acres less than could occur under existing conditions (a 6 percent decrease over existing conditions). Although the lake area has a potential for larger fluctuations as compared to existing conditions, the relatively small increases and decreases of 6 percent or less would not substantially alter water resources in the lake. This minor percent variation would not substantively change lake hydrology.

Alternative 1 would have **substantial benefits** to surface water resources because it provides IPID the ability to optimize reservoir operation, including water storage and downstream release for irrigation supply, and augmentation of instream flows during both drought and non-drought years. The combined total use for storage and instream flow with Eightmile Creek would remain within the limits of existing storage water right and there would not be enlargement of existing rights. There are **no significant adverse impacts** on surface water quantity for Alternative 1.

Surface Water Quality

No significant adverse impacts on water quality are expected from operations under Alternative 1. The greater potential range in maximum and minimum water surface elevations in the lake relative to existing conditions would represent relatively small changes in maximum and minimum lake surface area (a 6 percent increase/decrease). As noted in the *Water Quantity* section above, this small variation would not substantially change lake hydrology, and it would also not substantially change water quality conditions in the lake. Shoreline conditions would remain similar to existing lake levels in terms of riparian vegetation coverage (shading), nature of the adjacent bedrock and talus slopes (erosion potential), and proximity to human recreational uses (potential for exposure to camping litter, bacteria).

The greater water storage potential for Alternative 1 relative to existing conditions, and the greater flexibility for managing release rates during a wider range of conditions in both drought and non-drought years, could provide a substantial benefit for downstream water quality in Eightmile Creek and Icicle Creek during summer low-flow conditions. Augmenting baseline streamflows with cool water releases from the low-level outlet pipe could benefit downstream temperature and DO conditions in particular, when baseline water temperatures are highest and DO levels are lowest.

The greater storage potential of the lake under Alternative 1 provides opportunity for some additional peak flow attenuation relative to existing conditions, which could reduce excessive sediment transport and elevated turbidity levels during high-flow conditions. However, as described in the *Water Quantity* section above, wet season flows rates would be reduced by less than 1 cfs on average under Alternative 1, so any benefits to turbidity levels would be minor under most conditions.

Climate Change and Surface Water

Given the increased ability to manage reservoir storage and outflow during both drought and non-drought years, implementation of Alternative 1 would improve IPID's ability to adaptively operate the reservoir in response to changes in inflow timing and magnitude as a result of climate change. The ability to release flows stored during the wet season during dry periods becomes an increasingly valuable tool to sustain flows for aquatic life in Eightmile and Icicle creeks and to manage downstream water uses in real-time. This increased adaptive capacity represents a substantial benefit when considering climate change.

4.5.3 Alternative 2: Wide Spillway without Gates

Surface Water Quantity

Alternative 2 includes replacement of the existing dam with an earthen embankment and reinforced concrete dam structure with a fixed crest elevation. The crest would be set at an elevation of 4,671.0 feet, providing a maximum storage equivalent to Alternative 1. Water would be released from the lake through a new 30-inch diameter low-level outlet pipe/siphon. This would allow the lake to be drawn down to a low water surface elevation of 4,636 feet without pumping. IPID would release water during the late summer to maintain the water supply available for irrigation and instream flows in Icicle Creek. Releases through the low-level outlet pipe would be controlled by an automated plug valve at the downstream end of the pipe. IPID would have the ability to adjust the valve remotely to release the flows needed to meet downstream water supply and instream flow needs.

As with Alternative 1, Alternative 2 would provide an operational drawdown of 35 feet and up to 2,000 acre-feet of storage without pumping. The increased storage would provide additional instream flow based on releasing up to an additional 600 acre-feet of water. Changes in release rates and durations are approximately the same as Alternative 1. Changes in lake surface area would also be approximately the same as Alternative 1. The primary difference would be that the

lake level would be held at 4,671 feet throughout the spring, rather than being held at 4,667 feet during late spring and then filled to 4,671 feet as summer approaches, as would be the case with Alternative 1.

Alternatives 1 and 2 have identical key water resource parameters, summarized in Table 4-8. The usable storage volume, peak water level, minimum water level, and typical and minimum flow rates are the same for the two alternatives. The primary difference between the alternatives is that Alternative 1 allows for flexibility in controlling water levels to respond to storm events by raising or lowering a gate over the primary spillway. This would typically only affect the flow rates in Eightmile Creek when the gates are lowered to spill water during a storm event. Flow rates in the creek and the rate of release would otherwise be similar between the two alternatives. Alternatives 1 and 2 generally have the same influence on water resources within the study area, and the differences between the two alternatives in terms of water resources are minor.

Like Alternative 1, Alternative 2 would have **significant benefits** to surface water resources because it provides IPID the ability to optimize reservoir operation, including water storage and downstream release for irrigation supply, and augmentation of instream flows, during both drought and non-drought years. There are **no significant adverse impacts** on surface water quantity for Alternative 2.

Surface Water Quality

Similar to Alternative 1, **no significant adverse impacts** on water quality are expected from operations for Alternative 2. With the same high and low-water surface elevations, lake surface areas, and lake volumes as Alternative 1, Alternative 2 would increase lake storage potential relative to existing conditions and increase the ability to release stored water during summer low-flow periods, providing substantial benefits for temperature and DO in Eightmile Creek and Icicle Creek.

Climate Change and Surface Water

As with Alternative 1, given the increased ability to manage reservoir storage and outflow, Alternative 2 would improve IPID's ability to adaptively operate the reservoir in response to changes in inflow timing and magnitude as a result of climate change. This increased adaptive capacity represents a **substantial benefit.**

4.5.4 Alternative 3: Narrow Spillway without Gates

Surface Water Quantity

Alternative 3 includes replacement of the existing dam with an earthen embankment and reinforced concrete dam structure with a fixed crest elevation. The crest would be set at an elevation of 4,667.0 feet, equivalent to the crest height for the No Action Alternative (see Table 4-8). Water would be released from the lake through a new 30-inch diameter low-level outlet pipe/siphon. This would allow the lake to be drawn down to a low-water surface elevation of 4,636 feet, which would allow access to stored water without pumping. IPID would release water during the late summer to maintain the water supply available for authorized diversions and instream flows in Icicle Creek. Releases through the low-level outlet pipe would be controlled by an automated plug valve at the downstream end of the pipe. IPID would have the ability to adjust the valve remotely to release the flows needed to meet downstream water supply and instream flow needs.

This alternative provides an operational drawdown of 31 feet and up to 1,698 acre-feet of storage without pumping. The increased storage would facilitate greater potential instream flow when compared to the No Action Alternative, but less operational flexibility compared to other action alternatives. IPID would have up to 1,698 acre-feet of active storage under this alternative. The increased storage would provide additional instream flow based on releasing up to an additional 298 acre-feet of water. Releases from the reservoir would be managed remotely by IPID and would be

less than 20 to 40 cfs between the months of July and August. Release rates would continue to vary depending on seasonal hydrology and irrigation needs. Additional storage capacity over the No Action Alternative would allow IPID to release slightly increased flow rates and/or slightly increase the duration of flow releases, although to a lesser degree than under Alternatives 1 and 2 (i.e., potentially release for more than 8 weeks or at maximum flow rates exceeding 40 cfs). Given the lower total storage volume, in drought years or in the future with climate change, IPID may have reduced ability to supplement instream flows or provide additional water for other uses under Alternative 3 when compared to Alternative 1 or 2.

During the winter months, additional inflow would be captured and stored within the reservoir rather than conveyed downstream. This would result in a minor reduction (less than 0.5 cfs on average) in wet season flow rates. Wet season flow rates are typically between 15 and 60 cfs (see Table 4-3), so a reduction in 0.5 cfs on average would be **less-than-significant**.

Alternative 3 would have **moderate benefits** to surface water resources because it provides IPID the ability to improve reservoir operation, including water storage and downstream release for irrigation supply, and augmentation of instream flows; benefits are to a lesser extent than Alternatives 1 and 2, and these benefits may not be able to be provided during drought years. There are **no significant adverse impacts** on surface water quantity for Alternative 3.

Surface Water Quality

Similar to Alternatives 1 and 2, **no significant adverse impacts** on water quality are expected from operations for Alternative 3.

With a greater drawdown potential and a maximum lake water level equivalent to the existing dam, Alternative 3 would improve usable storage capacity, and its operations would improve the ability to manage releases of stored water for downstream uses relative to existing conditions. Alternative 3 would have a lower maximum lake water level (4 feet lower) and lower active storage capacity (302 acre-feet less) than Alternatives 1 and 2, however, and it would have less ability to supplement instream flows during drought conditions when compared to Alternatives 1 and 2. Alternative 3 is therefore considered to have **moderate benefits** to water quality through its potential to moderate downstream water temperatures and DO levels during summer low-flow periods.

Climate Change and Surface Water

Given the increased ability to manage reservoir storage and outflow relative to existing conditions, Alternative 3 would improve IPID's ability adaptively operate the reservoir in response to changes in inflow timing and magnitude as a result of climate change. This increased adaptive capacity represents a **moderate benefit**, but to a lesser degree than the benefit provided by Alternatives 1 and 2. During future drought years, Alternative 3 may not be able offer such benefits.

4.6 Avoidance, Minimization, and Mitigation Measures

4.6.1 Construction

During construction of any action alternative, standard in-water construction and demolition BMPs would be implemented in accordance with environmental regulatory permit requirements. To minimize potential impacts on water resources, construction is planned as a single construction season to limit the duration of modified flows. If construction could not be completed in one season, actions would be taken to secure the dam for overwintering. Areas that could be overtopped would be secured and stabilized (hardened) with rock. All equipment would be stored on-site or removed if

feasible. The outlet pipe would be in working order, and the lake would be held at the lowest level (elevation 4,632 feet) for the winter. The relevant water quality BMPs will be implemented for all construction activities with the potential to create water quality impacts in Eightmile Lake and in Eightmile Creek, including activities associated with upland work such as road improvement, trail rerouting, and repeater station installation.

Water quality BMPs common to all action alternatives include the following:

- Cofferdams and/or other appropriate measures will be used to isolate dam and spillway construction work areas from open water in Eightmile Lake and active flows in Eightmile Creek.
- Temporary erosion and sediment control measures will be implemented to limit sediment inputs to receiving waters during and after construction.
- Cleared upland areas will be restored and replanted with appropriate native herbaceous and woody species to stabilize soils following construction.
- Spillage of concrete and releases of other construction materials into the water will be prevented through isolation of the work area and implementation of proper waste handling measures. Poured concrete will be allowed to cure prior to contact with any surface water.
- Pollution control measures will be implemented to ensure appropriate storage, handling, and use of petroleum products and other potential pollutants on-site during construction. Spill response materials will be maintained on-site during construction.
- During construction, the IPID will conform to all Ecology DSO requirements, which may include development of an Emergency Response Plan, among other requirements, and will conform to all special requirements for working in the Alpine Lakes Special Warranty Deed Area.

4.6.2 Operational

Under all action alternatives, operation of the dam will be improved relative to existing conditions, with the ability to better time and manage releases. The action alternatives will allow for greater adaptive management, including storage and water releases to reduce flooding risk, provide beneficial instream flows during drought years, and generally improve safety and reliability of operation.

4.7 Significant Unavoidable Adverse Impacts

No significant and unavoidable adverse impacts on water resources within study area would occur under Alternatives 1, 2, and 3. Under the No Action Alternative, the following significant impacts may occur:

- A catastrophic dam failure would have significant and unavoidable adverse impacts on the ability to store water in Eightmile Lake and control releases into Eightmile Creek and subsequently Icicle Creek. Uncontrolled erosion would also likely cause significant channel change within Eightmile Creek and potentially in Icicle Creek.
- Significant impacts on water quality would result from reduced storage volume with downstream impacts on instream flow, groundwater supply, and adjacent wetland process.
- Significant adverse impacts on water quality would result from such a dam failure through increased suspended sediment and turbidity levels, increased pollutant mobilization due to

flooding, and increased water temperatures and decreased DO levels downstream as a result of reduced lake storage and releases during summer low-flow periods. A DSO enforcement action would also likely have similar adverse impacts on the ability to store water in Eightmile Lake and control releases into Eightmile Creek and Icicle Creek. Loss of operation of the dam would likely mean that IPID would be unable to meet early season irrigation demand and reduce their ability to manage instream flows throughout the year.

- Significant impacts on the ability to respond to climate change would result from reduced adaptive management for storage volume and regulation of discharge from the dam.

CHAPTER 5: GROUNDWATER RESOURCES

This chapter describes the groundwater resources within the area of influence of Eightmile Lake that may be affected by the project.

Key findings for Groundwater

- Natural groundwater flows through the sediments underneath the dam. The main source of the groundwater is Eightmile Lake. Groundwater discharges a short distance east of the dam to Eightmile Creek.
- There is a strong relationship between the groundwater flow and flows in Eightmile Creek. This groundwater flow is a continual source of baseflow to Eightmile Creek.
- Impacts on the groundwater flow can result from construction dewatering, but these will be localized and temporary. The resultant reduction in groundwater discharge to Eightmile Creek will be offset by the dewatering discharge to the creek.
- Impacts on groundwater flow occur seasonally as a result of lake drawdown (both naturally and through dam operations). However, resultant decreases in groundwater discharge to Eightmile Creek are only a small percent of total creek flow due to operational discharges from the dam.
- There are no unavoidable adverse impacts on groundwater resources due to any of the action alternatives.
- Under the No Action Alternative, should the dam be removed, be breached, or fail, reductions in groundwater contributions to streamflow may increase the number of days when instream flows are not met and decrease the ability of surface water rights holders to divert water from Icicle Creek.

5.1 Methodology

The study area for this chapter is the Icicle Creek Subbasin of the Wenatchee River Basin from the mouth of Icicle Creek upstream to the headwaters of Eightmile Lake, the same as the Surface Water study area. The area of the Icicle Creek Subbasin that feeds the upper reaches of Icicle Creek, above the confluence with the mouth of Eightmile Creek, is not included in the study area (see **Figure 4-1**).

The affected groundwater environment and water quality were characterized by a review of existing studies and data. Conceptual hydrogeologic analysis was used to evaluate both the operational and construction impacts from the various alternatives. In addition, in the case of the operational impacts, a spreadsheet analysis using Darcy's Law of groundwater flow was also used to estimate impacts.

For the EIS evaluation, short- and long-term (construction and operational) impacts are considered significant if they would negatively affect groundwater users or if they would result in changes of the groundwater contribution to streamflow that would reduce instream flows to levels that are detrimental to aquatic life and/or reduce the ability of water rights holders to exercise their rights.

Darcy's Law states that groundwater discharge through a porous medium is directly proportional to the hydraulic gradient (the change in water level divided by the distance over which the change occurs), hydraulic conductivity (a measure of permeability in porous media), and cross-sectional area over which the flow occurs. Darcy's Law is defined by the equation:

$$Q = KA(dh/dl)$$

where Q = discharge rate, K = hydraulic conductivity, A = cross-sectional area, dh/dl = hydraulic gradient (change in head, i.e., water level, over change in length)

Concerning groundwater quality, construction and operational impacts would be significant if water quality conditions are out of compliance with Washington State groundwater quality standards, and if the groundwater contribution to baseflow causes existing surface water background conditions to be degraded beyond variations allowed by Washington State standards for fresh waters (WAC 173-201A).

5.2 Regulatory Context

The waters of the State of Washington, including groundwater, are a public resource. Individuals and groups can be granted a right by the state, known as a water right, to use up to a defined volume of water for a defined purpose and in a specific place. Groundwater rights in Washington are governed by Chapter 90.44 RCW, which is described in more detail in Chapter 6, *Water Rights*. Groundwater rights are also subject to instream flow rules for Water Resource Inventory Area (WRIA) 45 governed by Chapter 173-545 WAC, which is also described in Chapter 6.

Groundwater is typically captured for use by wells. Wells are regulated by Chapter 18.104 RCW and Chapter 173-160 WAC. Groundwater quality is regulated by Chapter 173-200 WAC. The various statutes and regulations that apply to groundwater in the study area are listed in Table 5-1.

Table 5-1. Regulations and Guidelines Applicable in the Study Area

Program, Plan, or Policy	Description
Chapter 18.104 RCW	Water Well Construction
Chapter 90.44 RCW	Regulation of Public Groundwaters
Chapter 90.54 RCW	Water Resources Act of 1971
Chapter 173-160 WAC	Minimum Standards for Construction and Maintenance of Wells
Chapter 173-200 WAC	Water Quality Standards for Groundwaters of the State of Washington
Chapter 173-545 WAC	Instream Resources Protection Program—Wenatchee River Basin, WRIA 45

5.3 Affected Environment

Groundwater is an important resource within the study area. At Eightmile Lake, surface water infiltrates beneath the lake to become groundwater; much of this water discharges downstream of the dam, providing an important component of baseflow within Eightmile Creek. Without the groundwater contribution to Eightmile Creek below the dam, the creek would be dry or nearly dry late in the season when there is no direct discharge from the dam. In the lower part of the subbasin, near

the City of Leavenworth, groundwater is a major source of potable and irrigation water, as well as providing water for the LNFH.

This section describes the general hydrogeologic setting for groundwater within the study area as well as by sub-region (i.e., Alpine Lakes, upper Icicle Creek, lower Icicle Creek). The section ends with a discussion of groundwater quality in the study area. Groundwater use is regulated by water rights, as discussed in Chapter 6.

5.3.1 Hydrogeologic Setting

As described in more detail within Chapter 7, *Geology*, bedrock geology dominates most of the study area. Unconsolidated sediments overlie the bedrock at scattered locations in the Alpine Lakes Wilderness, along Icicle Creek and its tributaries, and more extensively near the City of Leavenworth along lower Icicle Creek and the Wenatchee River. Groundwater is mainly derived from the infiltration of rainfall and snowmelt within the study area. Additionally, surface water is a major contributor to groundwater recharge in the lowest part of the subbasin—the area between the LNFH and the Wenatchee River. Infiltration can be limited where precipitation falls on bedrock, particularly in areas with steep slopes; in these areas, most precipitation runs off to become surface water. However, in areas where the surface geology is comprised of unconsolidated sediments, the amount of infiltration is greater. The amount of infiltration in these areas is largely determined by how permeable the sediments are, as well as vegetation, land use, and topography.

Groundwater flow generally follows topography, flowing from higher to lower elevations. In the upper subbasin, groundwater mainly discharges to the lakes and creeks. In the valley portion, groundwater generally flows sub-parallel to Icicle Creek before turning sub-parallel to the Wenatchee River in the downstream part of the subbasin. Here, groundwater discharges either locally to Icicle Creek or the Wenatchee River, or discharges somewhere farther downstream on the Wenatchee or Columbia rivers.

In the valley setting of the lower part of the subbasin, there is likely a high degree of hydraulic continuity between the groundwater in the unconsolidated sediments and surface waters. This is clearly demonstrated by well testing and the seasonal water level responses in wells at the LNFH (Reclamation 2010). At the hatchery, testing has demonstrated that water flowing in the Hatchery Channel actively recharges the groundwater, while drawdown is greater when the channel is dry. Conditions are expected to be similar for wells near Icicle Creek and the Wenatchee River.

The physical characteristics of the geologic units supporting aquifers primarily control the movement and occurrence of groundwater. Logs of wells completed in the bedrock aquifer generally report low yields, on the order of 1 gallon per minute (gpm), although yields of up to 15 gpm are occasionally reported (Ecology 1995). These wells typically serve single domestic households. Groundwater is more abundant in the unconsolidated-sediment aquifers, particularly where the sediments are coarse grained, with yields typically ranging from 5 to 100 gpm (Ecology 2019a). Where the unconsolidated sediments are fine grained, well yields are low to insignificant. Fine-grained units may act as barriers to groundwater flow and are referred to as confining layers. The occurrence and movement of groundwater is described further below by sub-region.

5.3.2 Groundwater Quantity

Eightmile and Other Alpine Lakes

Within the Eightmile Lake and the other alpine lake basins, groundwater is a minor component of the water budget except at some localities, such as the lower end of Eightmile Lake, where the rate of surface water infiltration is relatively high. This is because the surface geology in the Alpine Lakes Wilderness portion of the study area is dominated by metamorphic and intrusive igneous rocks

(bedrock). Unconsolidated sediment deposits are limited to sporadic talus slopes, landslide deposits at Eightmile Lake, and limited alluvial deposits along Eightmile and Snow creeks. As described in the FPEIS (Ecology 2019a), "*given the prevalence of low-permeability bedrock and the steep terrain, lake hydrology is expected to be dominated by precipitation and snowmelt runoff, with groundwater recharge and discharge a relatively minor component of the water budget.*"

With the dominance of bedrock and steep topography, the amount of groundwater recharge is limited. Flow is expected to be downslope toward and discharging to the lakes, supporting lake levels. When the lakes are full due to spring runoff or storage operations, they may provide limited recharge back to the bedrock aquifer, temporarily reversing the more typical discharge relationship. Below the lakes, groundwater flow is down valley along the drainages toward Icicle Creek. Where discontinuous alluvial sediments occur along the creeks, groundwater within these sediments may provide baseflow to the creeks, particularly where the sediments are truncated by bedrock.

As described in Chapter 7, Eightmile Lake was formed when a landslide created a natural impoundment across Eightmile Creek around 11,000 years ago. The landslide deposits have a variable permeability depending on their content, but it is much higher than the surrounding bedrock and allows groundwater flow through the natural impoundment. Much of this groundwater flow through the landslide deposits appears to discharge to Eightmile Creek a short distance downstream from the lake, with groundwater seeps noted at three locations about 300, 600, and 1,200 feet east of the dam (Aspect 2019). This flow provides a large natural groundwater discharge out of Eightmile Lake. The flow rate through these deposits varies seasonally with the stage of the lake, being higher in the spring and when active reservoir storage is taking place. The flow rate of this natural groundwater discharge has not been measured; however, it is estimated to be about 5 cfs (Jantzer, pers. comm.; Aspect 2022a). An analysis by the EIS team indicates that the groundwater discharge rate could be reduced roughly by half when the lake is at its lowest levels.

Although not mapped as being dammed by a landslide deposit (Tabor et al. 2017), Colchuck Lake may also have groundwater discharge. This is postulated due to a note on the Proof of Appropriation water right form for IPID's storage right on Colchuck Lake, which states "*owing to the looseness of [the] formation at a point on the west side of the Lake … it was deemed advisable to raise the water surface of [the] reservoir to the 5 foot storage instead of 10 foot.*" Groundwater discharge out of Snow and Nada lakes would be small as they are not naturally dammed by landslide deposits.

Upper Icicle Creek Subbasin

The Icicle Creek Subbasin can be roughly divided into two parts: the areas upstream and downstream from a point roughly coincident with the LNFH diversion at RM 4.5. In the upper subbasin, the geology along Icicle Creek and its tributaries is similar to that in the Alpine Lakes area—bedrock dominated with discontinuous patches of unconsolidated alluvial and glacial deposits, and groundwater is a relatively minor part of the water budget. The creeks generally run in narrow valleys with steep walls. Because the setting is similar to the Alpine Lakes area, the groundwater occurrence and flow are similar. Most precipitation and snowmelt runs off the bedrock valley walls with limited infiltration. The unconsolidated areas may have larger amounts of infiltration, but being discontinuous, groundwater flow through the unconsolidated sediments is focused locally on the creeks. Most groundwater flow, both from the bedrock and the unconsolidated sediments, is expected to discharge to the creeks, although during periods of high creek flow, the creeks may temporarily provide groundwater recharge. The slight amount of groundwater discharge to Icicle Creek and its tributaries provides a small measure of baseflow most of the year and likely helps support late season flows in the creeks.

There are no large wells in this portion of the subbasin, and groundwater use is limited. A review of well logs at Ecology's online well log database indicates there are about 38 permit-exempt wells within the study area above the LNFH diversion on Icicle Creek (Ecology 2021f). These are mostly

single-domestic wells, although the area contains several Group B[1] wells. Many of the wells are likely only used on a seasonal basis.

Lower Icicle Creek Subbasin

Near the LNFH, Icicle Creek leaves its narrow, bedrock-dominated valley and enters a broader alluvial valley with extensive unconsolidated sediments. This change in setting has a large effect on groundwater occurrence and flow. Unlike the bedrock-dominated setting of the upper subbasin, where groundwater is only a minor part of the overall water budget, in the lower subbasin, groundwater plays a significant role in the water budget. The unconsolidated sediments hold a large amount of groundwater, much of which is in hydraulic continuity with Icicle Creek and the Wenatchee River.

The surficial geology on the western valley floor is mapped as alluvial deposits, while along Icicle Creek and the eastern side of the valley floor glacial drift deposits are present (Tabor et al. 1987). The glacial deposits extend partway up the eastern valley slopes, covering sandstones and conglomerates of the Chumstick Formation. The western valley slopes are intrusive igneous and metamorphic bedrock, an extension of the bedrock from the upper subbasin. The unconsolidated sediments in the valley are generally 150 to 250 feet thick depending on location (Ecology 2019a).

Recharge from precipitation and snowmelt is much larger on the alluvial and glacial drift deposits than on the bedrock. Additional recharge occurs where Icicle Creek is above the water table, as well as seasonal leakage from unlined canals. While most of IPID's canal on the east side of the valley is lined, the Cascade Orchards Irrigation Company (COIC) canal on the western edge of the valley is unlined (Ecology 2019a). Seepage losses out of the COIC canal have been identified at about 5 percent of the total canal flow, or about 0.3 cfs (Ecology 2019a). Additionally, the LNFH operates a man-made channel off of Icicle Creek known as the Hatchery Channel. This channel is periodically inundated with water diverted from Icicle Creek to provide recharge directly to the unconsolidated aquifers near the fish hatchery's wells (Reclamation 2010).

Both the alluvial and glacial deposits contain coarse-grained sand, gravel, and cobbles, as well as zones with finer-grained silts and clays. The coarse-grained zones without a high fine-grained content are permeable, readily transmit water, and form aquifers where saturated. The finer-grained zones restrict water flow and, where contiguous, form confining layers. Studies of the hydrogeology at the LNFH indicate that two aquifers are present: a shallow unconfined aquifer that extends over most of the valley and a more limited, deeper confined aquifer (Reclamation 2010). In the area of the hatchery, the shallow aquifer is up to 200 feet thick, although it is more typically 80 to 100 feet thick. The deep aquifer is 30 to 50 feet thick and is thought to be semi-confined because the overlying layers of silt and clay do not appear to be continuous across the valley (Reclamation 2010). Pumping tests of hatchery wells found the shallow aquifer to be very transmissive, with transmissivity values ranging between 25,000 square feet per day (ft^2/d) and 85,000 ft^2/d, while the deeper aquifer is less permeable with a calculated transmissivity of about 6,000 ft^2/d (Reclamation 2010). The fish hatchery operates a series of wells in both aquifers, with well yields up to 4,000 gpm.

Groundwater flow is influenced by the pumping of the fish hatchery wells, drawing groundwater toward the wells, and by the operation of the Hatchery Channel, recharging the aquifer. Otherwise, flow is generally northerly in a down-valley direction.

[1] Group B public water systems have 15 or fewer connections and serve fewer than 25 people per day. All public water systems that exceed these limits are considered Group A systems. The only Group A water system in the study area is the City of Leavenworth.

In addition to the LNFH wells, there are roughly 280 wells in the lower subbasin (based on well log records at Ecology). However, there are no other major producers of groundwater outside of the hatchery within the study area.[2] Groundwater rights records indicate well yields of 10 to 50 gpm for wells with rights (see Chapter 6). Domestic and Group B wells typically have even smaller yields. While the Eightmile Dam and its operation do not directly affect groundwater in the lower subbasin, any impacts the dam may have on reducing streamflow within Icicle Creek may increase the dependence on, and potentially increase the use of, groundwater.

5.3.3 Groundwater Quality

The quality of groundwater in both the bedrock and unconsolidated aquifer is variable depending on the local geology, the quality of the surface water providing recharge to the aquifers, and the anthropogenic impacts such as agriculture and septic systems. Groundwater quality within the Upper Wenatchee River Watershed is considered to be excellent but deteriorates slightly in the Icicle Creek and Leavenworth areas (Ecology 2007a). However, the City of Leavenworth's water system plan indicates that their wellfield (just outside the study area) has excellent water quality (Varela & Associates 2018).

Groundwater quality is very good at the LNFH, being generally cold, pathogen free, and suitable for fish growth (McMillen Jacobs Associates and DJ Warren Associates 2016). A 1992 USGS study at the hatchery also found good groundwater quality (Drzymkowski and Swift 1992). However, while not particularly high for groundwater, the phosphorus concentration in the groundwater at the hatchery occasionally exceeds the hatchery's NPDES permit interim average monthly phosphorus concentration limit of 0.17 micrograms per liter (µg/L) (Hildenbrand 2019).

5.4 Construction Impacts

5.4.1 No Action Alternative

Because the No Action Alternative involves no construction, no construction-related impacts would occur.

5.4.2 All Action Alternatives

Groundwater flow is controlled by the permeability of the sediments below the water table, cross-sectional area of the sediments through which the flow occurs, and the head drive across the sediments (i.e., the change in water elevation) at the top and bottom of the flow zone. Under construction, the permeability of the sediments below the dam through which groundwater flow occurs would remain unchanged from existing conditions. However, the lake stage elevation would be modified during construction so that it will be different than that of the No Action Alternative. Consequently, groundwater flow would change during the construction from the existing condition. Impacts from construction from any of the action alternatives would be approximately the same.

Impacts on groundwater would only occur in the immediate area of the dam. Downstream, both in the bedrock-dominated portion of the basin and the lower alluvial basin, no impacts would occur due to the construction of any of the alternatives because the groundwater in the area around the lake is

[2] There are other large groundwater users in the region, specifically the City of Leavenworth and the Leavenworth Golf Course. However, the wellfields for both are near the Wenatchee River a short distance outside the study area.

disconnected from groundwater downstream, and there would be no significant changes in the groundwater contribution to stream baseflow.

Some portions of the construction would have no impact on groundwater, for example, the transportation of equipment and materials. Site preparation would have only a minor impact. The removal of trees would slightly increase the amount of groundwater recharge as the trees would no longer be removing groundwater by transpiration. However, site preparation would also likely increase runoff and, therefore, decrease groundwater recharge. Considering the small area (approximately 8,500 to 10,000 square feet) involved and that the two effects are offsetting, in total, site preparation for construction would have a minor impact on groundwater.

The only construction activities expected to have possibly significant impacts on groundwater are the early drawdown of the lake, the operation of the new outlet pipe during construction, and dewatering of work areas during construction. Normally, the lake is not fully drawn down until late summer. However, the year the dam improvements will be made, IPID will draw down Eightmile Lake early. The early drawdown of the lake would lower the lake stage, thereby decreasing the head drive controlling groundwater flow under the lake. Since essentially all of the groundwater flow at the lower end of the lake is discharged as baseflow to Eightmile Creek, the flow level in the creek will decrease. Essentially, the groundwater baseflow component of the Eightmile Creek streamflow will reach its typical late summer value much earlier in the season.

The construction sequence calls for the installation of the new outlet pipe early in the construction cycle. The outlet pipe would be operated throughout the rest of the construction period to keep lake levels low. As described, the lowering of the lake level would reduce the head drive of groundwater flowing under the lower lake area, which would reduce the groundwater baseflow component to Eightmile Lake. However, since the outlet pipe would be discharging to the creek, the direct contribution to creek flow would likely meet or exceed the reduction from groundwater baseflow resulting from the operation of the outlet pipe.

Cofferdams would be built to keep water away from the main construction zone at the dam site. Despite the cofferdams, some water may leak into the construction area, either from the lake or from groundwater, and dewatering of the construction area may be needed. Dewatering will occur by collecting any water leaking through the cofferdams at a low spot and pumping it out of the construction area, thus preventing the leaking water from pooling next to any water-sensitive construction activities (such as pouring or curing of concrete). This dewatering would remove groundwater that would have contributed to creek baseflow. However, since any dewatering will likely be discharged downhill of the construction area and return water to the creek, there would be no net decline in streamflow.

Groundwater quality is not expected to change as a result of construction or dam operations. Since activities that could result in changes in groundwater quality, such as exposure to curing cement, will occur above the groundwater level (due to the cofferdams and dewatering), water quality changes should not occur. After construction, the types of materials beneath the water table (cement, fill, and natural sediments) will be the same types of materials that are currently beneath the water table. Therefore, no changes in groundwater quality from operation of any of the alternatives are expected.

If construction is not finished in a single season, the overwintering condition of the construction site would also affect groundwater flow. In the case of overwintering, the outlet pipe would remain open, reducing the level of the lake and thereby reducing groundwater flow under the dam area and the groundwater contribution to creek flow during that time. However, since the outlet pipe will be open, the flow from the outlet pipe would likely exceed the reduction of groundwater discharge.

Although some construction activities would have possible impacts on groundwater, in all cases, the changes in groundwater will be constrained to the immediate area around the dam site and the lower lake since the groundwater near the lake is not directly connected to groundwater farther

down valley. Additionally, direct discharge to the creek would increase during construction. Therefore, impacts on groundwater during construction would not be significant anywhere downstream from the dam, and changes in groundwater levels and availability would not occur outside the local area.

5.5 Operational Impacts

5.5.1 No Action Alternative

With no changes to the dam structure or operations, there are no expected impacts on groundwater from present-day conditions under the No Action Alternative. If in the future the dam is removed, breached, or there were a catastrophic failure, groundwater flow would be reduced from present-day values. This is because dam removal or failure will lower the lake level, reducing the head drive from the lake to the area down valley where the groundwater discharges to the creek. The result will be a lower level of the groundwater baseflow component of streamflow. Particularly when coupled with lower surface water contributions to streamflow possible under this scenario, the reduction in groundwater baseflow will likely be significant, increasing the number of days when instream flows set by 173-545 WAC (see Chapter 6) are not met and decreasing the ability of water rights holders to divert water from Icicle Creek. If surface water rights need to be curtailed, this could potentially increase the use of groundwater in the subbasin and result in significant impacts in drought years, as described below.

Reductions in streamflow due to lessening groundwater baseflow contributions would also reduce the amount of groundwater recharge to the aquifer in the alluvial valley at and below the LNFH. While not expected to rise to a level of significance in most years, the reduction in groundwater recharge in the lower portion of the subbasin could become significant in drought years, reducing the ability of groundwater uses to produce water from their wells.

5.5.2 Action Alternatives

Downstream of the dam, both in the bedrock-dominated portion of the basin and the lower alluvial basin, there are no expected significant impacts on groundwater due to the operations of any of the action alternatives since the groundwater at the dam and lake is not directly connected to the groundwater system down valley, and there would be no significant changes in the groundwater contribution to stream baseflow.

However, at the dam and in the area around the lower lake, each alternative would result in differing amounts of groundwater flow below the dam. As mentioned, groundwater flow is controlled by the permeability and area of the sediments through which the flow occurs, as well as the head drive between the top and bottom of the flow zone. The permeability of the sediments below the dam would remain unchanged with all action alternatives. However, the area of sediments below the dam would be different with each action alternative due to differing configurations of the concrete dam structures below ground. Further, operations of the different alternatives would result in differing maximum and minimum lake surface elevations, resulting in differing heads driving water through the permeable sediments underneath the dam.

Overall, the differences in groundwater flow would likely be relatively small. The difference in lake elevation at full storage between the alternatives is 4 feet; at low water (estimated as the outlet pipe elevation for each alternative), the difference is also 4 feet. These differences in head will create small changes in groundwater flow relative to the average creek flow. Small additional changes in groundwater flow under the dam would occur due to the amount of concrete used in the different alternatives because concrete will block/replace natural sediments, reducing the cross-sectional area of the natural sediments, which have a much larger hydraulic conductivity than the concrete. All

three action alternatives would have more concrete below the water table than the No Action Alternative, reducing the cross-sectional area of the natural landslide deposits that currently exist. Alternatives 1 and 3 use the same amount of concrete, while Alternative 2 uses roughly double the amount. In total, these two effects would combine to slightly reduce the estimated amount of groundwater flow underneath the dam.

The impacts would all be local to and immediately downstream from the dam since groundwater flow from under the lake and dam discharges to Eightmile Creek a short distance downstream from the dam. Although small changes in streamflow are expected due to the various alternatives, these small changes would only create de minimis changes, at the most, to the level of groundwater farther down the valley. Further, they are unlikely to impact aquatic life or impair the ability of water rights holders to exercise their rights. The largest expected reduction in the flow of Eightmile Creek under any of the action alternatives represents less than half of one percent of the flow of Icicle Creek.

Under drought conditions, the small changes due to dam operations will become slightly more important in that the groundwater component of baseflow to Eightmile Creek will become a larger percentage of the overall creek flow. However, farther down valley, the changes in groundwater due to dam operations would still be de minimis.

Alternative 1: Narrow Spillway with Gates

Alternative 1 would result in a 4-foot higher full-storage lake elevation, a 4-foot lower lake elevation at low water, and slightly decrease the cross-sectional area of sediments below the full-storage water table (due to more concrete in the dam structure than under the No Action Alternative). These factors would cause a very small decline in the amount of groundwater discharge to Eightmile Creek east of the dam, less than 0.1 cfs, at full-storage conditions and a decline of about 0.5 cfs at low-storage conditions.[3] Based on data from the Ecology Eightmile Creek gage below the dam (Station 45W003), these declines represent about 0.2 percent of the Eightmile Creek streamflow when the lake is full and about 5 percent of the Eightmile Creek streamflow when the lake levels are low;[4] this represents less than half of one percent of the streamflow of Icicle Creek.

Alternative 2: Wide Spillway without Gates

Alternative 2 would result in a 4-foot higher full-storage lake elevation, a 4-foot lower lake elevation at low water, and a modest decrease to the cross-sectional area of sediments below the full-storage water table (due to more concrete in the dam structure than under the No Action Alternative). These factors would cause a small decline in the amount of groundwater discharge to Eightmile Creek east of the dam, about 0.3 cfs, or about 0.7 percent of the Eightmile Creek streamflow, at full-storage conditions and a decline of about 0.6 cfs, or about 6 percent of the streamflow, at low-storage conditions. This represents less than half of one percent of the streamflow of Icicle Creek.

Alternative 3: Narrow Spillway without Gates

Alternative 3 would result in no change in the full-storage lake elevation from the No Action Alternative, but a 4-foot lower lake elevation at low water. It would also create a slight decrease in

[3] The analysis here and for the other alternatives was conducted using Darcy's Law, as described in the *Methodology* section above.

[4] Ecology Station 45W003 has been sporadically active from late May 2018 to the present. The full streamflow is based on the average streamflow in June 2018 and 2019, and the low streamflow is based on the average streamflow in September 2018 and 2019. June and September data are not available for 2020, 2021, and 2022.

the cross-sectional area of sediments below the full-storage water table (due to more concrete in the dam structure than under the No Action Alternative). These factors would cause a small decline in the amount of groundwater discharge to Eightmile Creek east of the dam, about 0.3 cfs, or about 0.7 percent of the Eightmile Creek streamflow, at full-storage conditions and a decline of about 0.5 cfs, or about 5 percent of the streamflow, at low-storage conditions. This represents less than half of one percent of the streamflow of Icicle Creek.

5.6 Avoidance, Minimization, and Mitigation Measures

The changes in groundwater flow during construction are unavoidable. However, they will be offset and effectively mitigated by the discharge of lake water to Eightmile Creek to keep the lake level low during construction.

During dam operations, the slight decline in groundwater flow under the dam and discharge to Eightmile Creek is an unavoidable impact based on the physics of groundwater flow. It cannot be avoided unless the proposed dam structures are changed. However, the slight decreases in groundwater discharge are relatively minor and not significant within the overall flow regime of Icicle Creek.

5.7 Significant Unavoidable Adverse Impacts

With construction and operation of the project, there would be no significant unavoidable adverse impacts on groundwater resources.

CHAPTER 6: WATER RIGHTS

The purpose of this chapter is to identify and assess any potential impacts on water rights that may occur as a result of the action alternatives and No Action Alternative during construction and operation. To support this assessment, this chapter and associated appendix (Appendix B, *Water Rights*) generally describe and summarize the water rights within the study area, including the instream flows set by rule. In addition, this chapter provides background on IPID's water right at Eightmile Dam and assesses whether the action alternatives analyzed are reasonable given IPID's existing water right authorization. However, it does not make a tentative determination of the validity and extent of IPID's water right because no application has been filed to trigger a formal review of the right. Finally, it addresses potential implementation of the project, including continued water storage and releases proposed at Eightmile Lake for both ongoing irrigation water use by IPID and for streamflow augmentation within the study area as part of the Icicle Strategy.

Water use in Washington State requires a water right. Water rights in Washington State follow the "first-in-time, first-in-right" doctrine, meaning whoever first uses water and establishes a water right has a senior right to water and, in times of scarcity, more junior water right holders must curtail their use if it would negatively affect the senior user's ability to use water. While the concept is simple, over the years, the administration of water rights has become quite complex due to changing law, policies, and regulations; court rulings; lack of uniform record keeping; and the realization of environmental and ecological needs for water.

This chapter describes the water rights within the Icicle Creek Subbasin up to the headwaters of Eightmile Lake. In no case can a water right holder, including IPID, legally divert or withdraw[1] more water than is authorized by their water right. Therefore, while water rights records can serve as a proxy for legal water use, they only represent an upper limit on legal water use as most water rights are not fully exercised year-to-year. Additionally, some water rights are no longer used (and thus may have been relinquished) but no action has triggered a determination of their validity and extent, so they are still listed in state records as being active. As a result, compilations of quantities from water right documents possibly over-estimate the actual total quantities of water authorized for use under rights that are actually valid.

The regulatory context behind water rights is explained, followed by descriptions of the water rights within the basin. Both surface water and groundwater rights are discussed, as are pertinent instream flow rules, which essentially establish water rights for streams, rivers, and lakes. Finally, the water rights are discussed in terms of how they would be affected by the various alternatives for the project.

IPID holds a water right on Eightmile Lake authorizing the storage and use of 25 cfs of water (with no maximum annual quantity specified on the water right certificate) for irrigation purposes. While the certificate does not indicate a maximum annual authorized quantity, an adjudication of the right determined that the maximum annual quantity is 2,500 acre-feet.[2] However, the current active

[1] When discussing water rights, a diversion involves diverting water from a surface water source, while a withdrawal involves using a well to produce groundwater. While occasionally the two terms are used interchangeably, within this document, the words "divert" and "diversion" always refer to surface water, and "withdraw" and "withdrawal" always to groundwater.

[2] The adjudication decree states that this annual quantity of 2,500 acre-feet is "inchoate." Inchoate water rights have not yet been used, and are, therefore, not perfected. However, since the dam was completed in 1929, IPID has been storing water. Thus some, if not all, of this 2,500 acre-feet has been used and, therefore, is perfected and no longer inchoate. That said, the perfected amount has not been determined by Ecology or by a court through an adjudication of water rights.

(single-fill) storage capacity is estimated at approximately 1,151 acre-feet[3]. When accounting for refilling of the lake during the summer, IPID estimates that it stores a cumulative total of approximately 1,464 to 2,228 acre-feet of water in the lake under a range of dry, wet, and average conditions (Aspect 2022a). IPID has indicated that, based on current water use and conservation practices by irrigators within the District, it needs 1,400 acre-feet of storage capacity at Eightmile Lake. Operationally, IPID indicates that any excess storage capacity above 1,400 acre-feet can be used for augmentation of instream flows.

Key Findings for Water Rights

- There are four major entities with diversionary rights on Icicle Creek: IPID, USFWS, COIC, and the City of Leavenworth.
- IPID has a water right on Eightmile Lake authorizing the use of 25 cfs for irrigation purposes. While the certificate does not indicate a maximum annual authorized quantity, an adjudication of the right determined that the maximum annual quantity is 2,500 acre-feet, but noted that this quantity was inchoate. It has not been determined how much of this total has been perfected through actual beneficial use of water.
- The Eightmile Dam has been eroded in the past, reducing the active storage volume to 1,151 acre-feet. However, IPID reports that additional storage capacity is regularly used through multiple partial re-fillings of the reservoir.
- IPID indicates they currently require storage of 1,400 acre-feet in Eightmile Lake to provide sufficient water for irrigation use by landowners within the District.
- IPID intends to gain an authorization for the use of water for instream flow purposes through a donation to the State Trust Water Rights Program of the portion of the right above 1,400 acre-feet, with the actual annual quantity to be ascertained through the Trust Water Right Program process for donations.
- All of the action alternatives would increase single-fill active storage volume capacity in Eightmile Lake from current conditions.
- There are no significant unavoidable adverse impacts under any of the action alternatives.
- The No Action Alternative has the potential for unavoidable impacts in the form of curtailment of diversionary rights and increased numbers of days when instream flows are not met.

With respect to water rights permitting for this project, since their Eightmile Lake water right authorizes the use of water for irrigation, IPID must gain authorization to also release water from storage for instream flow purposes. There are several methods to accomplish this. In this case, IPID intends to donate a portion of the right to the State Trust Water Rights Program (Trust) for instream flow purposes. When a trust water donation application is filed, Ecology will evaluate the historical

[3] This represents the current active, physical storage capacity at the dam with the flash boards in place at the control notch and the gate closed. Following the Jack Creek Fire, and requirements by the DSO that the flash boards remain out and that the gate remains open, the actual current active storage is less than 1,151 acre-feet, and will remain so until the dam is repaired and safety risks are addressed.

use of water under the Eightmile Lake water right to determine the quantities of water that IPID can transfer to the Trust for instream flow purposes and how much water IPID can retain for irrigation purposes.

Cumulatively, the EIS team estimates there are water rights authorizing the diversion of 185.603 cfs and 68,710.8 acre-feet per year (afy) from Icicle Creek[4]. Approximately 96 percent of the diversionary rights come from four diverters: the IPID, USFWS, Cascade Orchards Irrigation Company (COIC), and the City of Leavenworth. IPID is the largest of the these, with diversionary rights totaling 117.71 cfs and an estimated annual total of 35,315 afy.[5] In addition, there are 12 groundwater rights in the study area with a total allowed instantaneous withdrawal of 5,402.1 gallons per minute (gpm) and a total annual quantity of 6,592.6 acre-feet. The vast majority of this is used non-consumptively by the Leavenworth National Fish Hatchery (LNFH). IPID does not have any groundwater rights.

6.1 Methodology

The study area for the water rights analysis is the Icicle Creek Subbasin of the Wenatchee River Basin, from the mouth of Icicle Creek upstream to the headwaters of Eightmile Lake. The area of the Icicle Creek Subbasin that feeds the upper reaches of Icicle Creek, above the confluence with Eightmile Creek, is not included in the study area (Figure 4-2).

The Water Rights Tracking System (WRTS) and Geographic Water Rights Information System (GWIS) maintained by Ecology were used to research the water rights in the area. Ecology conducted several searches of the WRTS and GWIS for the study area to identify water rights in the area (Ecology 2021a, 2021b, 2021c). The first searched for all water rights with surface water sources within the subbasin, and the second used a GIS search for surface water points of diversion located within the study area. These searches and initial screening by the EIS team returned a total of 70 surface water rights records for the study area. Two similar searches were made for groundwater rights. This resulted in 82 groundwater rights records for the study area.

Most water rights records on WRTS contain one or more scanned documents. This documentation, as well as selected additional documentation (not scanned as part of WRTS), was reviewed. The

[4] The water right quantities reported in this EIS, including the appendix to this chapter, do not represent a determination of the validity and extent of any of the rights in the basin. The estimation of total annual quantities and other parameters of water rights in the study area were based on the review and analysis of the EIS team and do not represent determinations or estimations of water right quantities by Ecology. Ecology reviewed estimated quantities to the general extent necessary to be able to identify and understand potential effects of the project on water rights in the basin and identify any potential for impacts to basin water rights. Additional information detailing the EIS team's review of basin water rights is presented in the appendix, including methodology and assumptions. Final determinations of water right quantities can only be made by the legal determination of a court through an adjudication process.

[5] This value is believed to be a maximum and the actual total may be less. It is the sum of Qa's listed on Table A-2 in the appendix. Some of the Qa's listed on that table are estimates; see the table notes for information on how the estimates were made. Additionally, the Qa for one right, with a 1912 priority date, belonging to the City of Leavenworth, is based on the continuous operation of a diversion at the full Qi rate. Concerning a different water right held by the City, Ecology disputed the City's interpretation of the Qa that was based on the same theory. However, it appears that for the 1912-priority City right, the City's interpretation of Qa based on continual use at the Qi was not challenged because, in decisions on subsequent water right applications, Ecology determined that an annual quantity of 1,465 afy of water was valid under Leavenworth's water right portfolio, including the 1912-priority right.

review revealed location errors for points of diversion or withdrawal for some of the rights, and these rights were removed from further consideration. Records that were still in the application phase were also not considered further. The remaining records were divided by right status. Rights listed with an inactive status were removed from consideration. This final screening resulted in 45 active surface water rights and 39 active groundwater rights.[6]

For the evaluation of short-term impacts (construction), impacts on water rights are considered significant, as follows:

- Impacts are considered significant if construction would cause impairment of existing water rights due to a reduction in streamflow.

For the evaluation of long-term impacts (operational), impacts on water rights are considered significant, as follows:

- Impacts are considered significant if long-term operation of the facility would cause impairment to existing water rights due to lack of streamflow.

6.2 Regulatory Context

The waters of the State of Washington are a public resource. Individuals and groups can be granted a right by the state, known as a water right, to divert surface water or withdraw groundwater from a specific location, and use up to a defined volume of water for a defined purpose and in a specific place. Water rights in Washington are governed by Chapter 90.03 RCW for surface water and Chapter 90.44 RCW for groundwater (with certain provisions in RCW 90.03 also being applicable to groundwater use). Additionally, Chapter 90.14 RCW governs the registration of claims to water rights that were established prior to the permitting system (that was established in RCW 90.03 and RCW 90.44) and the relinquishment of water rights. Water rights in Washington State are issued and managed by Ecology. However, the courts have final adjudicative authority to determine the validity and extent of water rights within the state. The various statutes, regulations, and guidelines that are applicable to water rights in the study area are listed in Table 6-1 and described below.

Table 6-1. Regulations and Guidelines Applicable in the Study Area

Program, Plan, or Policy	Description
Chapter 90.03 RCW	Washington State Water Code
Chapter 90.14 RCW	Water Rights Registration, Wavier, Relinquishment
Chapter 90.22 RCW	Minimum Water Flows and Levels
Chapter 90.42 RCW	Water Resource Management
Chapter 90.44 RCW	Regulation of Public Groundwater
Chapter 90.54 RCW	Water Resources Act of 1971
Chapter 173-545 WAC	Instream Resources Protection Program—Wenatchee River Basin, WRIA 45
Chapter 508-12 WAC	Administration of Surface and Groundwater Codes

[6] As mentioned in the introduction to this chapter, some water rights are no longer used (and thus may have been relinquished), but no action has triggered an extent and validity determination, so they are still listed in state records as being "active." As a result, the totals listed here possibly over-estimate the actual number of current valid rights being exercised within the study area.

Program, Plan, or Policy	Description
Ecology Policy 1060	The Relinquishment, Rescission, and Abandonment of Water Rights
Ecology Policy 1120	Water Resources Program Policy for Conducting Tentative Determinations of Water Rights
Ecology Policy 2030	Municipal Water Law Interpretive and Policy Statement

As described above, water rights in Washington State operate using the prior appropriation doctrine (i.e., "first-in-time, first-in-right"). In other words, an entity first using water from a certain source has the right to fully exercise their right before others may use water from, or otherwise impede, the source. Consequently, each water right is assigned a priority date based on first use (for rights that precede the water code) or the date on which an application for a water right is filed (for rights established pursuant to the water code), which establishes the seniority of the right. Based on priority dates, junior right holders (those with rights with later priority dates) are subject to interruption of their water use when there is insufficient water to meet the needs of senior right holders (those with rights that have earlier priority dates).

Water rights provide for the diversion/withdrawal and use of water within specific limitations and provisions. There are three classes of water rights: surface water rights, groundwater rights, and reservoir, i.e. storage (both above and below ground), rights. There are also three basic phases or types of water rights: claims, permits, and certificates. Claims are an official statement claiming a right for water use that predates the state's water permitting system (1917 for surface water and 1945 for groundwater). Validity of claims can only be determined and confirmed through a legal adjudication by the courts. Permits document authorization to develop a water right, but are not a final water right. Once the water system using the permitted water is fully developed and the water is put to beneficial use, the final water right, known as a water right certificate, is issued confirming that all the conditions and provisions of the permit have been met. Beneficial use is defined in RCW 90.14.031, which states "'beneficial use' shall include, but not be limited to, use for domestic water, irrigation, fish, shellfish, game and other aquatic life, municipal, recreation, industrial water, generation of electric power, and navigation."

Part of the Groundwater Code (RCW 90.44.050) exempts certain small groundwater withdrawals from the state's water right permitting process. The law is commonly known as the "groundwater permit exemption," and such wells are commonly known as "permit-exempt wells." Although such wells do not require a water right permit, they do have water rights, with a priority date established when the water is first put to beneficial use. As with all rights, permit-exempt wells are subject to water law principles, including interruption or curtailment of use when they interfere with senior rights, including previously established minimum instream flows established through water management rules (which are equivalent to water rights).

There are two types of water right applications: new applications and change applications. A new application is simply an application to obtain a new water right permit and, by itself, does not provide any legal right to use water. A change application is an application to change an existing water right claim, permit, or certificate.

The process for obtaining a new water right is prescribed in Chapter 90.03 RCW. A water right application must be submitted to Ecology, and the date Ecology receives an application sets the priority date for any permits or certificates that result from the application. As part of the application process, the applicant must make a public notice of their application, which allows the public to be informed about the proposed water use and an opportunity to make protests to Ecology concerning the water right application.

During the processing of a new application, a Report of Examination (ROE) is written in which Ecology applies a four-part test to determine if the water right can be legally permitted. The four-part test

addresses: (1) whether the water is available, (2) whether the proposed use is beneficial, (3) whether it will impair the exercise of other water rights, and (4) whether it is not detrimental to the public welfare. A draft version of the ROE is posted for public review, providing an opportunity for comments from the public. When the review period ends and all comments have been addressed, Ecology issues a final version of the ROE and a decision on the application. If the four-part test is satisfied, Ecology proceeds to issue a water right permit.

The water right permit specifies: (1) how much water can be used, typically both at an instantaneous rate (referred to as the "Qi" and listed in gpm for groundwater rights and cfs for surface water rights) and as an annual amount (referred to as the "Qa" and listed in afy); (2) the place the water can be used; (3) the point of diversion (for surface water) or withdrawal (for groundwater); (4) the specific type(s) of beneficial use allowed; and (5) the period of use.

Once a permittee puts the water to beneficial use, fully develops the project associated with the water right, and files a proof of appropriation form, the project is reviewed by a Certified Water Rights Examiner (CWRE) to confirm the amount of beneficial use.[7] Based on the recommendation provided by the CWRE as well as Ecology's review and decision, Ecology issues a certificate for the water right.

Following certification, the allocated quantities of the water right must be fully utilized at least once every 5 years (unless it qualifies for one of a limited number of special exceptions, including municipal use, see Appendix B) in order not to be relinquished due to nonuse without sufficient cause. Relinquishment has a specific definition within water law. As described further in the Appendix B, RCW 90.14.130 – .180 governs the relinquishment of water rights, and Ecology's Policy 1060 covers specifically how Ecology deals with relinquishment. This an issue of potential concern with respect to the water right associated with the project because of uncertainty over the historical amount of water that has been stored in and released from Eightmile Lake.[8]

Change applications are processed in a similar manner to new applications, with some additional work, including reviewing the history of beneficial water use that has occurred under the underlying permit or certificate. When processing change applications, a tentative determination of the extent and validity of the right is made based on historic use. If all or a portion of the right has been relinquished for non-use, that portion of the right is not eligible for the change and is deemed to be invalid.

"Tentative determination of extent and validity" is defined by Ecology Policy 1120, as shown in Appendix B. This policy lists both when a tentative determination should be made and when it is not warranted. Tentative determinations are made as part of Ecology's or a water conservancy board's permitting activities. According to Policy 1120, they are required to evaluate rights that are the subject of change applications but are not warranted when a water right is donated to the State Trust Water Rights Program (described below).

[7] WAC 173-165 established CWREs in Washington State and has an effective date in 2012. Prior to this time, review of beneficial use prior to certification was accomplished directly by Ecology.

[8] IPID conducted a multi-fill analysis (Aspect 2022a) for Eightmile Lake based on a water-balance model for a range of historical operational uses and representative wet, dry, average years. Based on this analysis and IPID's description of historical practices, IPID estimates that while the active storage volume of the lake currently is about 1,151 acre-feet, when multi-fill events (runoff into the active storage portion of the lake after releases have started for the year) are considered, the irrigation season storage may regularly be over 1,400 acre-feet, and may exceed 2,500 acre-feet in some years. While WAC 508-12-270 specifies that only the initial reservoir filling is allowed under a water right, Ecology has ascertained that the "one-fill" requirement under WAC 508-12-270 is not applicable to the Eightmile Lake water right. This is because WAC 508-12-270 was adopted on March 23, 1960, after the water right was established with its priority date of August 2, 1926.

With respect to water rights permitting for this project, since their Eightmile Lake water right authorizes the use of water for irrigation, IPID must gain authorization to also release water from storage in the lake for instream flow purposes. Rather than filing a change application seeking to add instream flows as a purpose of use or applying for a new secondary use permit for instream flow purposes, IPID intends to gain authorization for the new use through a donation to the Trust.

Under RCW 90.42.080(1), the holder of a water right may donate all or a portion of such right to the Trust "to assist in providing instream flows or to preserve surface water or groundwater resources on a temporary or permanent basis." Under RCW 90.42.080(4), a water right donated into the Trust "shall not exceed the extent to which the water right was exercised during the five years before the donation nor may the total of any portion of the water right remaining with the donor plus the donated portion of the water right exceed the extent to which the water right was exercised during the five years before the donation." Under RCW 90.42.080(10) and (11), the 5-year period shall be adjusted to include earlier years if any nonuse of water is excused under a statutory exception to relinquishment.

At the time a donation request may be submitted by IPID, Ecology would then evaluate historical water use under the Eightmile Lake water right for the purpose of meeting the quantification requirement in RCW 90.42.080(4) for acceptance of a permanent donation of a portion of the water right into the Trust for instream flow purposes. Through this evaluation, Ecology would ascertain the annual quantities of water that can be recognized for the purpose of IPID's donation of a portion of the water right to the Trust and their retention of the portion of the water right that is not donated into the Trust for irrigation use. As described above, this process does not include a tentative determination of the water right as would be conducted for a water right change application, and water use under the portion donated to Trust is limited to instream flow purposes and cannot be relied on for mitigation of any new out-of-stream uses.

Although Ecology has not yet conducted an evaluation of water rights quantities for IPID's Eightmile Lake right through the process for donation of a water right into the Trust, the range of the storage volumes for the action alternatives (from up to 1,698 to 2,000 acre-feet) appears to be reasonable based on IPID's records of their historical storage and release practices at the lake and their estimated range of multi-fill volumes presented in their multi-fill analysis (Aspect 2022a). The initial design volumes of 1,698 acre-feet for Alternative 3 and 2,000 acre-feet for Alternatives 1 and 2 are maximum active storage volumes. If the Trust volume calculation under RCW 90.42.080 results in reduced annual quantities, these maximum design volumes will need to be reduced, possibly through modification of the syphon and intake pipe[9] as part of the final design phase. Since IPID intends to retain 1,400 acre-feet for irrigation, this means that any reductions in annual quantity that result from the Trust donation process would reduce the amount of water available for instream flow augmentation.

Pursuant to the Water Resources Act of 1971 (Chapter 90.54 RCW), the state established a water resources management program and Ecology is required to retain adequate flow in streams and rivers to protect instream resources and uses, including fish, wildlife, recreation, aesthetics, water quality, and navigation. As part of the water resources management program, and of particular interest here, is Chapter 173-545 WAC, which regulates the instream resources protection program for the Wenatchee River Basin, also known as Water Resource Inventory Area (WRIA) 45. WAC 173-545 divides the basin into stream management units, including those listed in **Table 6-2**.

[9] Each design alternative includes an assumed intake pipe elevation within the lake that allows for the range of maximum storage volumes described in the alternatives. Reducing the length of the intake pipe during final design would result in reduced storage volumes without substantially changing the main elements of the existing design for each alternative.

Table 6-2. WRIA 45 Stream Management Units Applicable in the Study Area

Stream Management Unit Name	Control Station Number	Affected Stream Reaches
Icicle Creek near Leavenworth	12-4585.00	Headwaters of Icicle Creek to its mouth.
Wenatchee River at Peshastin	12-4590.00	From the confluence of Derby Creek to Beaver Valley Highway, River Mile 46.2 excluding Derby and Icicle creeks.
Wenatchee River at Monitor	12-4625.00	From mouth to confluence of Derby Creek, including Derby Creek and excluding Mission Creek

Ecology is authorized to establish minimum instream flows for streams and lakes under RCW 90.22.010 and RCW 90.54.040. Minimum instream flows established by rule are considered to be the equivalent of water rights, whose priority date is either the effective date of the rule, or a date specified in the rule. Instream flows in WRIA 45 were initially established with a priority date of June 3, 1983 (WAC 173-545-050). Following recommendations of the Wenatchee watershed planning unit, WAC 173-545 was amended, and additional instream flow rules were added under WAC 173-545-060 with a priority date of November 2, 2001. For Icicle Creek, both sets of instream flows are listed in Table 6-3 and presented graphically in Appendix 1 of WAC 173-545.

Thus, there are two distinct instream flows for each reach of the Wenatchee River, or its tributaries, and the flow that applies to any specific water right generally depends on the date that the water right permit was issued (see Table 6-3). For Icicle Creek near Leavenworth, the 2001 instream flows established based on watershed planning are generally higher (that is, more restrictive to water users) than the 1983 instream flows, except during the period from May 15 through June 30. WAC 173-545-050 allows for rights subject to the 1983 flows to be subject to the lower (less restrictive) WAC 173-545-060 instream flows during this period. The situation is similar for instream flows for the Wenatchee River at Peshastin and the Wenatchee River at Monitor.

Table 6-3. Instream Flows Applicable to Icicle Creek (cfs)

Month and Day	Icicle Creek at Leavenworth	
	WAC 173-545-050: 6/3/1983 Priority Date	WAC 173-545-060: 11/2/2001 Priority Date
January 1	120	267
January 15	120	267
February 1	120	267
February 15	120	566
March 1	150	518
March 15	170	518
April 1	200	650
April 15	300	650
May 1	450	650
May 15	660	650
June 1	1000	650
June 15	660	550

Month and Day	Icicle Creek at Leavenworth	
	WAC 173-545-050: 6/3/1983 Priority Date	WAC 173-545-060: 11/2/2001 Priority Date
July 1	450	550
July 15	300	550
August 1	200	400
August 15	170	343
September 1	130	275
September 15	130	275
October 1	130	267
October 15	130	267
November 1	150	267
November 15	150	267
December 1	150	267
December 15	150	267

Note: the effective date for WAC 173-545-060 is January 12, 2008. Generally, water right permits issued after 1983 but before January 2008 are subject to the -050 flows except for the period of May 15 to June 30 when they are subject to the -060 flows. Water rights permits issued after January 2008 are subject to the -060 flows.

Instream flows for the Wenatchee River at Peshastin and the Wenatchee River at Monitor are listed in WAC 173-545-050 and -060. Interruptible water rights in the upstream stream management units, including Icicle Creek, may also be curtailed when flows established at Monitor and Peshastin are not met at those locations.

The instream flow rules for the Wenatchee River Basin also established a reservation of water of up to 0.5 cfs for Icicle Creek, not subject to the instream flows, for certain beneficial uses, including domestic, municipal, commercial, and industrial purposes and stock water (see the Wenatchee River Watershed Instream Resources Protection Program section below).

The instream flows in both the Icicle Creek Basin and the Wenatchee River are often not met, particularly in drought years. For example, the instream flows are not met in Icicle Creek more than 90 percent of the time in late July, August, and early September and are not met over 50 percent of the time in late June through mid-late September and January through mid-March (see Chapter 4, Water Resources).

6.3 Affected Environment

As described above, water use within the Icicle Creek Subbasin is controlled by water rights. Water uses, including municipal, rural domestic, irrigation, fish propagation, power generation, and instream flows, are all defined and limited by existing water rights. The review of the water rights of the subbasin presented in this EIS does not represent an extent and validity review (see above) and does not determine whether the quantities of water listed for the rights are actually available for use. Further, maximum Qa's are not specified on some water right certificates, particularly older ones that only specify maximum Qi's. In these cases, the EIS team estimated Qa's based on other documents

or records (refer to Appendix B for further information). Estimated total water rights quantities stated within may include amounts that are not valid or that may be inchoate[10] rather than perfected.

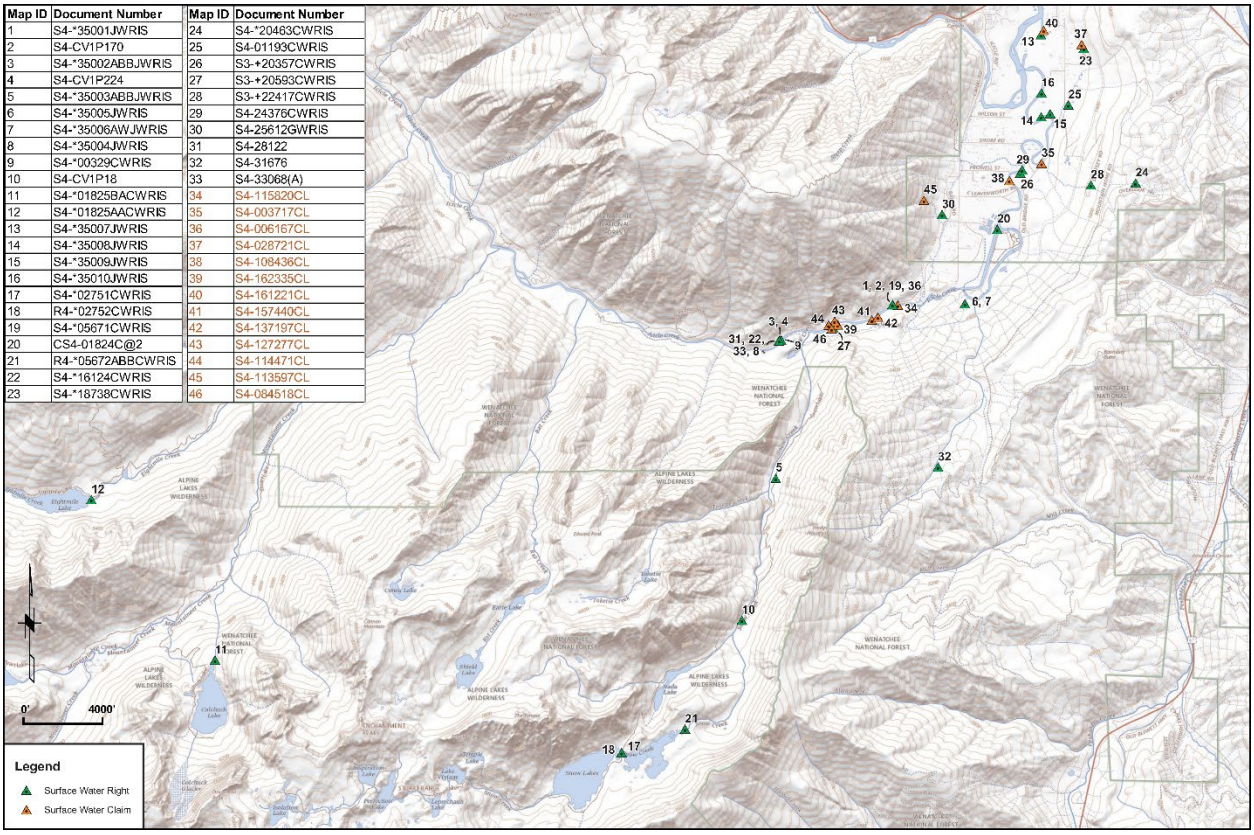
The rights described are located in the area from the headwaters of the Eightmile Lake Subbasin downstream to the confluence of Icicle Creek with the Wenatchee River; as described previously, the study area generally does not include the upper reaches of Icicle Creek (upstream of the confluence with Eightmile Creek). The discussion is based largely upon water rights records supplied by Ecology, studies of water management within the subbasin, water rights adjudication files, and the water rights summary provided in the FPEIS (Ecology 2019a).

6.3.1 Surface Water Rights

Most water use in the Icicle Creek Subbasin comes from surface water rights, and these rights have more potential to be affected by the Eightmile Dam rebuild than groundwater rights. Existing surface water rights in the basin are used for irrigation, municipal supply, domestic uses, fish propagation, instream flow, and fire protection (Figure 6-1). There are also active surface water right applications seeking permits for the additional uses (beyond those for existing rights) of power generation and recreation-beautification.

Figure 6-1. Existing Surface Water Rights in the Basin

Map ID	Document Number	Map ID	Document Number
1	S4-*35001JWRIS	24	S4-*20463CWRIS
2	S4-CV1P170	25	S4-01193CWRIS
3	S4-*35002ABBJWRIS	26	S3-+20357CWRIS
4	S4-CV1P224	27	S3-+20593CWRIS
5	S4-*35003ABBJWRIS	28	S3-+22417CWRIS
6	S4-*35005JWRIS	29	S4-24376CWRIS
7	S4-*35006AWJWRIS	30	S4-25612GWRIS
8	S4-*35004JWRIS	31	S4-28122
9	S4-*00329CWRIS	32	S4-31676
10	S4-CV1P18	33	S4-33068(A)
11	S4-*01825BACWRIS	34	S4-115820CL
12	S4-*01825AACWRIS	35	S4-003717CL
13	S4-*35007JWRIS	36	S4-006167CL
14	S4-*35008JWRIS	37	S4-028721CL
15	S4-*35009JWRIS	38	S4-108436CL
16	S4-*35010JWRIS	39	S4-162335CL
17	S4-*02751CWRIS	40	S4-161221CL
18	R4-*02752CWRIS	41	S4-157440CL
19	S4-*05671CWRIS	42	S4-137197CL
20	CS4-01824C@2	43	S4-127277CL
21	R4-*05672ABBCWRIS	44	S4-114471CL
22	S4-*16124CWRIS	45	S4-113597CL
23	S4-*18738CWRIS	46	S4-084518CL



Source: Prepared by Robinson|Noble based on data from Ecology

[10] When water rights are put to beneficial use they become "perfected." Inchoate rights are rights (or portions of rights) that have not yet been put to beneficial use, and, thus, have not been perfected.

Alpine Lakes Water Rights

Several water rights were established within the boundaries of the Alpine Lakes Wilderness prior to the wilderness designation in 1976. Specifically, storage rights for irrigation were established on several alpine lakes by the Icicle Irrigation District (IID, a predecessor to the IPID) and the U.S. Bureau of Reclamation (Reclamation; these are now exercised by the USFWS). The water rights were established for Eightmile, Colchuck, Nada, and Snow Lakes within the study area, and on Upper and Lower Klonaqua and Square Lakes outside the study area. Additionally, several water rights were established for water from Snow Creek within the wilderness area. These rights form an important and large component of the total water use in the subbasin. While the rights are located in the wilderness area, the stored water from these rights is used in the lower, more developed part of the subbasin.

Eightmile Lake Water Rights

Generally, the water right on Eightmile Lake tends to be exercised earlier in the season than the other Alpine Lakes rights because the lake is at a lower elevation and access there is easier earlier in the season. The rights on Eightmile Lake date back to 1926, when on August 2, the IID filed an application with the Washington Office of Supervisor of Hydraulics (a predecessor agency to Ecology) for a permit to use 25 cfs "to the extent of 2,000 acre-feet" for the beneficial use of irrigation from Eightmile Lake. The State Hydraulic Engineer approved a water right permit on January 22, 1927, and a Notice of the Beginning of Construction was filed by IID on July 26, 1927.

IID also filed a petition with the Washington State Department of Public Lands (a predecessor agency to WDNR) for shore and overflow rights from Eightmile Lake. On October 26, 1927, the Department of Public Lands granted an easement right to "overflow and perpetually inundate" the "bed and shores of … Eight Mile Lake." The same order also applied to the bed and shores of Colchuck and Klonaqua Lakes.

In 1927, IID filed a petition with the State Supervisor of Hydraulics requesting determination of the relative rights of claimants to the waters of Icicle Creek and its tributaries. This petition started the legal process that led to the 1929 general adjudication of the water rights from Icicle Creek and its tributaries in Chelan County Superior Court. On October 29, 1929, the court issued the Icicle Creek Decree (Decree). It affirmed IID's water right on Eightmile Lake (as well as Klonaqua and Colchuck Lakes), assigning the respective lands to Class 5 of the six classes in the Decree.[11] The adjudication confirmed an inchoate right at Eightmile Lake for development of a Qi of 25 cfs and a Qa of 2,500 afy (Table 6-4)[12]. The Decree stated that IID's Eightmile Lake right was *"inchoate but may be perfected by compliance with provisions under which the permits were issued."* Since the maximum Qa was specified in the Decree as being inchoate, the court did not make any final determination of the Qa that is authorized under this water right.

Following the Decree, the District filed a Notice of Complete Application of Water to a Beneficial Use, Proof of Appropriation, and a Notice of Completion of Construction on August 15, 1939. These documents confirm completion of construction on October 10, 1929 with water put to use by

[11] In the 1929 Icicle Creek Decree, the court designated water rights into six general classes (Class 1 through Class 6) based on priority date, with Class 1 water rights having the earliest priority dates and the Class 6 water rights having the latest priority dates.

[12] Available documentation does not explain how the 2,000 acre-feet originally requested in the water right application was increased in the Decree to allow for development of up to a potential maximum of 2,500 acre-feet.

summer of 1930. In part, the Proof of Appropriation[13] states the lake has a natural outlet, through the loose landslide materials that formed the lake, some 30 feet below the normal high water. Because of this, the dam was not constructed to the originally planned height.

A water right certificate was issued by the State Supervisor of Hydraulics on August 21, 1939 for 25 cfs, with no annual quantity stated, for the irrigation of 7,000 acres within the boundaries of the Icicle and Peshastin Irrigation Districts.

This water right, together with IPID's other Alpine Lakes storage rights, are used to supplement the natural flow in Icicle Creek to allow IPID to divert their full diversionary rights and meet mid- to late-season irrigation needs from Icicle Creek (see below) in the summer. According to the IPID Comprehensive Water Conservation Plan (Anchor QEA 2018b), currently during normal and wet years, IPID typically only draws down one of the lakes, but in dry years, multiple lakes may be drawn down. The plan states "*IPID typically releases water from Eightmile Lake first, because it is the easiest lake to access and had the highest probability of refill based on the volume of storage relative to the watershed size and annual runoff*."

Table 6-4. Alpine Lakes Water Rights

Water Right Certificate and Record No.	Person or Organization	Priority Date	Purpose of Use	Qi (cfs)	Certificated Qa (afy)	Adjudicated Qa (afy)	Source Name
01228 / S4-*01825AACWRIS	Icicle Irrigation District	08/02/1926	Irrigation	25[a]	--	2,500[a]	Eightmile Lake[b]
01229 / S4-*01825BACWRIS	Icicle Irrigation District	08/02/1926	Irrigation	50[a]	--	2,500[a]	Colchuck Lake
01591 / S4-*02751CWRIS	Icicle Irrigation District	10/29/1929	Irrigation	25		Na	Snow Creek[c]
01592 / R4-*02752CWRIS	Icicle Irrigation District	10/29/1929	Irrigation, Storage[d]	--	1,000	Na	Snow Creek[c]
01825A / R4-*05672ABBCWRIS	U.S. Bureau of Reclamation	03/26/1942	Fish Propagation	--	16,000[e]	Na	Snow Lakes, Nada Lake

[a] Set as inchoate and in Class 5 by adjudication in Icicle Creek Decree of October 28, 1929; Qi confirmed on certificate; Qa blank on certificate; perfected portion has not been determined.
[b] The Icicle Creek Decree and the certificate for this right both state the source is Eightmile Lake; the WRTS listing for this right says the source is Eightmile Creek.
[c] The WRTS and the certificates for these rights both indicated the source is Snow Creek; however, the water is stored in Snow Lakes.
[d] The WRTS indicates the purpose of use is irrigation, but the certificate states it is "storage for irrigation."
[e] Although certificated for 16,000 afy, available documentation suggests only 12,000 afy has been perfected (see Appendix B).

[13] The full remarks from the Proof of Appropriation form are as follows: "*Cut was made 25 feet deep in outlet channel, creosoted wood stave pipe 30 inches in diameter with standard reservoir cast iron gate installed. Gate thoroughly embedded in concrete and concrete cut-off wall placed in channel approximately 50 feet down the stream from control gate. The lake has a natural outlet channel some 30 feet below normal high water and due to difficulty in securing water tightness in formation of slide responsible for the lake dam was not constructed to height first intended, the District preferring to use pumping equipment for securing full appropriation of water during period of extreme drought.*"

Other Alpine Lakes Water Rights

There are four other water rights on lakes within the Alpine Lakes Wilderness that are also within the study area (Table 6-4). These involve rights to water from Snow, Nada, and Colchuck Lakes. As previously mentioned, these are typically used later in the season than the Eightmile Lake right because the elevations of these lakes are approximately 250 to 750 feet higher than Eightmile Lake. The most senior of these other Alpine Lakes Wilderness rights is the IID storage right on Colchuck Lake. The right was certificated in 1939 for 50 cfs; no Qa is listed.

The IID also has two other rights in the wilderness area. They applied for these rights in 1929, and therefore the rights were not part of the adjudication. One application was for water from Snow Creek, the other application is a reservoir application to store water in Snow Lakes. The IID entered into a contract with Reclamation for Reclamation to construct the control works for Snow Lakes in return for granting Reclamation the right to use 250 acre-feet of IID's permitted 1,000 acre-feet of storage at Snow Lakes, with the remaining 750 acre-feet to be used only after the water in the District's other reservoirs is tapped.

In 1942, Reclamation applied for a right for storage of 16,000 acre-feet in Nada and Upper and Lower Snow Lakes for the purpose of fish propagation at the LNFH (at the time called the Leavenworth Hatchery Station). This right was certificated that same year.

IPID has storage rights outside the study area, but also in the Alpine Lakes Wilderness, on Klonaqua and Square Lakes for 2,500 and 2,000 acre-feet,[14] respectively. With these two rights, and the rights on Eightmile, Colchuck, Snow and Nada lakes, IPID has estimated total storage rights of up to 10,500 acre-feet.[15] However, due to the agreement with the Reclamation, only up to 10,250 acre-feet of the storage is available for IPID use.

Eightmile Creek Water Rights

The WRTS lists only one water right with Eightmile Creek as a source. However, this is IID's right to water from Eightmile Lake, and both the Icicle Creek Decree and the certificate for IID's right list the source as Eightmile Lake. Therefore, it is likely that the WRTS erroneously lists the source as Eightmile Creek.

Water Rights for Icicle Creek and Its Tributaries

Outside the wilderness area, there are rights on Icicle Creek and its tributaries. These also form an important and large component of water usage within the subbasin. These rights rely on runoff and snowmelt from all up-basin (headwater) areas rather than at specific lakes. Within the study area, Ecology records show 22 surface water rights for diversions from Icicle Creek or its tributaries (for a full listing, see the table in Appendix B). Three rights are interruptible when the flows in Icicle Creek fall below the minimum flows set in WAC 173-545. Cumulatively, the EIS team estimates that these 22 rights authorize the diversion of 185.603 cfs and 67,900.8 afy. Approximately 96 percent of the diversionary rights come from four diverters: the IPID, USFWS, COIC, and the City of Leavenworth.

Most of the rights on Icicle Creek and its tributaries have priority dates earlier than the instream flow rules set by WAC 173-545 and, therefore, are not interruptible when instream flows are not met. The City of Leavenworth's right S4-28122 is senior to the instream flow rule; however, it is interruptible

[14] The certificate for Klonaqua Lake does not list a Qa; 2,500 acre-feet was described as being inchoate in the 1929 adjudication. The Qa for Square Lake is listed on the right's certificate.

[15] This total estimate may include some inchoate quantity that may have not been perfected and, thus, may not be valid. The total of perfected rights has not been determined by Ecology or a court.

when instream flows are not met due to a provision written into the permit. Two rights have priority dates later than those set for instream flows in WAC 173-545 and are partially interruptible.

IPID Diversionary Water Rights

The IPID holds three diversionary rights from Icicle and Snow Creeks for a total of 117.71 cfs. Two of these rights were issued to the IID with 1910 priority dates,[16] and another to the Peshastin Irrigation District with a 1919 priority date. All three were part of the 1929 Icicle Creek adjudication, with the earlier rights assigned as Class 2 and the more junior right as Class 5. The IPID diversion is a gravity-flow headworks, located approximately at RM 5.7 on Icicle Creek. IPID manages storage rights on Eightmile, Colchuck, and Snow lakes (discussed above), as well as on Square and Upper and Lower Klonaqua Lakes, to ensure adequate flow for their diversion. Currently during normal and wet years, IPID typically only draws down one of the lakes, but in dry years, multiple lakes may be drawn down (Anchor QEA 2018b).

None of the three rights have a listed Qa in the Icicle Creek Decree or on their certificates. However, one of the rights with a 1910 priority date, S4-*35002ABBJWRIS, has a Qa of 25,000 afy listed on WRTS. This amount appears to be based on water duty calculations presented in the Referee's Report for the adjudication (Superior Court of the State of Washington 1929). The other 1910 right has a change certificate, indicating that any Qa used by it counts against the 25,000 afy. The EIS team estimates the Qa of the 1919 right at 10,315 afy based on the Referee's Report water duty calculations, giving the IPID a total estimated Qa of 35,315 afy[17] under their rights authorizing the diversion of water from Icicle and Snow Creeks.

The IPID's Comprehensive Water Conservation Plan (Anchor QEA 2018b) includes quantity data for the rights from 2013 to 2017. The highest instantaneous diversion rates are listed as occurring during July. The full Qi was reached in 2016, and the peak summer diversion rate typically exceeds 100 cfs. The highest annual diverted total was 29,615 acre-feet in 2015. The 2016 total was only slightly less at 29,335 acre-feet.

USFWS Diversionary Water Rights

The USFWS holds a diversionary right for 42.0 cfs from Icicle Creek. The certificate for right S4-*05671CWRIS does not list a Qa. However, in 2011, the USFWS requested a change to add a point of diversion (CS4-01824C@2). During the processing of that change application, a Qa of 27,482 afy was assigned to the right. The water is non-consumptively used by the LNFH for fish propagation. The USFWS's main diversion, which is shared with COIC, is at RM 4.5. The change, authorized by a Chelan County Conservancy Board conditional decision that was affirmed by Ecology, added an alternative point of diversion at RM 2.8 to be used if the main diversion fails to provide sufficient water. The water is returned to Icicle Creek below the fish hatchery near RM 2.6. As discussed above, Reclamation has a storage right for 16,000 afy to ensure adequate flow for the USFWS diversionary right.

In addition to surface water rights, the LNFH has groundwater rights and claims totaling 6,700 gpm and 7,677 afy that are exercised through seven individual wells.

[16] Originally these two were a single Class 2 right for 83.33 cfs in the Icicle Creek Decree. A portion of that right was split off in a water right change in 1946, creating the two separate rights both sharing the same priority date.

[17] There has been neither a tentative determination of validity and extent by Ecology nor a court adjudication that has determined whether this entire figure is valid.

COIC Diversionary Water Rights

COIC holds several water rights to serve irrigators along Icicle Creek. In the 1929 Decree, COIC was granted adjudicated water right S4-*35001JWRIS, recognized as a Class 1 right with a 1905 priority date. This adjudicated right confirmed the use of 12 cfs of water on 600 acres within the COIC service area during the irrigation season. This right went through several changes in 1940 and has not been evaluated since that time; however, a change application was filed in 2020 to move the point of diversion downstream.

In 1939, LNFH purchased the property on which the COIC's present point of diversion is located. In 1939, LNFH and COIC entered into an agreement concerning the use of the point of diversion, associated infrastructure, and shared water use through exercise of COIC's water right. One of the key components of the agreement included the use of COIC's surplus water, assigning priority to COIC's water needs, and allowing the remaining available water each year from the original 12 cfs to be used by LNFH. This annual multi-purpose or "conjunctive" use by both COIC and LNFH each year for irrigation and fish propagation has been the normative diversion condition since 1940.

Following the 1939 agreement between COIC and LNFH, Certificate of Change S4-CV1P170 was issued in 1940 to formalize the 1939 Agreement. S4-CV1P170 changed the purpose and place of use for a total of 0.203 cfs of water from S4-*35001JWRIS. The purpose of use for 0.1 cfs was changed to fish propagation and domestic use on LNFH land. The place of use for the remaining 0.103 cfs was adjusted for COIC irrigation use. This reduced the water available for COIC irrigation from 12 cfs to 11.9 cfs. Additionally, the surplus water used by LNFH each year was formalized by Ecology in a permit that authorized changes to the place and purpose of use for the surplus water for an indefinite time period. While this permit does not have an identifier or permit number, it is included within the file in WRTS under S4-CV1P170, and Ecology interprets it as part of the same record and authorization as S4-CV1P170.

City of Leavenworth Diversionary Water Rights

The City of Leavenworth has four rights for municipal uses for a total diversion of 6.2 cfs from Icicle Creek, 3.11 cfs[18] of which is interruptible when the flows in Icicle Creek fall below the minimum flows set by WAC 173-545. The oldest right, S4-*35004JWRIS (Adj Cert No. 4), is part of Class 4 of the Icicle Creek Decree with a priority date of 1912. The next oldest, S4-*16124CWRIS (SWC 8105), has a priority date in 1960; and second newest, S4-28122, has a priority date in 1983–this is the right that is fully interruptible. The newest right, S4-33068(A), is non-additive to the earlier rights but does designate a small portion of its Qi as non-interruptible relative to instream flows. Together, the City has asserted that these rights have an estimated total annual quantity of 2,275 afy, although that amount is disputed by Ecology and is the subject of ongoing litigation (discussed below). The City's diversion is at RM 5.7 across Icicle Creek from the IPID diversion.

The City also has groundwater rights for a wellfield outside the study area, near RM 27.2 of the Wenatchee River, about 0.5 mile upstream from the Icicle Creek's confluence with the Wenatchee River.

The City's current Water System Plan (Varela & Associates, Inc 2018) identified alleged errors in Ecology's previous assessments of the City's water rights and claims a higher total diversionary right than Ecology recognizes. The dispute centers around the maximum Qa authorized under surface water certificate 8105 (S4-*16124CWRIS), which does not include a Qa figure but specifies a Qi of

[18] The Qi of 3.18 cfs for S4-28122 is interruptible. However, a later permit, S4-33068(A), includes 0.07 cfs of its Qi as not subject to interruption due to instream flows even though the entire Qi on the permit is non-additive.

1.5 cfs. The City asserts that the Qa should be based on the amount of water that would be used if the Qi is diverted on a continuous basis, which is 1,085 afy, while Ecology asserts the correct Qa is 275 afy based on a "reasonable quantity" relating to actual per capita demand for water. The City filed a declaratory judgment lawsuit against Ecology in Chelan County Superior Court to challenge Ecology's Qa figure. On July 19, 2012, a summary judgment order was issued ruling in favor of Ecology. The City appealed, but the case there has been suspended to allow for the City to seek additional water through the Icicle Creek Integrated Water Resource Management Strategy.[19] The City has communicated that it will withdraw its case in the Court of Appeals if that effort is successful. Currently, as a result of the Superior Court's decision, the Qa for this water right officially is 275 afy, which means that the estimated combined total Qa for the City's water rights is 1,465 afy from its Icicle Creek diversion.

The City also has two rejected surface water applications and two active change applications, which are described in Appendix B.

Icicle Creek Surface Water Claims

As described in Section 6.2, *Regulatory Context*, a water right claim is an official statement claiming a right for water use that predates the state's water permitting system (1917 for surface water and 1945 for groundwater). Validity of claims can only be determined and confirmed through a general adjudication by a court. However, based on dates of first water use on the claim forms, any surface water claim with a date after 1917 is probably not valid. WRTS lists 13 surface water claims in the study area (Table 6-5).

Table 6-5. Surface Water Claims in Icicle Creek Subbasin

Water Right No.	Person or Organization	Claimed Date of First Use	Purpose of Use	Qi	Qa (afy)	Source Name
S4-115820CL	Willet, W C	1905[a]	Irrigation	90 gpm	16.0	Icicle Creek
S4-003717CL	Templin, H L	1905[a]	Stock Water, Irrigation	160 gpm	200.0	Icicle Creek
S4-006167CL	Cascade Orchard Irr. Co.	3/13/1911	Irrigation	0.1750 cfs[b]	0.175	Icicle Creek
S4-028721CL	Easterly, G L	May-67	Domestic General	5 gpm	nl	Unnamed spring
S4-108436CL	Hania, G E	nl	Irrigation	nl	nl	Wenatchee River and/or Icicle Creek
S4-162335CL	Sullivan, J P	nl	Domestic General	nl	nl	Icicle Creek
S4-161221CL	Parsley, B W	nl	Stock Water, Irrigation, Domestic General	nl	nl	Icicle Creek
S4-157440CL	Bires, E R	nl	Irrigation, Domestic General	nl	nl	Icicle Creek
S4-137197CL	Liggett, D L	nl	Domestic General	nl	nl	Icicle Creek
S4-127277CL	Gross, E A	nl	Domestic General	nl	nl	Icicle Creek
S4-114471CL	Schmidt, H	nl	Domestic General	nl	nl	Icicle Creek

[19] The proposed Trust donation of part of the Eightmile Lake water right will only be for instream flow benefits and will not enable the allocation of additional water to the City of Leavenworth.

Water Right No.	Person or Organization	Claimed Date of First Use	Purpose of Use	Qi	Qa (afy)	Source Name
S4-113597CL	Palmer, I M	nl	Domestic General	400 gpm	80.0	"Icicle Ridge"
S4-084518CL	Kester, H R	nl	Domestic General	nl	nl	Icicle Creek

nl – not listed on claim form
[a] These claims have dates predating the 1929 adjudication. It is unclear why these water uses, if indeed occurring after the claimed date, were not addressed in the 1929 adjudication.
[b] A study for COIC (Anchor QEA et al. 2015) indicates that 0.103 cfs of this claim may be included in change certificate SA4-CV1P170; however, documentation of this assertion is not provided. If true, the Qi for the claim should be 0.072 cfs. S4-006167CL is a statement of claim filed by COIC in 1971 for 5.627 cfs of water for the irrigation of 422 acres of COIC land. This claim specifies the shared point of diversion between LNFH and COIC. The details of this claim are redundant to adjudicated water right S4-*35001JWRIS, and the claim is not additive to S4-*35001JWRIS.

Claims can only be filed during certain open claims registry periods prescribed by the legislature, and the claim form used depends on the particular open period. Long forms requested the claimant report the date of first water use (although not all claimants using the form filled in the date), while short forms did not ask for the first date of use or the amount being used. Therefore, many claims do not list a claimed quantity or date of first use.

Icicle Creek Water Use

While the water diverted for the LNFH is non-consumptively used for fish propagation, the water diverted by the City of Leavenworth, IPID, and COIC is used consumptively for either irrigation or municipal uses (which include domestic, commercial and irrigation uses). According to the FPEIS (Ecology 2019a), the three water purveyors serve approximately 3,250 parcels; however, the report notes that some parcels are counted twice due to dual water service (for example, outdoor water served by one of the irrigation districts and indoor water served by the City). Generally speaking, the City serves smaller parcels, most less than 0.5 acre, and the irrigation districts serve larger parcels, most larger than 1 acre (see Table B-1 in Appendix B).

Other Surface Water Rights

There are five other surface water rights in the study area outside the Alpine Lakes Wilderness with sources other than Icicle Creek and its tributaries (see table in Appendix B). These rights are all for various unnamed springs. Water from the springs may or may not be tributary to Icicle Creek; available records reviewed do not indicate where water from the springs naturally flows. In some cases it may reach Icicle Creek, in others it may be consumed by evapotranspiration prior to reaching the creek. Four of the five rights are located on hillsides east to southeast of Icicle Creek after it exits its canyon. The other is located on a hillside west of the creek. Together, these rights total 0.277 cfs and 60.7 afy.

Wenatchee River Watershed Instream Resources Protection Program

As discussed above in Section 6.2, *Regulatory Context*, Ecology is required to retain adequate flow in streams and rivers to protect instream resources and uses, including fish, wildlife, recreation, aesthetics, water quality, and navigation. As part of the water resources management program, the Wenatchee River Basin Instream Flow Rule, WAC 173-545, established minimum instream flows for WRIA 45. Instream flow rules establish minimum instream flows, which are equivalent to water rights with a priority date based on the date the rules became effective. The WRIA 45 instream flow rules were initially adopted in 1983 (WAC 173-545-050) and then amended in 2008 with larger minimum flows (WAC 173-545-060). All water rights in the watershed with later priority dates are junior to the

instream flow rules and are subject to interruption when flows are below the streamflow targets set in the rules (see Table 6-3).

Minimum instream flows in Icicle Creek are typically not met in average years and are often not met during drought years (see Chapter 4, Figure 4-6). This is particularly true for late July through early September when the minimum instream flows are not met in more than 90 percent of water years. Similarly, the instream flows for the Wenatchee River at Peshastin are often not met in drought years and only sometimes in average years.

WAC 173-545-090 established a water right reserve for the Icicle Creek Subbasin. The reservation was created with an Overriding Consideration of Public Interest (OCPI) determination, which the legislature affirmed in 2016 through enactment of a statutory provision codified at RCW 90.54.210. The reservation provides for 0.1 cfs, with an additional 0.4 cfs to "*be considered after completion of flow restoration efforts targeting habitat between the City of Leavenworth and Icicle Irrigation District's point of diversion and the U.S. Fish and Wildlife Service hatchery return. Rulemaking will be required to establish this additional reservation.*" The reservation makes water available, not subject to the minimum instream flows established under WAC 173-545-060, for the following beneficial uses: permitted and permit-exempt "*domestic purposes, irrigation associated with a residence, domestic water requirements associated with municipal, commercial, and industrial purposes, and stock water.*" All water uses under "*the reservation must implement water use efficiency and conservation practices*." Based on a review of water rights listed on WRTS by the EIS team, the only water right currently using water from the Icicle Creek Subbasin reservation, other than possibly permit-exempt water users, appears to be the City of Leavenworth's right S4-33068(A), with 0.070 cfs allocated from the reservation.[20]

Active Surface Water Right Applications

There are nine active surface water right applications listed on WRTS. These include the two City of Leavenworth applications and the COIC application discussed above and in Appendix B. The other applications include one change application and five new applications.

One change application seeks to change existing right S3-+22417CWRIS from a spring source to a well source. According to the application, the change is necessary because the "spring is failing."

One of the new applications is for non-consumptive power generation uses on Hook Creek, a tributary to Icicle Creek. Two are related to a golf course project along a tributary to Mountain Home Creek (which is tributary to Icicle Creek). These include an application for a reservoir right and an application for irrigation. The final two are for single domestic supply from Icicle Creek, each requesting 0.02 cfs. Ecology has not issued decisions on any of these applications.

6.3.2 Groundwater Rights

While most water use in the Icicle Creek Subbasin comes from surface water rights, there are 12 groundwater rights. In addition, there are 27 groundwater claims and several hundred permit-exempt wells. Existing groundwater rights and claims in the basin are used for irrigation, fish propagation, domestic (single and multiple), fire protection, and stock water. None appear to be in the Alpine Lakes Wilderness. Most are located in the subbasin downstream of the Icicle Creek canyon

[20] Page 15 of the ROE for S4-33068A notes: "Prior to issuance of this decision, reserve accounting based on observed permitted and exempt uses estimated 0.006 cfs has been allocated against the Icicle Subbasin Reserve as of 2011 (Aspect 2013)."

(Figure 6-2). The City of Leavenworth also has groundwater rights; however, these are located a short distance outside of the Icicle Creek Subbasin and are not included in the totals presented here.

The 12 groundwater rights have a Qi of 5,402.1 gpm and a total annual quantity (Qa) of 6,592.6 acre-feet. However, the vast majority of these are used non-consumptively for fish propagation by the LNFH. The total annual water production from the permit-exempt wells in the study area is estimated by the EIS team to be about 102 acre-feet (as explained in Appendix B).

Because the validity of claims cannot be established without an adjudication and many claims do not list the date of first use, the total amount of valid groundwater water rights claims in the study area cannot be determined. However, the two biggest groundwater water right claims (see Table B-5 in Appendix B), may be valid based on the claimed dates of first use. These are associated with the LNFH in the amounts of 1,600 gpm and 1,300 afy.

Additional information on groundwater rights and claims in the study area is provided in Appendix B.

6.4 Construction Impacts

6.4.1 Construction Activities

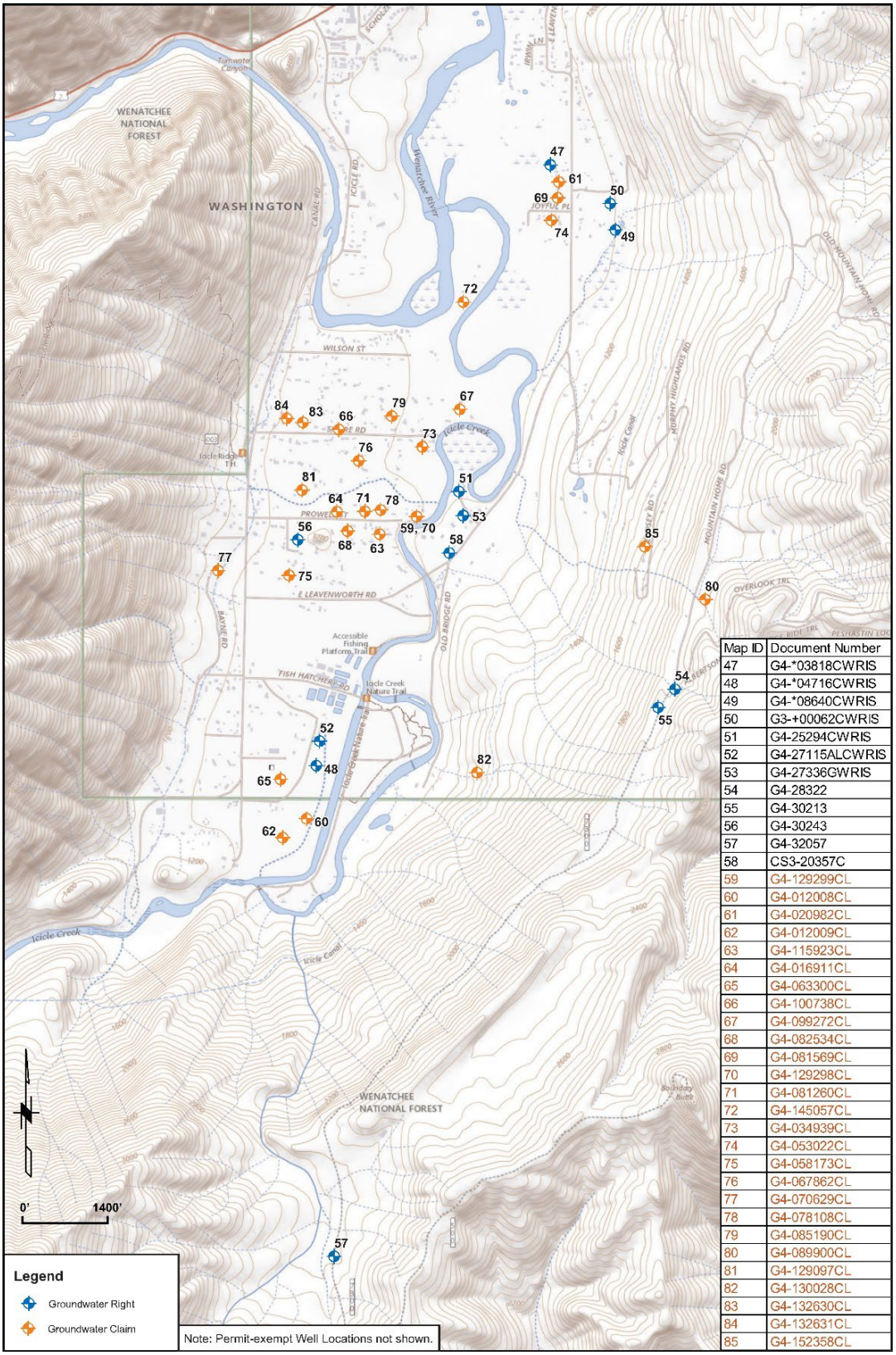
Impacts related to water rights would be very similar among the action alternatives. For each alternative, active storage of water during the construction period would be minimal and IPID's storage right on Eightmile Lake would not be available. Without the storage of water in, and the release of that storage from Eightmile Lake, flows in Icicle Creek will be reduced during the construction. This has the potential to lead to curtailment of junior diversionary rights (considered a less-than-significant impact in a water-rights sense because only IPID has the right to rely on the release of their stored water) and a lesser potential for impairment of more senior rights (a significant impact).

IPID's diversionary rights are separate from their storage rights, and even if the storage rights are not exercised, IPID can still operate their diversionary rights as long as they do not impair any senior water rights. Therefore, impacts on downstream water rights would depend on the precipitation amounts during the winter before construction as well as during the construction period. Construction is anticipated to occur during one season. If precipitation is above average, it is possible that no diversionary rights would be impacted and instream flow levels might even be met. If precipitation is below average, particularly extremely below average, diversionary rights may be affected, reducing the amount of water available for irrigation and other uses. The degree of reduction will depend on how far below average streamflow falls. Additionally, if precipitation is below average, instream flows would likely not be met.

However, even in the case of a drought, significant impacts (i.e., impairment of senior rights) are not likely. There are only 12.1 cfs of senior diversionary rights (Class 1 rights) to IPID's most senior diversionary rights of 83.3 cfs (Class 2 rights). There are an additional 5.79 cfs of rights (Classes 3 and 4) senior to IPID's Class 5 right of 34.38 cfs. Therefore, a streamflow of less than 101.19 cfs would need to occur for impairment of any rights senior to IPID's most junior right. According to the 63-year record of Icicle Creek flows at the USGS gage above Snow Creek (USGS 2022), there is less than a 5 percent chance of flows that low in Icicle Creek during any month of the irrigation season outside of September. When the contribution of Snow Creek is added, the percent chance is even smaller.

Only in the case of a very severe drought, particularly if it were preceded by another drought year that might prevent IPID from completely filling their other lake reservoirs, would significant impacts on senior water rights potentially occur.

Figure 6-2. Existing Groundwater Rights in the Basin



Map ID	Document Number
47	G4-*03818CWRIS
48	G4-*04716CWRIS
49	G4-*08640CWRIS
50	G3-+00062CWRIS
51	G4-25294CWRIS
52	G4-27115ALCWRIS
53	G4-27336GWRIS
54	G4-28322
55	G4-30213
56	G4-30243
57	G4-32057
58	CS3-20357C
59	G4-129299CL
60	G4-012008CL
61	G4-020982CL
62	G4-012009CL
63	G4-115923CL
64	G4-016911CL
65	G4-063300CL
66	G4-100738CL
67	G4-099272CL
68	G4-082534CL
69	G4-081569CL
70	G4-129298CL
71	G4-081260CL
72	G4-145057CL
73	G4-034939CL
74	G4-053022CL
75	G4-058173CL
76	G4-067862CL
77	G4-070629CL
78	G4-078108CL
79	G4-085190CL
80	G4-089900CL
81	G4-129097CL
82	G4-130028CL
83	G4-132630CL
84	G4-132631CL
85	G4-152358CL

Source: Prepared by Robinson|Noble based on data from Ecology

6.5 Operational Impacts

IPID has a right to discharge up to 25 cfs of water from storage in Eightmile Lake. Although the Qa is not specified on the water right certificate, the 1929 adjudication confirmed to IPID an inchoate Qa of 2,500 acre-feet, some or all of which has since been perfected. However, damage to the dam and more recent restrictions by the DSO have reduced the storage capacity in the lake. The current active storage capacity is estimated at approximately 1,151 acre-feet (Aspect 2022a)[21]. When accounting for refilling of the lake from precipitation during the irrigation season, which is when IPID actively discharges water from lake storage, Aspect (2022a) estimates that additional water is stored in the lake from partial refills, with actual quantities depending on the release period and climatic conditions for a given year.

The action alternatives would increase the physical (single-fill) storage capacity relative to current conditions, although storage and release will still be limited by the water right. Alternatives 1 and 2 would create up to 2,000 acre-feet of active storage capacity at any one time, while Alternative 3 would have up to 1,698 acre-feet of active storage.[22] Although a refill analysis has not been conducted for the action alternatives, presumably the total season storage would be higher for each of the alternatives than their active physical storage capacities; even so, the total water use under the right may not increase. The action alternatives would increase the single-fill/active storage capacity from current conditions providing up to between 1,698 and 2,000 acre-feet of total active storage.[22] An Ecology-approved annual monitoring plan will be developed prior to storage and release of water from the repaired dam to ensure that water use is not increased and remains within the limits of IPID's water right at Eightmile Lake. Under the plan, IPID will monitor and report to Ecology the total annual volume of water actively stored in the reservoir and the total annual volumes released for both instream flows (should IPID place part of the right into Trust) and for IPID's irrigation use. It is likely that IPID's diversionary rights could be fully exercised under all the action alternatives and that junior rights holders would not be affected under Alternatives 1 and 2. While there is some potential for impact on junior rights under Alternative 3, it is considerably less than under the No Action Alternative.

During the preparation of this EIS, IPID indicated that based on current water conservation practices, they need a minimum of 1,400 acre-feet of storage capacity at Eightmile Lake to meet needs for irrigation water (Jantzer, pers. comm. 2021). Operationally, IPID indicates that any excess storage capacity above 1,400 acre-feet can be used to support instream flows through a donation of a portion of this water right into the Trust.

IPID allows the lake to fill during the spring runoff season, then typically starts releasing stored water in July and commonly continues releasing water into, and sometimes through, August (Aspect 2022a). Released water is supplemented by natural groundwater leakage under the dam. IPID estimates a continual 5 cfs leakage rate, which discharges to the creek a short distance downstream of the dam (Aspect 2022a). Released water travels through Eightmile Creek and into Icicle Creek.

[21] Following the Jack Creek Fire, DSO has required that the flash boards remain out of the control notch in the dam and the outlet gate remain open for safety reasons given the unsatisfactory status. This has reduced the actual physical water storage during the last few years to less than 1,151 acre-feet, pending dam repair.

[22] The alternatives are designed for active storage capacities of 2,000 and 1,698 acre-feet. However, the amount of water that is stored cannot exceed the storage quantity authorized by the water right, and following IPID's potential request for Trust donation, this quantity will be determined through the process for donation of a portion of the water right into the Trust. Should that process indicate a Qa less than 2,000 or 1,698 acre-feet, the storage allowed under the alternatives will be reduced, as would the maximum active storage capacity for the final design.

IPID diverts water from Icicle Creek at RM 5.7 under their diversionary rights (see *IPID Diversionary Water Rights* section above, as well as Table B-2 in Appendix B). The stored water released from Eightmile Lake (along with IPID's other Alpine Lakes storage rights) supplements the natural flow of Icicle Creek to allow for IPID's exercise of their diversionary rights.[23]

In effect, utilization of the storage water right on Eightmile Lake (as well as IPID's other storage rights) allows IPID to exercise their divisionary rights to meet their irrigation water needs while keeping water in Icicle Creek. Flows in Icicle Creek at IPID's diversion are generally adequate in June to meet the IPID's full Qi (117.71 cfs) without releases from storage in Eightmile Lake's (or the IPID's other lakes). However, in dry years by the end of July, when the average mean daily discharge in Icicle Creek at the USGS gage above Snow Creek can fall below 200 cfs,[24] releases of stored water may be needed for IPID to exercise their full diversionary rights while keeping water in the creek. In August, even in normal water years, releases from storage may be necessary.

It is unlikely that any diversionary rights on Icicle Creek senior to those of the IPID would be impaired even if none of the stored water is released from Eightmile Lake (there are only rights authorizing the use of 12.1 cfs of water that are senior to IPID's most senior diversionary right). But without releases, particularly in dry years, rights junior to IPID's could potentially be curtailed if IPID does not release water from storage. Such an impact on junior water rights, however, would not be significant because junior rights holders are not legally entitled to the water if it is not available.

6.5.1 No Action Alternative

Under current conditions, Eightmile Lake has about 1,151 acre-feet of active storage capacity at any one time. Without refill water during the summer, this amount of storage is not sufficient to meet IPID's stated minimum need of 1,400 acre-feet of storage to supply water for irrigation. Even accounting for the refill water volume estimated by IPID described in their refill analysis (Aspect, 2022a), the total storage could still fall short of IPID's stated need during dry years. Therefore, under the No Action Alternative, in dry years, IPID may not be able to fully exercise their diversionary rights due to lack of capacity to exercise their storage water right on Eightmile Lake. Without the release of the full storage capacity in Eightmile Lake, in all but severe drought years, IPID could still exercise their full diversionary rights. This may impact some junior water rights holders, requiring the reduction or total curtailment of their diversionary rights to meet the senior rights including IPID's. Although an impact, curtailment of a junior right is a less-than-significant impact from a water-rights point of view as junior rights holders are not legally entitled to the water if it is not available.

If IPID does not store and release water from Eightmile Lake, it is doubtful that any diversionary rights on Icicle Creek senior in priority to those of the IPID would be impaired, while rights junior to IPID's could potentially be curtailed, particularly in drought years. Under the No Action Alternative, in dry years, IPID may not be able to fully exercise their diversionary rights due to lack of capacity to meet their storage water right on Eightmile Lake. This may affect junior water rights holders and instream flows. Should the dam fail under the No Action Alternative, while curtailment of junior water rights may occur, significant unavoidable impacts will only possibly occur, in the form of impairment of rights senior to IPID's most junior right, during severe drought years.

[23] As mentioned above, the EIS team estimates that IPID has total diversionary rights of up to 35,315 afy from Icicle Creek, while its total available storage rights (all tributary to Icicle Creek) are estimated to be up to 10,250 afy.

[24] Based on the 90 percent daily mean exceedance (see Chapter 4). Note that Icicle Creek flow levels in July include releases from Eightmile Lake since IPID usually starts releasing water from the lake during the month,

Currently, minimum instream flows in Icicle Creek are not met on most days from late July through the end of September[25] with average flow conditions, and sometimes even during very wet years (when the streamflow has 10 percent exceedance; see Chapter 4). Under the No Action Alternative, it is likely that the flows in Icicle Creek will fall below the instream-flow rule levels more frequently as they would under the action alternatives.

Impacts would occur more often for IPID, junior water rights holders, and instream flows should the dam fail. In that case, the active storage capacity would be greatly reduced, and controlled releases during low flow periods (or, in fact, at any time) would not be possible. However, significant impacts (impairment of senior water rights) would only likely occur during severe drought years.

6.5.2 Alternative 1: Narrow Spillway with Gates

Alternative 1 would have an active storage capacity of up to 2,000 acre-feet[21]. This would be sufficient to meet IPID's stated minimum need of 1,400 acre-feet and allow up to 600 acre-feet to be used to supplement instream flows if IPID donates some of the right to the Trust. Under this alternative (assuming that 2,000 acre-feet of storage is allowed following the Trust donation process), it is likely that IPID would be able to exercise their full diversionary rights. This alternative would provide the benefit of making it is less likely that junior rights would be subject to curtailment and instream flows would likely be met more often than under the No Action Alternative. Implementation of this alternative would fulfill the project purpose and need and would benefit instream flow volumes. There would be **no significant impacts** on water rights under operation of Alternative 1.

6.5.3 Alternative 2: Wide Spillway without Gates

Since this action alternative has the same storage characteristics as Alternative 1, the projected operational impacts would be the same. There would be **no significant impacts** on water rights under operation of Alternative 2.

6.5.4 Alternative 3: Narrow Spillway without Gates

Alternative 3 would have an active storage volume of up to 1,698 acre-feet.[21] This is sufficient to meet IPID's stated minimum need of 1,400 acre-feet and would still allow up to almost 300 acre-feet to be used to supplement instream flows if IPID donates some of the right to the Trust. It is likely that IPID's diversionary rights could be exercised under this alternative (assuming 1,698 acre-feet of storage is allowed following the Trust donation). This alternative would provide the benefit that junior rights would be less subject to curtailment and instream flows would likely be met more often than under the No Action Alternative, although not to the level of Alternatives 1 or 2. Implementation of this alternative would fulfill the project purpose and would benefit to instream flow volumes, although at a lesser amount than under Alternatives 1 and 2. There would be **no significant impacts** on water rights under operation of Alternative 3.

6.6 Avoidance, Minimization, and Mitigation Measures

The loss of storage through exercise of the Eightmile Lake storage water right during the construction timeframe is unavoidable. Downstream impacts may be avoidable if construction occurs during a

[25] The minimum instream flows are also not met during other times of the year. However, here the focus is on the time of year when storage releases from Eightmile Lake occur.

higher-than-average streamflow year. During some below-average years, mitigation of downstream impacts may be possible through IPID releasing water from storage on other lakes. Because some of the other lakes do not fill entirely during drought years (Jantzer, pers. comm. 2021), releases from these lakes may not be sufficient to entirely mitigate downstream impacts if construction occurs in the second of two consecutive drought years. In that case, mitigation of downstream impacts may be possible if construction is delayed, avoiding construction occurring in the year following a drought year. Regardless of the prior year's conditions, if construction occurs during an extreme drought year, downstream impacts may be unavoidable even with mitigation.

Following construction, under the action alternatives, impacts on water rights would be largely dependent on climatic conditions rather than dam operations, although significant impacts are unlikely under Alternative 3 and very unlikely under Alternatives 1 and 2. During dry years, all impacts downstream, may be partially mitigated by modifying typical releases from Eightmile Lake to best meet downstream conditions (for example, releasing water later than normal). Additionally, releasing water from storage on the other lakes may also mitigate impacts.

Under the No Action Alternative, impacts on water rights will be most severe if the dam fails. In the case of a complete dam failure, potential impacts are expected to be similar to those potentially occurring during construction (as described above). Maintenance of the dam in its current state, if possible, may reduce impacts by preventing a dam failure.

6.7 Significant Unavoidable Adverse Impacts

The loss of storage through exercise of the Eightmile Lake storage water right during construction could lead to a significant unavoidable adverse impact—impairment of water rights senior to those of IPID's most junior right (except those of the COIC)— if it occurs during an extreme drought year. Impairment of the most senior rights, those of the COIC, are extremely unlikely even during the most severe droughts. However, downstream impacts, both significant and otherwise, may be avoidable if construction occurs during a higher-than-average streamflow year or during below-average years when mitigative releases from storage on other lakes are sufficient to overcome the loss of storage releases from Eightmile Lake.

During operation, there are no significant unavoidable adverse impacts under the action alternatives should the mitigation measures identified above be followed. Should the dam fail under the No Action Alternative, significant unavoidable impacts—impairment of water rights senior to those of IPID's most junior right (except those of the COIC)—would possibly occur during extreme drought years.

CHAPTER 7: GEOLOGY

For the purposes of this EIS, geology refers to the earth resources within the potential area of project disturbance.

Key Findings for Geology

- Eightmile Dam is underlain by fill with surficial cobble and boulder sized riprap material.
- Site-specific geotechnical investigations determined that the site geology is non-liquefiable under the existing conditions.
- The main construction-related impact would be from the excavation of the new core wall, embankments, and pipe trench.
- The deepest impact would be the construction of the outfall pipe structure below the core wall and dam embankment.
- The depth of the excavation, without appropriate shoring, could reduce stability of the embankment.
- Significant impacts are not expected because all permit requirements will be followed.
- Alternative 2 would result in the largest dam footprint and earthwork volume.
- There are no unavoidable adverse impacts on the study area geology due to construction of any of the action alternatives.

7.1 Methodology

The study area for geological resources includes:

- Eightmile Lake from the current maximum pool elevation of 4,667 feet up to the proposed restoration of lake capacity at the water surface elevation of 4,671 feet, the reported historic full lake elevation.
- Portions of the natural earthen embankment at the east side of the lake that could be impacted by proposed flow-control improvements and associated construction activities, including the primary and intermediate spillway, replacement of fill earthen embankment, outlet-pipe replacement, and secondary spillway.
- Eightmile Creek downstream of the natural earthen embankment and existing/proposed flow-control facilities.
- FSR 7601-116, which was most likely built during construction of the dam in the 1920s.
- The Forest Service local repeater station on Icicle Ridge.

At a broader scale, the study area covers the Alpine Lakes Wilderness; specifically, it includes the 3,822 acres of the Eightmile Creek Subbasin which feeds Eightmile Lake, as well as the Eightmile and the lower portion of Icicle Creek Subbasins downstream to the Wenatchee River Valley. The portion of the basin along the upper reaches of Icicle Creek, above the confluence with Eightmile Creek, is specifically not included in the study area because it would not be affected by project construction or operation. A small portion of Icicle Ridge is included in the study area where the

proposed repeater station would be co-located with the Forest Service local repeater station on Icicle Ridge.

The information presented in this chapter is primarily derived from geologic mapping of the study area by Tabor et al. (1987) as well as the Draft Geotechnical Report for the project prepared by Aspect Consulting (Aspect 2019). The Aspect report utilized site reconnaissance, a limited geophysical survey, and a single test pit exploration at the location of the proposed primary/intermediate spillway. The geophysical survey included electrical resistivity and refraction microtremor analyses limited to an effective depth of approximately 60 feet below ground surface (bgs). The test pit was limited to a depth of 16 feet bgs, from the ground surface at approximately 4,664 feet elevation down to approximately 4,648 feet elevation. Aspect later completed two deep borings and produced a brief memorandum (Aspect 2022b).

For the evaluation of short-term impacts (construction), impacts are considered significant, as follows:

- Impacts are considered significant if construction would be unable or unlikely to comply with construction standards for geotechnical safety, resulting in potentially unsafe geotechnical conditions for workers and/or members of the public.

For the evaluation of long-term impacts (operational), impacts are considered significant, as follows:

- Impacts are considered significant if long-term operation of the facility would create unsafe geotechnical conditions, resulting in a risk of dam failure or an inability to comply with dam safety requirements for operation and maintenance.

7.2 Regulatory Context

Regulatory review for the project will be completed according to the Washington State Dam Safety Guidelines per the DSO.

7.3 Affected Environment

The study area is located on the eastern flanks of the Cascade Range in the Alpine Lakes Wilderness in central Washington, approximately 10 miles west-southwest of Leavenworth. Topographically, the project area generally consists of uplifted mountains incised into ridges and peaks, with steep-sided valleys cut by scouring glacial ice. The Eightmile Creek Subbasin is generally oriented eastward and is bounded on the north by Eightmile Mountain and on the south by a large, unnamed ridge. Eightmile Lake is a naturally occurring impoundment upgradient of the natural earthen embankment composed of landslide deposits at the east end of the lake that blocks the drainage of Eightmile Creek. The landslide deposits are identified by Tabor et al. (1987) as discussed further in Section 7.3.5 below. The lake is fed primarily by surface water runoff from the upland areas surrounding the basin.

7.3.1 Initial Dam Construction and Current Conditions

The natural earthen embankment of the lake was altered by an excavation between1927 and 1929 at the head of the outflow creek. A man-made dam (the existing facility) was constructed within the excavated portion of the embankment with the initial intention to increase the height of the lake by approximately 10 feet, which correlates roughly to elevation 4,681 feet. During construction, it was redesigned to eliminate the additional storage and only utilize the maximum historic water elevation of 4,671 feet. The existing facility was constructed to allow the lake elevation to be lowered to regulate discharge into the creek. The dam structures included a flow-control notch with insets for

"stop logs," as well as wing walls and a spillway (all constructed of stone and concrete masonry), an earthen fill embankment to backfill the excavated area and connect the structures to the natural earthen embankment, and a low-level outlet pipe with a water-control gate at the upstream end.

In 1995, DSO performed an evaluation of the dam on September 27 and summarized their findings in a letter, dated December 7 (Ecology 1995a). It is unclear what prompted the evaluation by Ecology. For the purposes of the geologic review, a few comments from Ecology's letter are summarized below:

- *"….The downstream face [of the fill earthen embankment] was oversteepened at a slope of about 1.5:1 and had also been undercut by spillway releases."*
- *"Immediately adjacent to the central rock masonry element was a rectangular slot cut through the embankment roughly 25 feet in width and 5-feet deep. Initially, it was uncertain whether this was cut [or] was an emergency overflow spillway, or if this section had been eroded out as a result of overtopping."*
- *"After viewing high water marks left from last year's flooding, which were within one foot of the crest elevation of the [fill] earthen embankment, it was clear that this section of the embankment had failed at some time in the past."*
- *"The possibility of surges in the on-going flood releases from lateral erosion of the existing breach may be construed by the owner to be a liability concern. If so, they may wish to minimize their liability posture by widening and hardening the channel now. In the judgement of the Dam Safety Section, the present dam configuration does not pose a sufficient incremental damage threat to warrant mandating a retrofit of the spillway."*

Ecology's field notes also describe "*considerable leakage through [the] bottom of [the] lake*" (Ecology 1995b).

In 2017, the Jack Creek Fire changed the runoff, erosion, and sediment conditions of the basin as described in the letter by United States Forest Service, dated February 20, 2018 (USFS 2018a). Higher runoff events occurred because of the lack of vegetation. Concerns about the increased runoff potential led to some emergency repairs to the outfall structure of the dam. These emergency repairs were conducted in May 2018 in coordination with Ecology's Dam Safety Office.

7.3.2 Forest Service Road 7601-116 (Current Conditions)

FSR 7601-116 consists of an approximately three-quarter mile section of currently closed road that extends from the Eightmile Lake Trailhead parking lot. Photos and video were provided that were taken by IPID personnel walking portions of the closed road (IPID 2021). This documentation indicates that the road has vegetation growing within the road along with vegetation overgrowing from the sides of the road. The vegetation within the road consists of small trees and shrubs. Fallen trees across the road are periodically present. Potholes were observed within the road up to approximately 1.5 foot deep. The video indicated a mound of soil within the roadway that was inferred to be deposited from a slide. Some areas of the road have been washed out from surface water flow through natural drainage channels.

7.3.3 Local Repeater Station (Current Conditions)

The local repeater station would be located on top of Icicle Ridge next to an existing Forest Service repeater station. Based on a review of recent photos of the proposed location of the repeater station, the ridge is open and rocky with scattered evergreen trees.

7.3.4 Regional Geology

In the Eightmile Creek Subbasin, the primary bedrock formations along the north valley wall are rocks of the Ingalls tectonic complex, with windows of exposed Chiwaukum Schist. The south wall of the valley is comprised of pluton tonalite—a granitic rock—associated with the Mount Stuart batholith.

The soils of the Alpine Lakes Wilderness are predominantly derived from glacial activity as well as post-glacial erosion. Glaciers eroded sediment and transported the scoured material downstream before depositing it as materials including glacial outwash, till, and ice-contact deposits (known collectively as glacial drift). Post-glacial reworking of these materials generated colluvium (deposits transported by downslope movement such as rock talus and landslides), alluvium (deposits transported by flowing water), and lacustrine (lake) sediments. Deposits overridden by glacial ice, such as glacial till, are generally denser and more consolidated than they otherwise would be, which is important for bearing capacity and stability. Colluvial deposits such as landslide deposits are the least sorted and compacted and generally present less favorable conditions for engineering. Because both glacial and colluvial deposits may be diamictic (comprised of a wide range of grain sizes ranging from clay and silt particles up to boulders), geotechnical explorations rely upon sediment source to interpret origin.

7.3.5 Site Geology

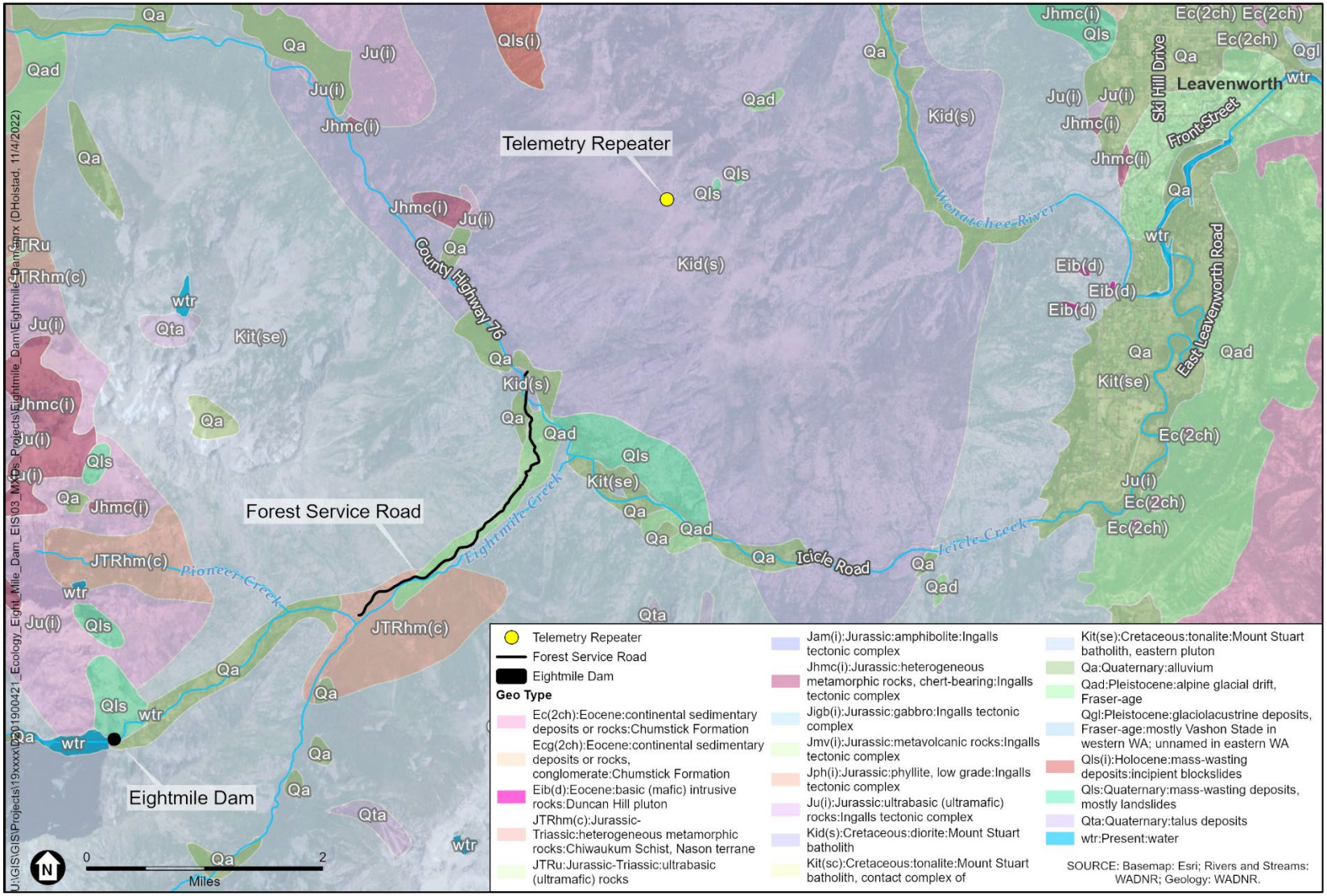
The following section summarizes the individual geologic units in the immediate site vicinity. The intent is to provide a general understanding of the site geology as context for potential impacts. A geologic map of the immediate site vicinity is included below in **Figure 7-1**.

Fill: Fill refers to materials placed by human activities. Fill was observed at the existing dam surface and in the explorations completed in the dam, as reported by Aspect (2019), and serves as the non-concrete composition of the dam itself. Most, if not all, of the existing fill would be removed, and partially replaced, during construction of the new dam. The existing on-site fill consists of surficial cobble and boulder-sized riprap material underlain by gravel with clay or silt and sand. The fill is derived from on-site landslide deposits and is estimated to be approximately 50 percent cobble and boulder content.

Landslide Deposits (Qls): The natural earthen embankment along the east side of Eightmile Lake that underlies the dam structure is mapped as landslide deposits originating in the bedrock upslope of the dam. These deposits would serve as foundation material for the new dam. They consist of angular gravel, cobbles, and boulders deposited from landslides originating upslope on the basin walls. When old and weathered, they are distinguished by hummocky or indistinct rolling, hilly topography.

Alluvium (Qa): This unit consists of alluvium, colluvium, fan deposits, and undifferentiated valley soil where continuous and thick enough to obscure the underlying geology. Alluvium is mapped within the valley and channel of Eightmile Creek both upgradient and downgradient of the lake and dam. It may underlie the landslide deposits at the natural embankment, although explorations have not directly observed the material at depth (Aspect 2019, 2022b).

Figure 7-1. Geologic Map of the Study Area



Glacial Till (Qgt): Glacial till was encountered when Aspect advanced deep borings (Aspect 2022b). Aspect (2022b) states that the glacial till "generally consists of very dense gravel with sand and clay."

Talus (Qta): Talus consists of non-sorted, angular, colluvial diamict ranging from gravel- to boulder-sized material; it includes small avalanche deposits as well as undifferentiated rocky Holocene glacial deposits. Talus is mapped in the upper portions of the basin. It has also been observed along much of the north and south shores of the lake, and within narrow chutes and channels along the basin walls. Along the sides of the valley floor, talus may grade and interfinger with alluvium. Talus deposits generally lack the fine sediment of landslide deposits but are derived from similar downhill slides and rockfall modes of emplacement. These deposits are not likely to be encountered during construction of the new dam, but the depositional processes forming talus would continue to occur throughout the life of the new dam, potentially impacting the shoreline at or near the dam in the future.

Tonalite Bedrock – Mount Stuart Batholith (Kit(se)): Tonalite is a felsic intrusive igneous rock that comprises the outcropping bedrock of the Eightmile Creek Subbasin upstream from the lake including Eightmile Mountain, the south shore of Eightmile Lake up to the ridge, and both the north and south sides of the Eightmile Creek Subbasin and Icicle Creek Subbasin eastward to Leavenworth. Where present, the tonalite regularly forms steep, well-exposed outcrops.

Serpentinite Bedrock—Ingalls Tectonic Complex (Ju(i), Jhmc(i)): Serpentinite is a low-grade metamorphic rock composed primarily of serpentine group minerals derived from the hydrothermal alteration of ultramafic (rich in iron and magnesium, low in silica) rocks. Although unweathered serpentinite is typically green, these rocks characteristically weather to rusty browns in outcrop and exhibit blocky jointing fractures. Ingalls Tectonic Complex outcrops on the north shore of Eightmile Lake and the area of Eightmile Creek just downstream of the lake, extending up to the ridge. The landslide deposits that dammed the valley and created the valley and created the lake originated from the Ju(i) unit (Aspect 2019).

Schist Bedrock—Chiwaukum Schist (JTRhm(c)): Schist is a foliated, regional metamorphic rock ultimately derived from clay-rich sedimentary rocks and characterized by the planar alignment of platy mica and elongate amphibole mineral groups. The Chiwaukum schist is exposed in minor portions of the valley walls on the north and south sides of the Eightmile Creek Subbasin downstream of the lake.

7.3.6 Seismicity of the Study Area

Seismic activity in the Pacific Northwest is driven by regional convergent plate tectonics. Off the coast, the Juan de Fuca (oceanic) Plate collides into and subducts (descends) under the North American (continental) Plate. The contact between these plates forms an approximately 600-mile-long fault known as the Cascadia Subduction Zone (CSZ). The resulting stresses generate three unique types of earthquakes that contribute to seismic risk in the region (CREW 2013), described below.

Subduction (or Megathrust) Earthquakes: Megathrust earthquakes are formed by a rupture of the contact between the plates along the CSZ. These events are capable of generating a magnitude 9 or larger earthquake. These earthquakes are relatively far from Eightmile Lake, but still pose great risk due to their extreme intensity and duration. Along the CSZ, megathrust earthquakes are understood to have a recurrence interval of roughly every 500 years. The last such event along the CSZ happened in 1700 AD, lowering the coastline several feet and generating a large tsunami across the Pacific Ocean.

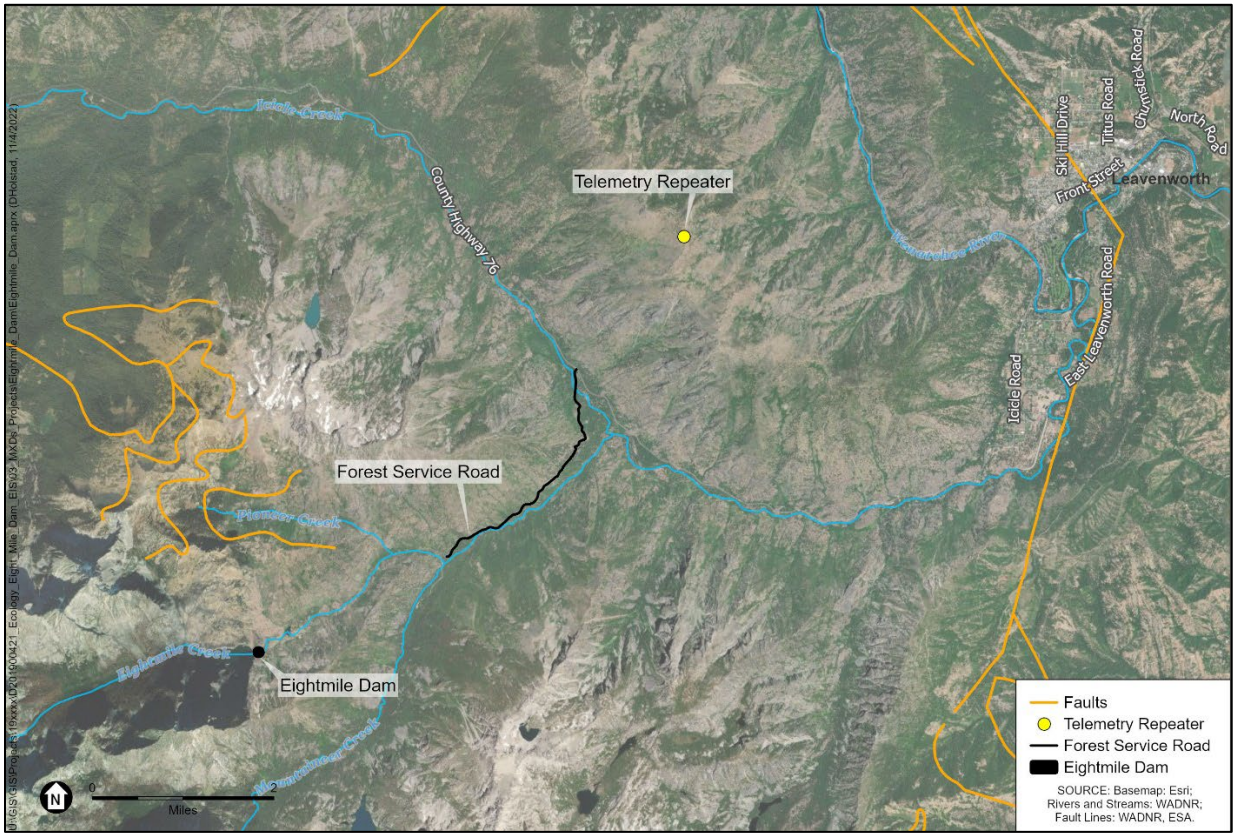
Deep (or Intraslab) Earthquakes: Intraslab earthquakes are associated with stress fractures within the subducting Juan de Fuca Plate as it bends underneath the North American Plate. Because they

occur at depths over 18 to 30 miles beneath the surface, the energy of these earthquakes is dissipated over large areas of ground surface, increasing their zone of influence but limiting their severity. These earthquakes concentrate underneath the Puget Sound region to the west of the study area and are closely associated with the depth of the plunging plate.

Shallow (or Crustal) Earthquakes: Stress from the predominantly compressional forces of the CSZ fractures and deforms the continental crust across the Pacific Northwest. When these near-surface crustal faults break, they generate earthquakes that affect smaller areas, but can locally be more intense than the subduction events off the coast. These faults are considered to be more likely to significantly impact the study area.

Numerous faults are present in the Cascade Range, but the majority of these faults have not exhibited evidence of displacement for millions of years and are considered seismically inactive. The WDNR Geologic Information Portal (WDNR 2022) shows the identified faults near the site (located at the tip of the arrow). A map of the faults is presented in **Figure 7-2**.

Figure 7-2. Mapped Faults near Eightmile Lake



The largest historical earthquake to affect the region surrounding the study area was an 1872 event with an epicenter likely located between Lake Chelan and Entiat, approximately 45 miles northeast of the study area. This earthquake had an estimated magnitude of 6.8 and has been attributed to the recently identified Spencer Canyon fault (Sherrod et al. 2015), although the exact location and magnitude of the event are unknown. All known faults with attributable Quaternary (1.6 million year ago to recent) activity are considered to be of sufficient distance from the study area to not pose a risk of fault rupture to the existing or proposed facilities. Future seismic activity in the region could be expected to be shallow earthquakes of comparable or greater magnitude than the 1872 event.

7.3.7 Conditions in the Special Warranty Deed Area

The Special Warranty Deed Area encompasses the existing facilities of Eightmile Dam and the natural earthen embankment that prehistorically created Eightmile Lake. Aspect (2019) and (2022b) describe the soil conditions as existing fill for the dam, underlain by landslide deposits, which in turn is underlain by glacial till.

Aspect (2019) describes groundwater seepage observed emanating from the creek channel at distances of approximately 300, 600, and 1,200 feet to the east and downstream of the existing dam location.

7.3.8 Conditions in the Study Area

Eightmile Lake and Shoreline: Eightmile Lake was created by a large natural earthen embankment (landslide) that blocked the drainage of Eightmile Creek. Around the shore of Eightmile Lake, small drainages feed directly into the lake as well as into Eightmile Creek, which is both the principal tributary to and distributary from the lake. Together, the lake is fed by 3,822 acres of basin, defined by Eightmile Mountain to the north, Jack Ridge to the west, and an offshoot ridge of the Stuart Range to the south.

The topography around the south shore of Eightmile Lake is strongly influenced by outcropping bedrock and forms glacially incised slopes, which can exceed 60 degrees, up to the surrounding ridges and peaks. Glacial features such as headwalls, chutes, and a sharp crest at the top of the ridge are present. The chutes descend and merge into two large talus fields. The southern lakeshore is covered with talus, is technically challenging to traverse, and is sparsely vegetated.

In contrast, the bedrock on the north shore of the lake has exhibited some mass wasting, which was likely a consequence of glacial erosion over-steepening the slopes of highly fractured bedrock. Aside from the landslide deposit at the east end of the lake, a large rockslide also abuts the west end of the lake. Ongoing rockfalls are evident farther up this chute. The northern shoreline is also littered with boulders but is vegetated with large evergreens, suggesting greater stability.

Eightmile Creek: Eightmile Creek downstream of the dam is fed by the outlet flow from Eightmile Lake. Natural groundwater seepage through the landslide deposits of the natural embankment also feed into Eightmile Creek below the dam. As the creek flows to the northeast down the Eightmile Creek Valley, it merges with its main tributaries—Pioneer Creek and Mountaineer Creek.

Icicle Creek: Eightmile Creek feeds into Icicle Creek roughly 4.5 miles east of Eightmile Lake. Icicle Creek drains the larger Icicle Creek Subbasin area. Below its confluence with Eightmile Creek, Icicle Creek wraps east around Icicle Ridge. Downstream of Icicle Ridge, the valley widens into an alluvial plain, the creek turns north into the City of Leavenworth, and flows into the Wenatchee River.

As with Eightmile Creek, the Icicle Creek channel at the base of the incised valley is filled with alluvial, colluvial, and glacial soils. As a larger valley at lower elevation, the channel flows at a shallower inclination than the more alpine Eightmile Creek channel.

Icicle Ridge: Icicle Ridge forms the northern side of the Icicle Creek Subbasin at its confluence with Eightmile Creek. It continues as the basin edge until Icicle Creek wraps around it to the east. It is a generally steeply sloping feature with exposed outcrops of bedrock.

7.4 Construction Impacts

The initial comments from the DSO and EIS team, based on Aspect's (2019) draft geotechnical report, identified the need for re-evaluation of geotechnical engineering parameters used in analyses of dam stability, seepage, and liquefaction susceptibility. The need for re-evaluation was based on

concerns about the lack of deep subsurface investigations to form conclusions in Aspect's draft report (2019). The resolution of these comments and the resulting design needs could have influenced construction of the future dam. To address these, Aspect completed deeper soil borings, the analysis of which was used to form their conclusions. In Aspect's (2022b) memorandum, published following the deep borings, they concluded that:

> *"geotechnical engineering soil and rock parameters/properties presented in the Draft Report are generally conservative. Revised stability and seepage analyses using the updated soil/rock parameters using less conservative parameters will result in factor of safety (FOS) values that are equal to or greater than those in the Draft Report and meet minimum required values. Additionally, the factor of safety against soil liquefaction initiation is equal to or exceeds minimum values such that additional subsurface explorations liquefaction analysis, and/or mitigation (such as ground improvement below the dam) is not needed."*

These conclusions imply that design needs that could influence the dam construction do not need to be undertaken.

Construction impacts would mostly be similar for all of the action alternatives, with differences only arising from differing dam footprints. Additionally, under any of the action alternatives, the new dam construction would involve the transport of equipment, materials, and personnel to the site. Several transportation options are being considered, as described in Chapter 2.

7.4.1 Transportation of Equipment and Materials

Access for helicopters to transport equipment and materials to the site will require the clearing of a staging area on the north side of the dam. The preparation of the staging area would consist of the removal of vegetation and grading to level the area. The size of the staging area varies based on the payload of the helicopter used for transport. The options being considered are either many trips with a high payload helicopter with a smaller helicopter used to fill in with items not previously transported (Option 1), or few trips with high payload helicopter then many trips with small helicopter to bring items gradually over the construction timeline (Option 2). Option 1 would require a staging area of approximately 10,000 square feet, and Option 2 would require approximately 8,500 square feet. Alternatives 1 and 3 propose the same staging area location. Alternative 2 includes a staging area that extends farther to the north due to the larger dam footprint. Under all three action alternatives, the impact on the geology of the site from establishing helicopter access remains relatively similar and is limited to the clearing and grading required to establish the staging area.

7.4.2 Construction Alternative Similarities

The initial construction activities for all action alternatives would involve the repair and improvement of FSR 7601-116, installation of temporary erosion controls, clearing and leveling of the staging area, and removal of wood and debris from the lake edge within the work area. The repair and improvement of FSR 7601-116 would involve the use of some heavy equipment to remove fallen trees and vegetation within the roadway. Some minor grading would be needed to fill in holes within the roadway, as well as to remove slide debris on the roadway and improve the washed-out areas. Permits would need to be obtained from the Forest Service, and all work would have to satisfy design and construction criteria.

Clearing of the staging area would include the removal of up to 30 trees. The removed trees would be used to help level the staging and work area. The size of the staging area varies depending on the alternative, with Alternative 2 requiring the largest area at 10,000 square feet. During this phase of construction, an approximately 150- to 300-foot-long section of the Eightmile Lake Trail would be temporarily re-routed around the active construction and staging area to ensure hiker safety near the active construction zone.

The existing outlet pipe for the lake would be removed, and excavation work to install a new outlet pipe would occur prior to further dam construction. Appropriate excavation cut angles or shoring of the trench to install the new pipe would be employed. The new outlet pipe would be the new exit point for water from the lake throughout the dam construction. In-water work would be needed to install cofferdams around the work area. Cofferdams would be constructed using large bulk bags. The bulk bags would likely be filled with on-site material. Pumps would be used as needed to dewater the work area.

Once the work area has been established, the existing dam structure would be removed. Excavation work would consist of the removal of the existing dam material and excavation for the foundation of the reinforced concrete dam structure. The excavated landslide deposits would be stockpiled and sorted for re-use as common embankment fill and as riprap armoring. During excavation, the excavated existing fill would be removed and stockpiled. Following the construction of the dam wing walls, the stockpiled sorted material would be placed to construct the embankment and backfill around the core wall.

The secondary spillway would be improved by adding armoring with both gabion baskets and riprap. The stockpiled sorted material would be used for the armoring.

All of the action alternatives would utilize automated valves and/or gates, which would require telemetry equipment to operate remotely. A local repeater station is proposed on top of Icicle Ridge, co-located with an existing Forest Service repeater station. Foundation supports would need to be installed, requiring some minor site preparation and excavation. The equipment and materials for the repeater station would be flown in by helicopter. The installation would consist of bolting down the equipment onto the foundation supports and securing with guyed wires.

The main impact on the geology of the site would be from the excavation for the new dam core wall, embankment, and pipe trench. All action alternatives would require extending the foundation for the core wall into the underlying landslide deposits, which would serve as the bearing material for the dam. This material would be stockpiled and re-used to construct the dam embankment for all action alternatives. The deepest impact of the dam would be the construction of the outfall pipe structure below the core wall and dam embankment, extending to approximately elevation 4,647 feet. The depth of the excavation could have an impact on the overall stability without appropriate shoring. The construction methods should ensure that the stability can be maintained by using trench boxes or other shoring methods during construction of the outfall pipe structure.

7.4.3 Construction Alternative Differences

The main difference in construction impacts between the alternatives consists of the difference in excavation and backfill required to create the dam footprint for each alternative. Alternative 2 requires the largest footprint and would result in more excavation and backfill activities compared to Alternatives 1 and 3, which have similar footprints. The alternatives also have slightly different outlet pipe alignments but the start and end points remain relatively similar.

In general, for all of the action alternatives, no significant impacts would occur during construction. In comparing the three action alternatives, Alternative 2 results in the largest dam footprint and the largest volume of earthwork movement and impact on geology. As previously described, this impact comes from the excavation activities required to construct the dam core wall, embankment, and pipe trench.

7.5 Operational Impacts

7.5.1 No Action Alternative

Under the No Action Alternative, DSO requires the existing low-level outlet gate to remain open during the winter and early spring to reduce the risk of a dam failure. The impact on geology is similar to that of the action alternatives (described below) and results from potential erosion at the lake edges from the fluctuating lake level. The No Action Alternative has a higher risk of dam failure, which could cause a greater impact on the site geology than the action alternatives. Dam failure would result in sudden lake drawdown, which would have a significant erosive/scour effect through the existing drainages. This could lead to slope stability issues in the sidewalls of Eightmile Creek. It would also likely release sediment farther downstream into Icicle Creek.

Regulatory enforcement by DSO in accordance with WAC 173-175-620(3) would consist of restricting the filling of the reservoir. Further regulatory enforcement, if the owner is unwilling or unable to resolve safety issues, would consist of abatement or removal of the dam. Implementation of WAC 173-175-620(3)(b) and (c) would eliminate the ability of the dam to operate.

7.5.2 Action Alternatives

Under the three action alternatives, the dam operation would allow the water levels in the lake to rise through the winter and spring until late-July each year, at which point the valve on the low-level outlet would be regulated to meet downstream needs. At the end of the irrigation season, the valve would be closed, allowing the lake to fill. Seepage through the soil under the dam would also continue to occur throughout the dam operation. The impact on the geology of the site from the dam operation would be from potential erosion at the lake edges resulting from the fluctuating lake levels. This impact would be minimal because the shore of the lake is mainly composed of talus and bedrock outcrops that are relatively resistant to erosion that may occur from lake level fluctuations.

In general, for all of the action alternatives, no significant impacts would occur during operation. All three action alternatives would result in similar fluctuating lake levels. As previously described, the lake level fluctuation would have a minimal impact on the site geology. The No Action Alternative has the highest potential for impact from continued operation as it has a higher risk of dam failure.

7.6 Avoidance, Minimization, and Mitigation Measures

The measures available to avoid, minimize, and mitigate impacts on the geology of the site are minimal for all action alternatives. All construction methods would require excavation into the underlying landslide deposits to construct a new dam embankment structure. Excavated material would be reused to construct the new dam embankment. This avoids having to dispose of the material at the site and having to source additional soil to construct the dam from elsewhere at the site. The geotechnical report (Aspect 2019) included the results of the liquefaction potential of the existing subsurface soils, and Aspect determined that an adequate factor of safety exists. Therefore, deep mitigation options are not needed with any of the alternatives. Aspect (2022b) confirmed with their deep explorations that liquefiable soils do not exist below the dam.

The existing trail would need to be temporarily rerouted around the active construction area at the dam during the construction of all action alternatives. To minimize impact, the trail could be re-routed using the shortest route possible just outside of the construction area. Impacts from the trail

reroute could also be minimized by employing measures after construction to fully block the trail reroute and facilitate revegetation to the pre-construction condition.

During project construction, FSR 7601 could be improved to acceptable conditions to allow for vehicle access, provided it is permitted and constructed in accordance with Forest Service guidelines. The rehabilitation of the road for temporary use during construction could be minimized to allow access for one truck width using proper construction techniques and BMPs for controlling erosion. After project construction, FSR 7601 would be closed as per direction by the Forest Service, similar to existing conditions.

7.7 Significant Unavoidable Adverse Impacts

7.7.1 No Action Alternative

There could be significant impact from the No Action Alternative. Leaving the dam in its current condition could result in a dam failure, which would cause a significant disturbance to the geology due to erosion from the increased flow of water. The increased flow of water would scour the Eightmile Creek corridor, undercutting the hillside slopes. This undercutting of the hillside could result in landslides at various areas downslope of the dam. The disturbance area could cause issues for several miles downslope of the dam.

Regulatory enforcement by DSO in accordance with WAC 173-175-620(3) would consist of restricting the filling of the reservoir. Further regulatory enforcement, if the owner is unwilling or unable to resolve safety issues, would consist of abatement or removal of the dam. Implementation of WAC 173-175-620(3)(b) and (c) would eliminate the ability of the dam to operate. Additional geologic impacts would be minor if the elevation of the reservoir is lowered due to regulatory enforcement. Unavoidable adverse impacts could occur if further regulatory enforcement requires that the dam be abated by removal. This would require excavation cuts into existing native material to create safe slopes, and that the existing fill material be stockpiled on-site. The complete removal of the dam could cause the lake level to lower below the historic elevations. This is a result of the lower maximum lake elevation and then the continued natural infiltration.

7.7.2 Action Alternatives

Impacts from the construction and operation of the project would not cause significant unavoidable adverse impacts on geology.

CHAPTER 8: PLANTS AND ANIMALS

This section describes plants and animals in the study area, including existing wildlife and aquatic species and their habitats. The analysis focuses on protected species and their habitats.

Key Findings for Fish and their Habitat

- Resident fish utilize Eightmile Lake, while salmonids (including three species listed under the Endangered Species Act) utilize fish habitat in the lower reaches of Eightmile Creek and the mainstem Icicle Creek.
- The Leavenworth National Fish Hatchery (LNFH) is an important component of mid-Columbia River fisheries, producing 1.2 million juvenile spring Chinook salmon and acclimating coho salmon.
- Construction of all action alternatives may result in very minor impacts on individual fish within Eightmile Lake and Eightmile Creek, but these impacts would be temporary and minimized by application of project BMPs (e.g., sediment curtains). None of the action alternatives would affect populations of fish or result in significant negative impacts on either fish species or fish habitat.
- Under existing conditions, extremely low summer streamflow conditions reduce the quantity of accessible fish habitat in Eightmile and Icicle creeks and can limit fish passage and increase water temperatures.
- Under all action alternatives, the increase in storage capacity would potentially provide more water for summer instream flow supplementation, which would benefit fish downstream of the lake in Eightmile and Icicle creeks, including ESA-listed fish species and other anadromous salmonids that use these waterbodies. There are no significant unavoidable adverse effects from the operation of any of the action alternatives.
- Under the No Action Alternative, whether the dam were removed, breached, or fail, there is a high potential for significant unavoidable adverse impacts, including large-scale fish mortality, habitat destruction, and long-term effects on summer flows and stream temperatures. These effects would also apply to the LNFH and could reduce or eliminate production at the facility.

Key Findings for Wildlife and their Habitat

- Wetlands and other water features occur throughout the wildlife and wildlife habitat study area, including near the loading and drop-off points of the staging areas, dam site, upstream (western) end of Eightmile Lake, and shoreline of Little Eightmile Lake. Although these features would be impacted by construction and operations of all project alternatives (including the No Action Alternative), alterations would be confined to shifting the distribution and the size of these features, but would not fundamentally change their type or function.

- Of the listed species in the study area, three federally protected wildlife species and 20 Washington State-protected wildlife species were determined to have a reasonable likelihood of occurring in the study area.
- No protected plants were found to occur in the staging area or FSR 7601-116 corridor.
- Various habitats protected by the State of Washington's Priority Habitats and Species (PHS) program are mapped and occur within the plants and animals study area.
- Impacts on wildlife habitat from helicopter use would be minimal, assuming that landing zones would not need to be substantially altered from current conditions. Propwash would be strong but would not damage vegetation to the point that it is fundamentally unusable by wildlife.
- Helicopter use would disturb avian species and terrestrial mammals, including those with state and/or federal protections. Protected bat species, which may roost near the loading and unloading areas, may also be disturbed and stressed by helicopters as cargo is shuttled during construction.
- The establishment of the FSR 7601-116 road segment would require vegetation removal and road grading using heavy equipment and hand crews. These activities would cause localized noise disturbance and alter wildlife habitats along the segment. Noise would displace wildlife able to flee the area, which would likely occur prior to the associated physical habitat changes. Human presences, largely associated with the heavy equipment, would further disturb wildlife in the area. Because the road segment is currently overgrown with vegetation and not typically used, the alterations would remove wildlife habitat.
- In general, impacts from project operations would have minimal effects on plants and animals due to the similarity with pre-construction conditions, as well as the proposed mitigation actions that would return areas impacted by construction to natural conditions.

8.1 Methodology

Wildlife, aquatic species, and their habitats were evaluated by reviewing species known or expected to be found in the study area. Habitats in the study area were determined based on the available geographic information system (GIS) data, aerial imagery, and existing studies. This analysis was supplemented with a site reconnaissance to Eightmile Lake in the summers of 2020 and 2021, and a targeted botanical survey was conducted for the proposed staging area and access road on September 30, 2021 (ESA 2021; Appendix C). No formal delineation of jurisdictional wetlands and waters of the U.S. or State of Washington was conducted as part of this EIS analysis; however, wetland and water features were specifically examined during the multiple site visits, and conditions were compared ("ground-truthed") to available mapping data, including National Wetlands Inventory (NWI), National Hydrography Dataset (NHD), and Priority Habitats and Species (PHS) datasets. Additional available data were also considered, including soil data from the Web Soil Survey (WSS), as well as various aerial and topographic maps.

The study area is based on the area where wildlife, aquatic species, and habitats could be most directly affected by the construction or operation of the project (**Figure 8-1**), which includes the project area (Eightmile Dam, access roads, and repeater station site) as well as portions of the Alpine Lakes Wilderness.

Potential impacts include short-term impacts related to construction of the action alternatives and long-term impacts from operation of the dam under the No Action and action alternatives. Potential

significant impacts are defined below; impacts that do not reach that threshold would be less-than-significant.

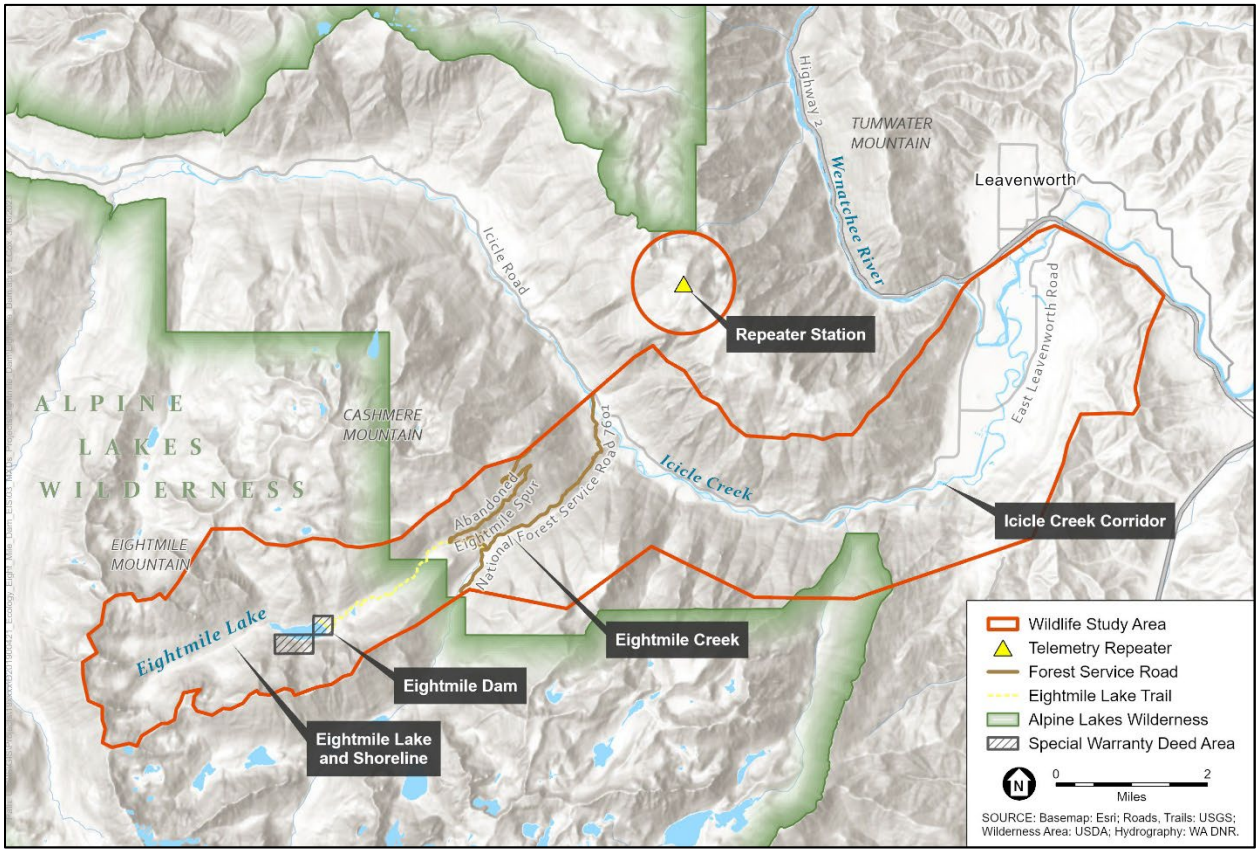
Criteria for Significant Construction Impacts: Impacts would be significant if construction activities would result in a large-scale take (mortality, injury, or deleterious behavioral changes on more than a few individual organisms) on fish and wildlife species listed under the federal Endangered Species Act (ESA) (threatened or endangered) or similar effects on those species under the Washington State ESA (threatened, endangered, sensitive, or candidate).

Construction activities would be considered a significant impact if they eliminate, or make non-viable, a species within the study area through the loss of suitable habitat.

Criteria for Significant Operational Impacts: Impacts would be significant if operation of the dam would result in a large-scale take (mortality, injury, or deleterious behavioral changes on more than a few individual organisms) on fish and wildlife species listed under the federal ESA or similar effects on those species under the Washington State ESA.

Criteria for Significant Habitat Impacts During Operation: Operation of the dam would eliminate, or make non-viable, a species within the study area through the loss of suitable habitat.

Figure 8-1. Study Area for Wildlife, Aquatic Species, and Habitats



8.2 Regulatory Context

The project is subject to a number of regulations at the federal, state, and local levels. **Table 8-1** lists and describes the applicable regulations.

Table 8-1. Regulations and Guidelines Applicable in the Study Area

Program, Plan, or Policy	Description
Wilderness Act	The Wilderness Act created the National Wilderness Preservation System and provides the highest level of conservation protection of federal lands. The purpose of the Act is to manage wilderness areas to preserve and, where possible, to restore their wilderness character. To support the mandates of the Wilderness Act, the National Park Service established the National Park Service Management Policies (2006) and Director's Order 41 (2013), which are updated on a periodic basis.
Federal Endangered Species Act (50 CFR Part 17)	Protects species identified as endangered or threatened along with designated critical habitat required for the conservation of those species. The National Marine Fisheries Service (NMFS) has authority over most anadromous fishes, marine mammals, marine reptiles, and other marine fish species, while the United States Fish and Wildlife Service (USFWS) has authority over terrestrial wildlife and resident fish species that inhabit inland waters. Requires that federal actions (such as issuing a permit for wetland fill) do not jeopardize the continued existence of any threatened, endangered, or proposed species or result in the destruction or adverse modification of critical habitat.
Magnuson-Stevens Fishery Conservation and Management Act (MSA) - Public Law 104-297, October 11, 1996, as amended	Requires federal agencies to consult with NMFS on activities that may adversely affect Essential Fish Habitat (EFH). The EFH designation for the Pacific salmon fishery (Chinook, coho, and pink salmon) includes all those streams, lakes, ponds, wetlands, and other waterbodies currently or historically accessible to salmon in Washington, except upstream of identified impassable barriers.
Fish and Wildlife Coordination Act	Requires that federal agencies consult with the USFWS, NMFS, and state wildlife agencies for activities that affect, control, or modify waters of any stream or bodies of water, in order to minimize the adverse impacts of such actions on fish and wildlife resources and habitat.
Bald and Golden Eagle Protection Act	Protects bald and golden eagles from the unauthorized capture, purchase, or transportation of the birds, their nets, or their eggs.
Executive Order 12962 (Recreational Fisheries)	Mandates federal agencies, to the extent permitted by law and where practical, to improve the *"quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities."*
Migratory Bird Treaty Act	Protects migratory birds by prohibiting private parties (and federal agencies in certain judicial circuits) from intentionally taking, selling, or conducting other activities that would harm migratory birds, their eggs, or nests (such as the removal of an active nest or nest tree), unless the Secretary of the Interior authorizes such activities under a special permit.

Program, Plan, or Policy	Description
Clean Water Act (33 CFR 320) Sections 401 and 404	Regulates discharges of dredged or fill materials into waters of the U.S., including wetlands and streams. Also requires any activity that may result in a discharge of a pollutant into waters of the U.S. to obtain a certification from the state that the discharge complies the applicable water standards.
Washington State Endangered Species Act	Oversees the listing and recovery of those species in danger of being lost in the state. Pertains to all state-listed threatened and endangered species.
State Hydraulic Code (WAC 220-660)	Regulates hydraulic projects (construction or performance of work that will use, divert, obstruct, or change the natural flow or bed of any of the salt or fresh waters of the state) by requiring a Hydraulic Project Approval (HPA) for all such projects. The purpose of the HPA is to ensure that construction or performance of work is done in a manner that protects fish life.
Priority Habitats and Species (PHS) Program	State nonregulatory program that provides information on documented locations of fish and aquatic resources, terrestrial plants and animals, and habitats listed or defined as priority. Priority species include state endangered, threatened, sensitive, or candidate species; animal aggregations considered vulnerable; and species of recreational, commercial, or tribal importance that are vulnerable (WDFW 2015). Priority habitats are habitat types or elements of habitat with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type (e.g., shrub-steppe) or dominant plant species, a described successional stage (e.g., old-growth forest), or a specific habitat feature (e.g., cliffs).
Washington State Shoreline Management Act	Shorelines of the state (defined in RCW 90.58.030(2)) are regulated through the Shoreline Management Act (SMA). The SMA is administered by Ecology, who delegates authority to local jurisdictions to manage their shorelines through the preparation and implementation of a Shoreline Master Program (SMP).
Fish and Wildlife Habitat Conservation Areas Overlay District (FWOD) Chelan County Code (CCC) 11.78	To designate and classify fish and wildlife conservation areas and to protect, restore where practical, and enhance fish and wildlife populations and their associated habitats.
Wetland Areas Overlay District (CCC 11.80)	To protect the ecological and environmental functions of wetlands and protect the public health, safety, and welfare benefits provided by wetlands by preventing the continual loss of wetlands and, where practical, enhancing or restoring wetland functions and values.

8.3 Affected Environment

8.3.1 Wildlife and Wildlife Habitat

Ecosystem Setting

The ecosystem within the study area for wildlife is composed of a diversity of habitats that support a wide array of wildlife species. The North Cascades Physiographic Province, in which the study area occurs, is a topographically mature area of great relief with very deep, glacially carved valleys with steep slopes (Franklin and Dyrness 1973). Past glacial activity has left rocky, shallow soils that readily pond water or convey it to form springs and streams, all manifesting along valley bottoms. The generally high elevation results in a relatively short growing season and cold, snowy winters. Together, these conditions create a relatively harsh environment that constrains vegetation, as well as the wildlife that resides within it, yet also drives the unique qualities of this landscape.

The study area for wildlife includes the entire length of the Eightmile Creek watershed and the portion of the Icicle Creek drainage extending from its confluence with Eightmile Creek downstream to the Wenatchee River (Figure 8-1). The study area extends vertically from the bottomlands of the various stream drainages, upslope to the surrounding ridgetops. For the purposes of this EIS, four geographic sub-areas have been identified within the study area according to their jurisdiction or the habitats present. These include the Alpine Lakes Wilderness, the Eightmile Lake and shoreline area, the Special Warranty Deed Area overlapping Eightmile Lake, and the Icicle Creek corridor, as shown on Figure 8-1. Overall, naturally occurring wildlife habitat throughout these sub-areas is moderate to high in quality and provides diverse features that support a variety of species. The exceptions are found in discrete but large areas that receive high human use. These areas include portions of the Icicle Creek corridor, Eightmile Creek drainage, and Eightmile Lake and shoreline area. Human use of these sites is generally seasonal, but becomes pronounced in the summer months where roads, parking and camping areas, and backcountry hiking trails are present. In addition to human presence, high use of backcountry sites has led to soil erosion, damage to vegetation, and long-term behavioral alterations of some wildlife species through habituation and learned association with various resources.

Vegetation and Protected Habitats

Environmental Science Associates conducted a vegetation survey of habitat conditions; rare, threatened, and endangered vascular plant species; and undesirable plant species on September 30, 2021 (ESA 2021; Appendix C). The survey focused on locations within the study area including the Eightmile Dam staging area, the portion of FSR 7601-116 to be improved as a part of the project, and the repeater station site. A site reconnaissance was also conducted in August 2020. As part of the survey and site reconnaissance, ecologists examined wetland and water features in the study area, and compared current on-the-ground conditions to existing mapping data sources, including the NWI, NHD, and PHS datasets (USFWS 2022; NRCS 2022; WDFW 2021c). No formal jurisdictional wetland delineation was conducted as part of this EIS analysis, but most of the study area was examined for wetland features, including hydrology, hydrophytic vegetation, and soil conditions (no test pits were excavated). The watershed for Eightmile Lake is generally confined to the ridgetops surrounding the basin in which it sits. It is bound by Jack Ridge to the west, Eightmile Mountain and ridgeline to the north, and the ridgeline separating Eightmile Lake basin and Stuart Lake basin to the south. Both the 2020 and 2021 site visits were conducted during late summer/ early fall, during seasonal low-water conditions, and observations were considered in that context.

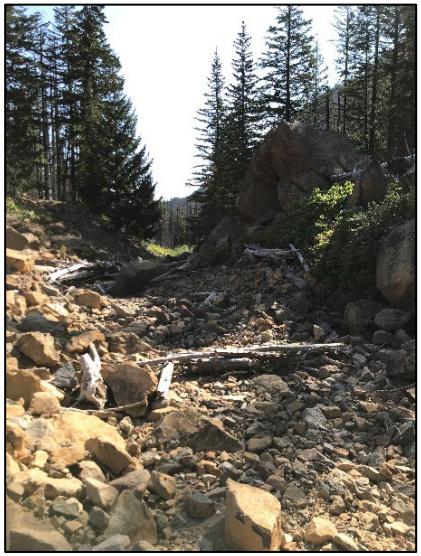
This section summarizes the findings of the survey and site reconnaissance. Representative photos taken during the site visits are presented in **Figure 8-2**, illustrating the current conditions of some of the key habitat features in the study area as described below.

The study area was burned by the Mt. Cashmere Wildfire in 2012 and Jack Creek Fire in 2017 (WDNR 2021; USFS 2021g), which altered vegetation by creating gaps in the forest canopy, removing vegetation, and altering soil compositions, thus allowing early seral communities to fill in these newly disturbed areas (see Figure 8-2).

Most of the study area is dominated by alpine and subalpine vegetation. The lower elevations of the study area have less drought-tolerant, more dense vegetation, while higher elevations have vegetation better adapted to a dry environment. The site around the staging area is dominated by fir trees with subcanopy vegetation dominated by Oregon boxwood (*Paxistima myrsinites*), currant (*Ribes* sp.), elderberry (*Sambucus* sp.), thimbleberry (*Rubus parviflorus*), and various grass species. The upper and lower portions of FSR 7601-116 have montane habitat with grand fir (*Abies grandis*) forest associations, but the lower portion of the road also has subalpine fir forest associations. The lower portion of FSR 7601-116 has a higher density of alders (*Alnus* spp.) with a lower density of pines than the upper portion of the road.

Figure 8-2. Representative Photos of Habitats in the Plants & Animals Study Area
(photos by Environmental Science Associates, 2020 and 2021)

Burned trees from the 2017 Jack Creek Fire



Steep, rocky shoreline along the Eightmile Creek corridor (looking downstream)

Wetland conditions at the upstream end of Eightmile Lake

Conditions along the shoreline of Little Eightmile Lake

Previous surveys completed by Forest Service botanists had identified invasive species such as Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), and mullein (*Verbascum thapsus*) near the staging area and Eightmile Dam (Furr 2021). Common tansy (*Tanacetum vulgare*) has also been identified in the vicinity of the study area (Furr 2021). The identified populations of common tansy and Canada thistle have been treated previously with herbicide (Furr 2021). Of these populations, only mullein was observed during the September 30, 2021 survey. All undesirable species observed during the survey are listed in Table 8-2.

The Washington Department of Natural Resources, Natural Heritage Program maps Seely's catchfly (*Silene seelyi*) near the staging area and Thompson's pincushion (*Chaenactis thompsonii*) near FSR 7601-116. However, no rare, threated, or endangered plant species or habitat likely to support these species was observed during the targeted survey (ESA 2021; Appendix C).

Table 8-2. Undesirable Plant Species Observed during the September 30, 2021 Vegetation Survey

Common Name	*Scientific Name*	Chelan County Noxious Weed Classification	Washington State Noxious Weed Classification	FS Region 6 Invasive Plant List
FSR 7601-116 Segment				
Bird's-foot trefoil	*Lotus corniculatus*			Yes
Bull thistle	*Cirsium vulgare*		C	Yes
Dandelion spp.	Genus *Taraxacum*			
Diffuse knapweed	*Centaurea diffusa*	B (non-designate selected for control)	B	Yes
Orchard grass	*Dactylis glomerata*			Yes
Oxeye daisy	*Leucanthemum vulgare*	C (selected for control)	Class C	Yes
Red clover	*Trifolium pratense*			
Ribwort plantain	*Plantago lanceolata*			Yes
Timothy grass	*Phleum pratense*			
Scentless mayweed	*Tripleurospermum inodorum*		Class C	Yes
White clover	*Trifolium repens*			
Yellow salsify	*Tragopogon dubius*			
Eightmile Dam Staging Area				
Mullein	*Verbascum thapsus*			Yes
Orchard grass	*Dactylis glomerata*			Yes
Red sand spurrey	*Spergularia rubra*			
Yellow salsify	*Tragopogon dubius*			

Sources: Chelan County (2021a), Washington State Noxious Weed Control Board (2021), USFS (2010).

Alpine Lakes Wilderness

The Alpine Lakes Wilderness intersecting the study area includes the mountain slopes extending to the ridgeline around Eightmile Lake, and the upstream portion of Eightmile Creek. This area is dominated by a mix of forest zones, subalpine meadow communities, alpine communities (Franklin and Dyrness 1973), and stream drainages including Eightmile Creek (the Eightmile Lake and shoreline are described in the section below). Alpine communities are found at the highest elevations where harsh conditions stunt or prevent tree growth. Subalpine communities, located just below alpine communities in elevation, host a greater diversity of plant species, which grow much larger and provide additional habitat structure.

Forested habitat is found at lower elevations and includes dense, somewhat mixed stands of trees including Douglas fir (*Pseudotsuga menziesii*) and western larch (*Larix occidentalis*) (Franklin and Dyrness 1973). A significant characteristic of this forested habitat is the condition created by the Jack Creek Fire, which severely burned much of the vegetation surrounding Eightmile Lake (U.S. Department of the Interior 2017). This intensive fire burned away large expanses of vegetation cover and killed or damaged many shrubs and trees. Although some habitats were degraded in the short term, the fire also created essential features for wildlife that will persist for some time (Fenger et al. 2006). These features include downed wood, standing-hollow snags, and stressed trees throughout the forests of the Alpine Lakes Wilderness area. These habitats provide opportunities for forage, shelter, and reproductive sites for a variety of wildlife species.

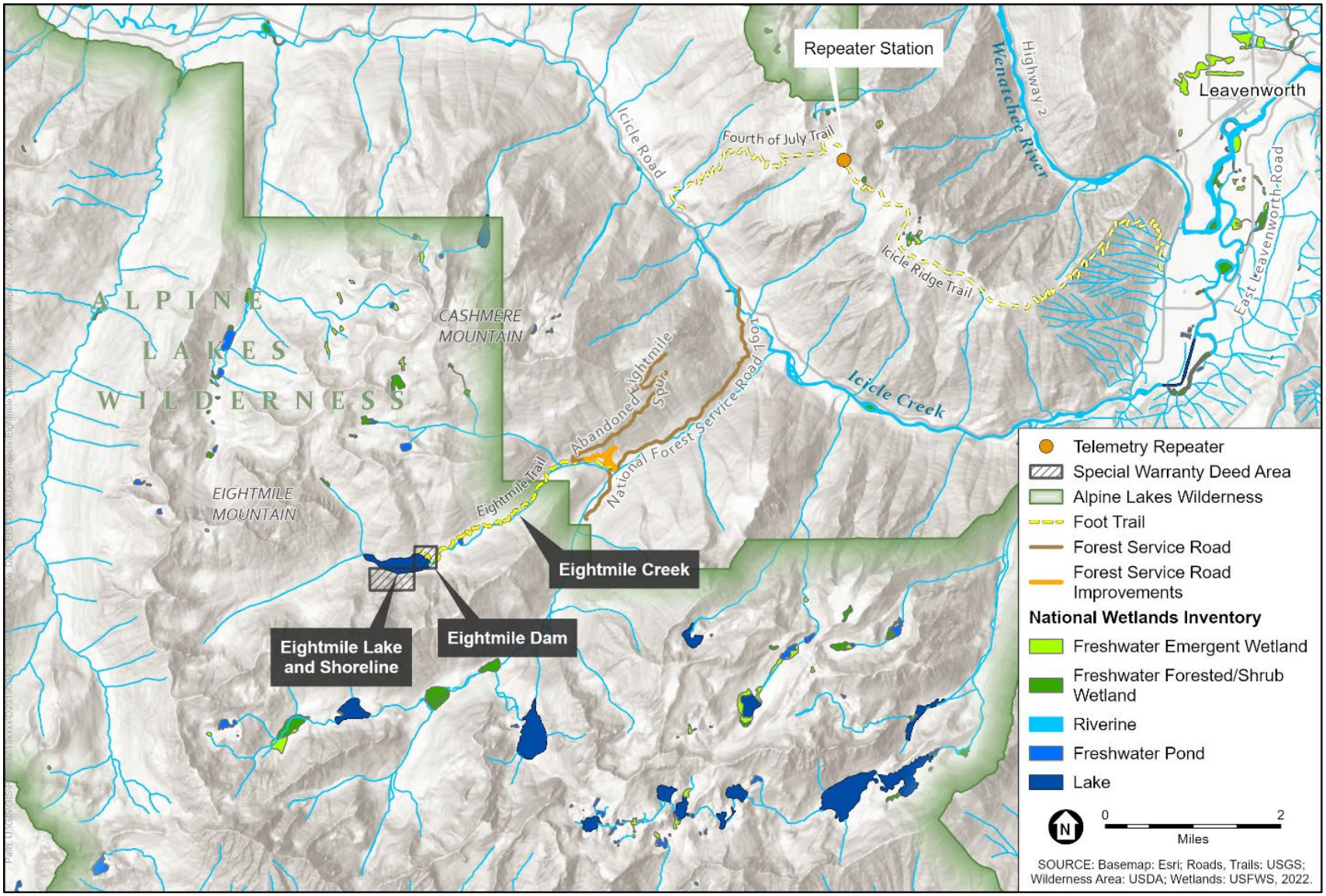
One state Priority Habitat is mapped within the portion of the study area overlapping with the Alpine Lakes Wilderness: Freshwater Wetlands – Fresh Deepwater. However, additional Priority Habitats are also present (Table 8-3) (WDFW 2021c). Protected habitats in this area are limited to wetlands and stream features (WDFW 2021c). The NWI maps numerous wetlands, lakes, and riverine waterbodies throughout the Alpine Lakes Wilderness (USFWS 2022). All wetlands and other waters mapped in the Alpine Lakes Wilderness area appeared to be accurately represented relative to baseline conditions (see Figure 8-3).

Table 8-3. WDFW Priority Habitats within the Study Area; Actual (verified present) and Mapped (not verified present) Occurrences are Indicated

Priority Habitat Type	Alpine Lakes Wilderness	Eightmile Lake and Shoreline	Special Warranty Deed Area	Icicle Creek Corridor
Terrestrial Habitats				
Biodiversity Areas	X	X	X	X
Old-growth/Mature Forest	X		X	X
Riparian	X	X	X	M
Aquatic Habitats				
Freshwater Wetlands	M	M	M	M
Instream	X		X	X
Priority Habitat Features				
Caves	X		X	X
Cliffs	X		X	X
Snags and Logs	X	X	X	X
Talus	X		X	X

M=Habitat types mapped by WDFW PHS as occurring, X=Habitat types likely present.
Source: WDFW 2021c

Figure 8-3. Wetland Habitats Mapped in the Study Area



Eightmile Creek Corridor

The upstream portion of the Eightmile Creek corridor provides habitat conditions that support a similar wildlife assemblage as what is present in the Alpine Lakes Wilderness forested habitat, as well as what is present in the Eightmile Lake and shoreline area (see discussion below). However, a greater diversity of plant species and vegetation communities is present in the Eightmile Creek corridor due to its lower elevation, higher precipitation, and the presence of perennially flowing water, which collectively support a small but mature riparian corridor. Common riparian trees include black cottonwood (*Populus balsamifera*) and Pacific willow (*Salix lucida*). Wildlife in the Eightmile Creek corridor, including large mammals and raptors, would tend to avoid areas of high human use such as around the roads, campgrounds, parking areas, and trails. FSR 7601 likely also functions as a potential barrier to movements of larger mammals, including deer and elk, limiting habitat quality for these species (Riley et al. 2014).

One state Priority Habitat is mapped as specifically within the portion of the study area overlapping with the Eightmile Creek corridor: Freshwater Wetlands - Fresh Deepwater. However, additional Priority Habitats are also present (Table 8-3) (WDFW 2021c). Within this portion of the study area, NWI maps Eightmile Creek as a riverine, upper perennial, unconsolidated bottom, permanently flooded (R3UBH) feature. This feature was determined to be accurately mapped during the site visits in 2020 and 2021. Based on observations during the site visits, the Eightmile Creek corridor downstream of Eightmile Dam is characterized by steep, rocky slopes and sandy soils, with very little vegetation cover (see **Figures 8-2 and 8-4**). A fringe of riparian trees is perched atop the steep banks, outside the rocky stream corridor, but the steep topography and substrate are not conducive to supporting a well-developed riparian corridor or riverine wetland. The area is best described as a stream corridor, with the steep slopes contributing to rapidly flowing hydrology through a channelized, rocky streambed devoid of riparian vegetation. No loamy soils are present that would support the anaerobic soil conditions associated with riverine wetlands. No Wetlands of High Conservation Value are mapped or recorded in this portion of the study area.

Little Eightmile Lake is mapped by NWI as a palustrine, unconsolidated bottom, permanently flooded (PUBH) wetland feature (2.96-acre Freshwater Pond) (USFWS 2022). This feature was determined to be accurately mapped during site visits in 2020 and 2021. Based on the observations made, which were conducted during the late summer low-water season, the wetland area at Little Eightmile Lake is generally characterized as discrete patches of scrub-shrub wetland with limited PUBH in areas (see Figure 8-2). No Wetlands of High Conservation Value are mapped or recorded in this portion of the study area.

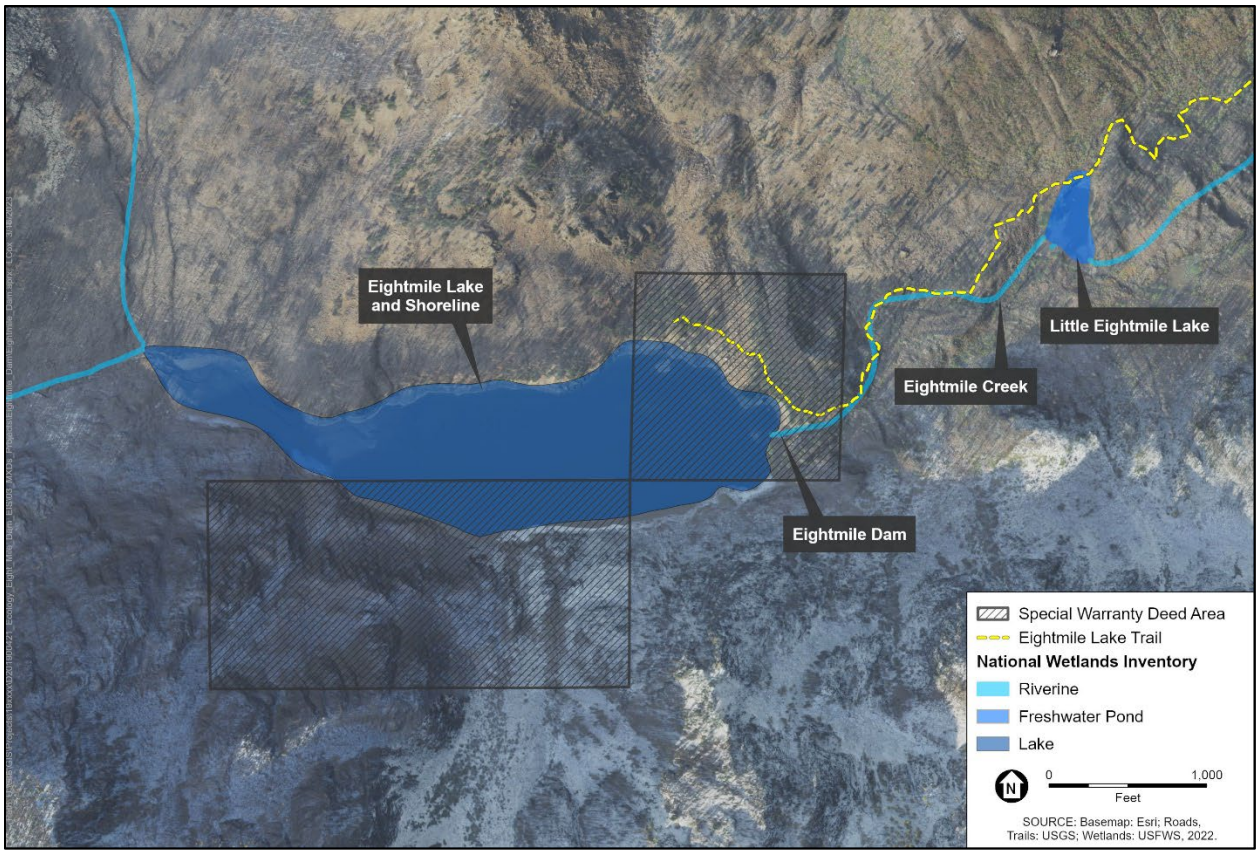
Eightmile Lake and Shoreline

The Eightmile Lake and shoreline area currently supports limited vegetation but provides habitat features for resident wildlife as well as for those who use it to move between adjoining habitats. Aquatic edges and limited wetlands provide habitat for several relatively common amphibian and reptile species. Many bird species use these aquatic habitats as well.

Eightmile Lake and the limited wetland habitats support a diversity of mammal species including various bats and other small mammals that depend on water or associated habitat features for foraging and breeding. Larger mammals such as deer, elk, bear, cougar, bobcat, and coyote would use the corridor to move through this area during seasonal migrations.

Because of the fluctuating water levels, Eightmile Lake has a seasonal lake fringe wetland located at the inlet that moves seasonally with changing surface water elevations. This wetland is emergent, herbaceous, and dominated by weedy wetland plants that quickly colonize the receding surface water elevation. It tends to be at its greatest size when the lake is at its lowest surface water elevation. The wetland likely supports a variety of wildlife species including amphibians and reptiles.

Figure 8-4. Wetland Habitats Mapped at Eightmile Lake and Downstream



The NWI maps Eightmile Lake as a lacustrine, limnetic, unconsolidated bottom, permanently flooded (63.6-acre lake habitat classified as L1UBH) feature (USFWS 2022), which was determined to be accurate from field observations during the 2020 and 2021 site visits. Based on observations during the site visits, which were conducted during the late summer low-water season, the wetland area at Eightmile Lake is characterized as PUBH (see Figures 8-2 and 8-4). As described above, this wetland is emergent, herbaceous, and dominated by weedy wetland plants.

Additionally, one Priority Habitat (Freshwater Wetlands - Fresh Deepwater) occurs within this portion of the study area and overlaps with the Eightmile Lake shoreline and waterbody. All other Priority Habitats within this portion of the study area are shown in Table 8-3 (WDFW 2021c). No species are mapped by the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consulting (IPaC) as occurring within the Eightmile Lake and shoreline area (USFWS 2021b). No Wetlands of High Conservation Value are mapped or recorded in this portion of the study area.

Special Warranty Deed Area

The Special Warranty Deed Area overlaps with the south and northeast sides of Eightmile Lake and adjoining upland habitats. This area therefore supports the same wildlife and wildlife habitats present in the Eightmile Lake and shoreline area, as well as the burned forests of the Alpine Lakes Wilderness.

One State Priority Habitat is mapped specifically within the portion of the study area overlapping with the Special Warranty Deed Area: Freshwater Wetlands – Fresh Deepwater. This feature was determined to be accurately mapped during site visits in 2020 and 2021. However, additional

Priority Habitats are also present (Table 8-3) (WDFW 2021c). No species are mapped by IPaC as occurring within the Special Warranty Deed Area (USFWS 2021b).

Icicle Creek Corridor

The same habitats and species found in the Eightmile Creek corridor of the Alpine Lakes Wilderness portion of the study area, described above, occur in the Icicle Creek corridor, which extends downstream to its confluence with the Wenatchee River. However, Icicle Creek has a larger, more diverse riparian zone that supports additional deciduous trees and shrubs and provides extensive instream habitat. The Icicle Creek corridor has suffered more human alterations and is more disturbed than the Eightmile Creek corridor, causing species sensitive to human activities, such as larger mammals like black bear and cougar, and raptor species, to avoid these areas. Human disturbance is greatest along Icicle Creek Road and the associated campgrounds and parking areas along the creek. The upslope areas in the Icicle Creek corridor are glacially carved slopes that provide a mix of alpine, sub-alpine, and forested habitats that are generally high quality.

Two State Priority Habitats are mapped as occurring specifically within the Icicle Creek corridor: Freshwater Wetlands – Fresh Deepwater and Riparian. However, additional Priority Habitats are also present (Table 8-3) (WDFW 2021c). Similar to the Alpine Lakes Wilderness, the NWI maps a variety of wetland and riverine resources along the Icicle Creek corridor, including Icicle Creek, which is mapped as a riverine, upper perennial, unconsolidated bottom, permanently flooded (R3UBH) feature, which is the same designation as Eightmile Creek (USFWS 2022). This mapping was determined to be accurate.

Repeater Station Site

The repeater station site is in the alpine habitat, up above Eightmile Lake on a ridgeline. Because of this, few large trees are present, and other plants occur only in low density. Bare ground is typical of this area. Wildlife use is limited to alpine-adapted species. No wetlands or other waters occur in this area. No wetlands or other waters have been mapped at the repeater station site.

Protected Plants and Wildlife

Aquatic and terrestrial habitats in the study area support a variety of plant and wildlife species; however, the degraded ecosystem both within and outside of the study area has reduced the vigor of some of these populations. The federal ESA protects species listed as endangered, threatened, or proposed for listing from "take," which is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. For wildlife species, these protections are implemented by the USFWS. A provision of the ESA allows for state fish and wildlife agencies to cooperate with federal agencies and implement applicable species protections. Washington maintains an active role in regulating and protecting at-risk species through their State Listed Species (SLS) program and PHS program. Protected fish species are described in Section 8.3.2, *Fish and Fish Habitat*.

A review of the wildlife species listed under ESA as threatened, endangered, or proposed for listing in Chelan County identified a total of five species mapped as having potential to occur, all of which are listed as threatened (USFWS 2021a). One additional federally protected species under the Bald and Golden Eagle Protection Act (BGEPA) also has been mapped as having potential to occur. A formal PHS GIS layer was obtained from WDFW that identified a total of 27 wildlife species mapped as having potential to occur in the study area (WDFW 2020a).

Of the listed species, three federally protected wildlife species and 20 Washington State-protected wildlife species were determined to have reasonable likelihood of occurring in the study area. These species are described further in this section and are listed in Table 8-4, along with ecological and

demographic information describing their likelihood of occurrence. Species determined to not have reasonable likelihood of occurring in the study area are not discussed further. No species were mapped by the USFWS IPaC tool as occurring within the Alpine Lakes Wilderness sub-area (USFWS 2021b). The targeted vegetation survey for the Eightmile Dam staging area and FSR 7601-116 did not identify any protected plant species within the Eightmile Creek corridor or Eightmile Lake and shoreline areas (ESA 2021; Appendix C).

The potential for protected plant and wildlife species to occur in the study area during at least part of the year is based on an array of characteristics including the biology of a species, demographic history, and the habitat conditions available in the study area. These characteristics were assessed during the 2020 and 2021 site visits, including the vegetation survey (ESA 2021; Appendix C). Compiling and overlaying these characteristics allows for a determination on the potential of occurrence for each protected species. Best scientific information, which is generally the most current and/or geographically applicable, is essential in assembling characteristics for this determination. Five criteria were developed and defined for this analysis that classify the potential for each species to occur in the study area. They are as follows:

- Does not occur – The species has not been recently observed in the study area, the study area is outside of the known current range of the species, no suitable habitat is found in the study area, or the species has restricted mobility or a small population size that substantially limits its dispersal ability to the study area.
- Unlikely to occur – The species has not been recently observed in the study area, the study area is outside of the species' known current range and/or suitable habitat may be absent, the species may have restricted mobility or a small population size, reducing but not preventing its dispersal potential to the study area.
- Possible to occur –The study area is within the species' known range but contains marginally suitable habitat, or suitable habitat may occur in the study area, but the species has not been reported observed despite being relatively mobile. If the species does occur within the study area, it may only be present infrequently, in small numbers, and only during short durations.
- Likely to occur – The study area is in the species' known current range and contains suitable habitat, and/or there are relatively recent records of the species from adjacent areas with similar habitat. Occurrence in the study area would likely correspond to supporting a portion of the life cycle of the species.
- Occurs – Recent records exist of the species in the study area based on USFWS, WDFW, or other reputable survey data, and suitable habitat is present. Occurrence in the study area would likely correspond to supporting a portion of the life cycle of the species.

8.3.2 Fish and Fish Habitat

The study area for fish and fish habitat includes the entire length of the Eightmile Creek watershed, including Eightmile Lake, as well as the portion of the Icicle Creek drainage extending from its confluence with Eightmile Creek downstream to the Wenatchee River (Figure 8-1).

Eightmile Creek Subbasin and Aquatic Habitat

Eightmile Creek (WRIA Stream Number 45.0506), itself part of the larger Icicle Creek watershed, drains a tributary area of 30 square miles and conveys surface water runoff from both Eightmile Lake and Colchuck Lake via Colchuck and Mountaineer creeks. Eightmile Creek confluences with Icicle Creek at approximately RM 9, and the stream provides approximately 3 to 5 percent of the

discharge to the Icicle Creek system, based on Ecology and USGS flow gage data between 2008 and 2021.

Table 8-4. Protected Wildlife Species likely to occur in the Study Area; Potential of Occurrence is included for Geographic Sub-areas

Common Name Scientific Name	Federal/ State Listing Status	Associated Habitat Characteristics	Potential to Occur Within Study Area	Potential of Occurrence in Geographic Sub-areas		
				Alpine Lakes Wilderness	Eightmile Lake and Shoreline / Special Warranty Deed Area	Icicle Creek Corridor
Invertebrate						
Giant Palouse earthworm Driloleirus americanus	--/SC,SP	Palouse prairies, open forest, and shrub-steppe in deep, loamy soils or gravelly and sandy soils.	Occurs. Species mapped as occurring on edge of study area. Habitat present may be marginal though little is known about this species.	U	U	O
Amphibians						
Western toad Anaxyrus boreas	--/SC,SP	Land dwellers found in woodlands, meadows, and mountainous wetlands. Prefer slow-moving, quiet waters, especially wetlands for breeding.	Possible to occur. While not reported in the study area, it is located within the species' current range, and habitat requirements are present at Eightmile Lake and riparian corridors.	P	P	P
Birds						
Harlequin duck Histrionicus histrionics	--/SP	Low to subalpine elevations within a closed forest canopy in turbulent mountain streams with midstream gravel bars or rocks.	Occurs. Species mapped as occurring within the study area. Habitat requirements present.	P	P	O
Sooty grouse Dendragapus fuliginosus	--/SP	Inhabit wet conifer forest from sea level to the subalpine and alpine zones where a well-developed understory of grasses, herbs, and shrubs is present.	Occurs. Sooty grouse have been observed in the study area, which is located within the species' current range.	O	O	O
Northern spotted owl Strix occidentalis caurina	FT/SE,SP	Mid- and late-seral coniferous forests with high canopy closure, complex canopy structure,	Occurs. Species mapped as occurring within the study area. Habitat requirements present.	P	U	O

Common Name Scientific Name	Federal/ State Listing Status	Associated Habitat Characteristics	Potential to Occur Within Study Area	Potential of Occurrence in Geographic Sub-areas		
				Alpine Lakes Wilderness	Eightmile Lake and Shoreline/ Special Warranty Deed Area	Icicle Creek Corridor
		large decaying trees and/or snags, and high volume of downed wood.				
Flammulated owl Otus flammeolus	--/SC,SP	Mid-elevation, open, coniferous forests with mature ponderosa pine, Douglas fir, or mixed conifers with a thick understory.	Possible to occur. While no occurrences have been reported in the study area, it is located within the species' current summer breeding range and habitat is present.	U	U	P
Northern goshawk Accipiter gentilis	--/SC,SP	Mid- to high elevation, mature coniferous forests and mixed coniferous and deciduous forest, often on moderate slopes and forest edge.	Occurs. Species mapped as occurring within the study area. Habitat requirements present.	O	O	O
Golden eagle Aquila chrysaetos	FP/SC,SP	Steep terrain in dry open forests, shrub-steppe, canyonlands, high-elevation alpine zones, and sparingly in clear-cut areas in western Washington.	Occurs. Species mapped as occurring within the study area. Habitat requirements present throughout the study area.	O	O	O
Black-backed woodpecker Picoides arcticus	--/SP	Associated with boreal and montane coniferous forests, especially in areas with standing dead trees such as burns, bogs, and windfalls; less frequently in mixed forest and rarely in winter in deciduous woodland.	Occurs. Species mapped as occurring within the study area. Habitat requirements present throughout the study area.	O	O	O
White-headed woodpecker	--/SC,SP	Relatively open ponderosa pine forests with both live trees and	Occurs. Species mapped as occurring within the study area.	L	P	O

Common Name Scientific Name	Federal/ State Listing Status	Associated Habitat Characteristics	Potential to Occur Within Study Area	Potential of Occurrence in Geographic Sub-areas		
				Alpine Lakes Wilderness	Eightmile Lake and Shoreline / Special Warranty Deed Area	Icicle Creek Corridor
Dryobates albolarvatus		snags, at altitudes from 2,000 to 5,000 feet.	Habitat requirements present.			
Vaux's swift Chaetura vauxi	--/SP	Found in mature forests but also forages and migrates over open country; forages over land and water; often roosts in large flocks in hollow trees or chimneys just prior to and during migration.	Occurs. Species mapped as occurring within the study area. Habitat requirements present throughout the study area.	O	O	O
Mammals						
Gray wolf Canis lupus	FE/SE	Found in a diversity of habitats, including relatively flat forested areas, rolling hills, or open spaces such as river valleys and basins away from human development and disturbance. Denning occurs from May 15-June 15.	Possible to occur. No occurrences have been reported in the study area, but it is located within the species' current range and documented packs occur in surrounding areas.	P	P	P
Mountain goat Oreamnos americanus	--/SP	Cliffs, snowfields, meadows, bare rock benches, and south-facing old-growth forest along crags and ridges.	Occurs. Species mapped as occurring within the study area. Habitat requirements present.	O	O	O
Rocky Mountain elk Cervus canadensis nelsoni	--/SP	Eastern slopes of the Cascade Range and shrub-steppe.	Occurs. Species have not been mapped in the study area but have been reported by several viable sources. Habitat is present, although the high elevation and limited rangeland would limit population size.	O	U	U

Common Name Scientific Name	Federal/ State Listing Status	Associated Habitat Characteristics	Potential to Occur Within Study Area	Potential of Occurrence in Geographic Sub-areas		
				Alpine Lakes Wilderness	Eightmile Lake and Shoreline / Special Warranty Deed Area	Icicle Creek Corridor
Rocky Mountain mule deer Odocoileus hemionus nelson	--/SP	Silver fir–Douglas fir, subalpine fir-mountain hemlock, and ponderosa pine shrub forests. Also utilize open bunchgrass hillsides and shrub-steppe.	Occurs. Species mapped as occurring within the study area. Habitat requirements present.	O	O	O
Big brown bat Eptesicus fuscus	--/SP	Forest, rangeland, and urban areas where bridges, trees (ponderosa pine and Douglas fir), snags, caves, mines, crevices in cliffs, and buildings occur.	Occurs. While no occurrences have been reported in the study area, it is located within the species' current range, and habitat characteristics important to this species occur.	L	L	O
California myotis Myotis californicus	--/SP	Deciduous and coniferous coastal and montane forests, riparian forests, dry interior forests, deserts, canyons, shrub-steppe, arid grasslands, and urban. Roosts in tree cavities, under bark, rocks, caves, mines, buildings, bridges, and shrubs.	Occurs. While no occurrences have been reported in the study area, it is located within the species' current range, and habitat requirements are present.	L	L	O
Little brown bat Myotis lucifugus	--/SP	Most commonly in both conifer and hardwood forests, but also inhabits open forests, forest margins, shrub-steppe, tree clumps in open habitats, cliff sites, and urban areas near water sources.	Occurs. Species mapped as occurring within the study area. Habitat requirements present.	L	L	O
Fringed myotis Myotis thysanodes	--/SP	Prefer drier woodlands (e.g., oak, pinyon-juniper, and ponderosa	Occurs. Species mapped as occurring within the study area.	U	U	O

Common Name Scientific Name	Federal/ State Listing Status	Associated Habitat Characteristics	Potential to Occur Within Study Area	Potential of Occurrence in Geographic Sub-areas		
				Alpine Lakes Wilderness	Eightmile Lake and Shoreline / Special Warranty Deed Area	Icicle Creek Corridor
		pine), but also desert scrub, dry grasslands, shrub-steppe, drier forest, moist coastal coniferous forest, and riparian forest near water sources.	Habitat requirements present.			
Yuma myotis Myotis yumanensis	--/SP	Moist and dry forests, riparian zones, grasslands, shrub-steppe, and deserts near rivers, streams, ponds, and lakes.	Occurs. Species mapped as occurring within the study area. Habitat requirements present.	L	L	O

Listing Status Key: FP=Federally Protected, FE=Federally Endangered, FT=Federally Threatened, SE=State Endangered, SC=State Candidate, SP=State Priority.
Potential of Occurrence Key: U=Unlikely to occur, P=Possible to occur, L=likely to occur, O=Occurs.
Source: Burke Museum 2021; Seattle Audubon 2021; NPS 2017; Innes 2011, 2013; WDFW 2015, 2016, 2021c; USFWS 2021a, b; WBWG 2021; and NatureServe 2021.

Eightmile Lake is one of the Alpine Lakes, which are characterized by naturally low productivity and provide relatively limited habitat for fish, primarily because of cold water from melting snow or glaciers, a short growing season, the lake location at the head of the watershed, and a general lack of inputs of organic material. The Alpine Lakes are relatively pristine compared to downstream habitats. The primary anthropogenic impacts on fish habitat in the Alpine Lakes are associated with dam structures to manage surface water and the introduction of sport fish.

The current high water surface elevation of Eightmile Lake is 4,667.0 feet (msl) (with stop logs in), with a corresponding surface area of 76.6 acres, as compared to a historical high of 4,671.0 feet and a surface area of 81.7 acres.

In August 2017, the Jack Creek Fire burned much of the Eightmile Basin adjacent to and upstream of Eightmile Lake, with a substantial portion of the burned area (64 percent) experiencing moderate to high soil burn severities (USFS 2021g). The rates of soil erosion and sediment delivery to Eightmile Lake and Eightmile Creek are presumed to be higher from these areas of moderate and high soil burn severity and potentially altered the hydrology of inflow to the lake and raised concerns about the condition and safety of the Eightmile Dam (USFS 2021g). Natural re-vegetation recovery should reduce runoff and erosion rates substantially, over time.

The available data indicate that for the 2019 water year, the average daily flow for Eightmile Creek was 23.1 cfs, with a low of 7.6 cfs on September 24 and a high of 102.0 cfs on May 27 and 28 (Ecology 2021e). Over the period of record (May 2018 to January 2021), the data indicate that the general low-flow period is from mid-to-late August, with low flows of approximately 10 cfs. Flows increase in the fall (October) and vary from 15 to 40 cfs over the winter months. From mid-March to mid-April, responding to snowmelt in the basin, the flows steadily increase over 1 to 2 months to a maximum of 90 to 110 cfs in mid- to late-May. Flows drop in early June and over the summer months, gradually returning to low flow conditions. Climate change will likely exacerbate summer low

flows through increased droughts and potential reduction of winter/spring snowpack. It may also increase high flows due to increases in the magnitude and frequency of rain-on-snow events.

Fish habitat conditions in the Alpine Lakes Wilderness, including Eightmile Creek, are relatively intact and well-functioning compared to downstream habitats, which have been subject to greater anthropogenic disturbances. Eightmile Creek and its tributaries cross a few roads and trails in some locations, with the primary crossing being the bridge near the confluence of Icicle Creek, where Eightmile Creek passes under FSR 7601, but habitat impacts from these crossings are minimal.

Past timber harvest and forest fires have somewhat altered the vegetation and increased the exposed soils in the drainage, and large woody debris recruitment potential is below sustainable levels. Some drainages in the Eightmile Creek subbasin have been scoured to bedrock due to the effects of fire (USFS 1995, 2021g). Sediment that does reach Eightmile Creek is transported to the alluvial fan at the confluence with Icicle Creek. FSR 7601 is a major contributor of sediment to Eightmile Creek (USFS 1995).

Fish passage is blocked in several areas downstream of Eightmile Lake, including a natural falls at RM 0.5 (Andonaegui 2001). Upstream fish passage in Eightmile Creek between Eightmile Lake and the confluence with Icicle Creek is also impeded because of the steep elevation along the stream up to Little Eightmile and Eightmile lakes (Anchor QEA and Aspect Consulting 2015). In addition, the lower–middle reaches of Eightmile Creek, between Mountaineer and Pioneer creeks, is steep, averaging 17 percent slope. Two State Priority Habitats relevant to fish, Riparian and Wetlands, are mapped specifically within the Icicle Creek corridor (see Table 8-3). Riparian areas provide instream shade, recruitment of large wood, and bank stability and sediment control. Freshwater wetlands can provide off-channel habitat and refugia to some fish species.

Fish Use in Eightmile Creek Basin

Eightmile Lake is considered a "high lake," which in Eastern Washington generally refers to those at an elevation greater than 3,500 feet. Prior to introductions of sport fish by humans in the 1930s, Eightmile Lake likely lacked suitable spawning habitat or productive conditions for rearing juveniles, and like most of the high lakes, probably contained no fish (Wydoski and Whitney 2003). Steep stream gradients downstream of Eightmile Lake preclude anadromous salmonids from entering the lake from downstream, limiting fish use of the lake to salmonids that display a resident form life history.

Eightmile Lake was periodically stocked by WDFW with cutthroat, rainbow, and lake trout, until 2005 (T. Maitland, personal communication). Eightmile Lake is one of the only alpine lakes with a naturalized population of lake trout (WDFW 2005). There is also evidence that eastern brook trout were introduced to the lake (T. Maitland, personal communication; WDFW 2021d), some of which now inhabit Icicle Creek (NWPPC 2004). Currently, the WDFW (2020b) and NWIFC (2020) salmon databases indicate documented presence of rainbow trout and eastern brook trout in the lake and mainstem of Eightmile Creek, while cutthroat trout distribution is mapped as limited to the tributaries of Eightmile Creek (see Table 8-5).

Icicle Creek Basin and Aquatic Habitat

Eightmile Creek drains to Icicle Creek, joining it at RM 9. Icicle Creek is approximately 32 miles long and located on the eastern flanks of the Cascade Mountain Range. The stream is the largest tributary to the Wenatchee River in terms of both flow and basin area, entering the Wenatchee River at RM 25.6 with a subbasin area of 213 square miles. The Wenatchee River Basin is defined as WRIA 45.

Approximately 87 percent of the Icicle Creek subbasin is in public ownership, including approximately 74 percent that consists of the Alpine Lakes Wilderness and the Wenatchee National Forest (Ringel 1997). Icicle Creek contributes approximately 20 percent of the annual average flow to the Wenatchee River (Andonaegui 2001). It is a high elevation drainage with 14 glaciers, 102 lakes, and 85 tributaries, and natural conditions (steep gradients, waterfalls, flows) limit fish access in tributaries. Most of the Icicle Creek valley has a narrow, U-shaped cross-section that reflects its history of alpine glaciation (Andonaegui 2001). Major tributaries to Icicle Creek downstream of the Alpine Lakes Wilderness include Leland, French, Eightmile, and Snow creeks.

The hydrology of Icicle Creek is typical for the area, with hydrology primarily driven by snowmelt. Flows peak in June, with a steady decline throughout the rest of the summer. Low flows typically occur in September and remain low through early October. Streamflow then begins to increase in response to fall precipitation and remains steady through winter. When snow begins melting in spring, streamflow increases until its early summer peak. For more information on streamflows, see Chapter 4, *Surface Water Resources*.

Stream habitat conditions, including floodplain connectivity and riparian habitat outside of the Alpine Lakes Wilderness, have been impacted by roads, campgrounds, timber harvest, private development, and water diversions (withdrawals) (Andonaegui 2001; Berg et al. 2002). Floodplain connectivity in Icicle Creek is limited between the LNFH and the wilderness boundary (RM 3.8–17.5) where roads and bridges confine the stream channel and riprap has been placed.

The upper watershed (upstream of RM 5.7) has higher flows than the downstream reaches, due to the lack of diversions and multiple surface water inputs. Several significant diversions are present in the lower watershed, including for the IPID, COIC, City of Leavenworth, LNFH, and numerous small local private diversions (Ecology and Chelan County 2019). See Chapter 6, *Water Rights,* for more details.

The effects of the major diversions on flow in Icicle Creek are substantial. For example, estimated flow in late summer/early fall 2016 upstream of major diversions was 203 cfs, while estimated flow below diversions was 92 cfs, a reduction of over 50 percent. Instream flow targets developed by the Icicle Work Group (IWG) were a minimum flow of 100 cfs in an average water year, and a minimum flow of 60 cfs during a dry water year (Irving 2015). See Chapter 4, *Surface Water Resources*, and Chapter 6, *Water Rights*, for more details.

In 2020, a project was undertaken to address a fish passage barrier at the boulder field at RM 5.6 of Icicle Creek. The field, located just downstream from the IPID and City of Leavenworth diversions at RM 5.7, consisted of boulders up to 60 feet wide, resulting in a setting where at low flows, they formed impassable falls with shallow sheetflow. At this location, fish could only navigate upstream during certain higher river flows (100 to 500 cfs), which created a barrier to upstream movement of salmon, steelhead, and bull trout during most flow conditions (Dominguez et al. 2013). The project removed boulders and created a series of step pools to facilitate fish passage. This work also involved the installation of a new mechanized self-cleaning fish screen on the intake to the City Leavenworth's water diversion at RM 5.7. Ecosystem Diagnosis and Treatment (EDT) modeling suggested that approximately 29 miles of mainstem habitat in Icicle Creek could be beneficial to overall salmon populations if anadromous and fluvial populations of steelhead and bull trout access the entire area on a regular basis. The project will likely have the greatest benefit to steelhead, which are much less likely than bull trout to encounter a low flow level during their migration period.

The LNFH is adjacent to Icicle Creek at RM 3.0. Since production began in 1940, the LNFH has produced several trout and salmon species, including spring and summer/fall Chinook salmon, steelhead and rainbow trout, and sockeye salmon (Muir et al. 2020). Currently, the hatchery annually produces 1.2 million juvenile spring Chinook salmon and provides acclimation facilities for coho salmon, which are Wenatchee River fish spawned on site, hatched at Columbia River

hatcheries, and then returned to LNFH for acclimation and release in Icicle Creek (Skalicky et al. 2013). The LNFH rears 90,300 pounds of spring Chinook salmon annually and acclimates an additional 46,700 pounds of coho salmon in March and April. These salmon contribute to commercial, sport, and tribal in-river and ocean fisheries alike.

In addition to creating effects on flow conditions in Icicle Creek, the LNFH also includes a constructed Hatchery Channel from RM 3.9 to 2.7. Flows from Icicle Creek can be diverted into the Hatchery Channel, bypassing a 1.2-mile section of Icicle Creek known as the Historical Channel through the use of a channel spanning dam (called Structure 2). The Hatchery Channel has an inverse grade, preventing adults from swimming up the Hatchery Channel. The Historical Channel suffers from passage issues during low-flow conditions because of channel morphology (Ecology and Chelan County 2019), with limited passage for fluvial bull trout when flows drop below 200 cfs. At flows under 120 cfs, passage is limited for mid-size fish, such as steelhead, and flows below 30 to 40 cfs limit passage for juvenile salmonids.

Another structure at the LNFH is Structure 5, a channel-spanning concrete bridge capable of supporting weir pickets, located in the Historical Channel. Fish traps are employed at Structure 5 to capture spring Chinook salmon, bull trout, and steelhead, and manually move collected fish either downstream (for pre-spawned steelhead kelts) or upstream (natural-origin spring Chinook salmon). Hatchery-origin spring Chinook salmon are placed downstream or transferred to the hatchery (Ecology and Chelan County 2019; NMFS 2017).

From approximately 1940 to 2001, LNFH operations blocked fish passage during most of the year and controlled surface flows between the two channels. Since 2001, the LNFH has adaptively managed the facility to block upstream passage of LNFH-origin spring Chinook salmon during broodstock collection (approximately May through July), increase flows in the Hatchery Channel to promote smolt emigration, provide groundwater recharge to hatchery wells, aid in flood control, and perform routine maintenance of structures.

Icicle Creek Fish Use

Icicle Creek provides approximately 29 river miles of spawning and rearing habitat to native salmon and trout species, including ESA-listed Upper Columbia spring-run Chinook salmon Evolutionarily Significant Unit (ESU), listed as endangered. However, spring-run Chinook produced at the LNFH are not included in listed Upper Columbia spring-run Chinook ESU, as this stock is more closely related to lower Columbia River stocks (Muir et al. 2020).

Upper Columbia summer steelhead and bull trout, both listed as threatened under the ESA, are also present in the Leavenworth subbasin, although distribution of these species is limited, depending on flows and passage through several natural and artificial barriers (Dominguez et al. 2013). As described above, the boulder field project was undertaken in 2020 to remove fish passage barriers at RM 5.6. Available fish habitat in the lower reaches of Icicle Creek is reduced in late summer and early fall because of low instream flows.

As with other anadromous salmon in the Columbia River Basin, both the number of salmon in the Wenatchee River Basin and the extent and quality of fish habitat have substantially decreased due to anthropogenic activities. These include overfishing in the Columbia River, as well as impacts on fish habitat and fish access from logging, grazing, mining, and water withdrawals for irrigation, the majority of such impacts having occurred since 1900 (Andonaegui 2001; USFWS 1999, 2005). Major impacts on fish from hydroelectric dams have also occurred. Seven major dams impound the Columbia River downstream of the confluence with the Wenatchee River.

The project area is within the Yakama Ceded Lands, to which the Yakama Nation exercises its Treaty Reserved Rights, and traditional use area of the Confederated Tribes of the Colville Reservation for

hunting, fishing, and gathering resources. These tribes target non-listed spring-run Chinook salmon returning to the LNFH (with known fishing areas including the plunge pool immediately downstream of the LNFH Hatchery Channel spillway). Since the reintroduction of coho salmon to the Icicle Creek drainages, tribal subsistence fisheries for coho salmon have been opened when runs are large and surplus fish are available.

In addition to the three ESA-listed fish species in Icicle Creek, the stream also supports a number of other anadromous and resident fish **(Table 8-5).** Brief descriptions of the primary salmonid species in the subbasin are given below.

Spring-run Chinook Salmon

In 1999, NMFS listed the Upper Columbia River spring-run Chinook salmon ESU as endangered. The ESU includes all naturally spawned populations of spring-run Chinook salmon (spring Chinook) in Columbia River tributaries upstream of the Rock Island Dam as well as six artificial propagation programs, but not including the spring Chinook program at the LNFH. Spring Chinook are considered a "stream-type" salmonid (spending one or more years in freshwater).

ESA-listed Wenatchee spring Chinook adult salmon (both natural-origin and hatchery-origin) may be present in Icicle Creek from May until September. Most spawners are likely hatchery-derived. Spawning surveys in Icicle Creek indicate an average number of spring Chinook salmon redds of 62 from 1989 to 2013, while in more recent years (2006 to 2013) the number of redds has decreased to 18 (Hillman et al. 2014). In 2013, Icicle Creek contained 9.2 percent of all the spring Chinook salmon redds in the Wenatchee River Basin (Hillman et al. 2014). Redd counts in the Wenatchee River Basin were 211 in 2014, 132 in 2015 (Hillman et al. 2018), and 72 in 2016 (Kondo 2017). A small number of Chinook were observed in snorkel surveys upstream of the LNFH (USFWS 2016). Subsequent to the project to improve fish passage conditions through the boulder field at RM 5.6 on the mainstem Icicle Creek, hatchery spring Chinook salmon have been upstream of the boulder field.

With the exception of the reach of Icicle Creek immediately adjacent to the Wenatchee River, the remainder of the Icicle Creek Basin is not designated as critical habitat for Upper Columbia River (UCR) Spring Chinook salmon (NMFS 2005). Although some spawning occurs in the lower Icicle Creek mainstem and in the Icicle Creek Historical Channel, this is classified as a minor spawning area with medium intrinsic potential for UCR spring Chinook salmon (UCSRB 2007).

Table 8-5. Fish Distribution in Eightmile and Icicle Creeks

Species Group	Salmonid Species and *Scientific Name*	Listing Status	Eightmile Creek Fish Distribution	Icicle Creek Fish Distribution
Anadromous Salmonids	Spring Chinook *Oncorhynchus tshawytscha*	FE	None and no designated critical habitat.	Documented presence in lower 6 miles. Potential presence extends upstream of confluence with Eightmile Creek. Wenatchee River at mouth of Icicle Creek is designated critical habitat.
	Summer Chinook	NL	None.	Documented spawning in lower 3 miles.
	Summer Steelhead *O. mykiss*	FT	None and no designated critical habitat.	Documented spawning in lower 3 miles. Potential presence in approximately lower 20 miles of mainstem. Lower 15.4 miles of mainstem is designated critical habitat.
	Coho *O. kisutch*	NL	None.	Artificial propagation/reintroduction. Documented in lower Icicle Creek.
Resident Salmonids	Bull Trout *Salvelinus confluentus*	FT	Presumed presence in lower 1.9 miles of Eightmile Creek. Historical observations in lower Eightmile Creek. Documented spawning immediately in lower 0.6 mile of Mountaineer Creek immediately upstream of the confluence with Eightmile Creek. No designated critical habitat.	Documented rearing in majority of Icicle Creek both upstream and downstream of Eightmile Creek confluence, with substantial spawning upstream in the headwaters. Almost entire mainstem is designated critical habitat.
	Eastern Brook Trout *S. fontinalis*	NL	Documented presence in lower 8.0 miles of stream and in Eightmile Lake.	Documented presence in entirety of Icicle Creek downstream of Eightmile confluence.
	Lake Trout *S. namaycush*	NL	Presence in Eightmile Lake.	None.
	Rainbow Trout *O. mykiss*	NL	Documented presence in lower 8.0 miles of stream and in Eightmile Lake.	Documented presence in entirety of Icicle Creek downstream of Eightmile Creek confluence.
	Westslope Cutthroat Trout *O. clarkii lewisi*	NL	Documented presence in Pioneer Creek and Mountaineer Creek tributaries, but no documented distribution in Eightmile Creek.	Documented presence in headwater mainstem and numerous tributaries, primarily upstream of confluence with Eightmile Creek.
	Mountain Whitefish *Prosopium williamsoni*	NL	None.	Documented presence in mainstem up to approximately 1 mile downstream of confluence with Eightmile Creek.

Listing Status Key: FT=Federally Threatened, FE = Federally Endangered, NL=Not Listed.
Source: WDFW 2020b; NWIFC 2020; Ecology and Chelan County 2019; Andonaegui 2001.

In 2019, the LNFH released 1,248,910 juvenile spring Chinook Salmon into Icicle Creek, meeting the production goal of 1,200,000 (Muir et al. 2020). The 2019 adult return was 1,404 fish, about 27 percent of the 12-year return average. From 2008 through 2018, the average run size was 5,703 fish, with an average of 71 percent of the fish returning to the hatchery, 8 percent being taken by the sport fishery, 17 percent by tribal harvest, and the remainder (4 percent) remaining in the river. The adult fish return to the hatchery from late February to August, with the majority of returns from late April to early May.

Summer-run Steelhead

Steelhead exhibit the most complex cycle of any of the salmonid species in the region and generally spawn in the upper reaches of the watershed. UCR steelhead, listed as threatened under the ESA, are summer-run steelhead that return to freshwater between May and October, and require up to 1 year in freshwater to mature before spawning (Chapman et al. 1994). Spawning occurs between January and June. Juveniles typically reside in freshwater for 2 years before migrating to the ocean, but freshwater residence can vary from 1 to 7 years (Peven 1994). Marine residence for UCR steelhead is typically 1 year, although the proportion of 2-year ocean fish can be substantial in some years. In the Wenatchee River, spawning abundance for natural-origin UCR steelhead averaged 1,025 spawners from 2005 to 2014 (NWFSC 2015), slightly above the assigned minimum abundance threshold of 1,000. Steelhead were stocked in Icicle Creek below the hatchery in the years 1941 to 1945 and since 1978 (Carie 1995).

The USFWS Columbia River Basin Hatchery Review Team determined that ESA-listed steelhead inhabit all major tributaries of the Wenatchee River. Icicle Creek contains important habitat for ESA-listed UCR steelhead.

The vast majority of steelhead spawning in Icicle Creek occurs downstream of RM 2.8, likely indicating that the operations of the LNFH structures are not conducive to steelhead passage (Hillman et al. 2014).

Critical habitat for steelhead in Icicle Creek has been designated for the entire watershed, including all tributaries (NMFS 2005). Icicle Creek supports a major spawning aggregation for UCR steelhead. The lower Icicle Creek mainstem, from the mouth to the Historical Channel at RM 2.7, was identified as containing habitat of medium intrinsic potential for steelhead, while the upper mainstem and tributaries above LNFH were identified as containing habitat with high intrinsic potential supporting spawning, rearing, and migration.

Bull Trout

USFWS listed Columbia River bull trout as threatened under the ESA in 1998 (63 Federal Register 31647). A distinct native bull trout population exists in Icicle Creek (USFWS 2015). Two life history patterns have been present in the Icicle Creek watershed: fluvial and resident. Most bull trout in Icicle Creek are of a fluvial life history type, meaning they migrate downstream to rear in tributary rivers, the mainstem Wenatchee River, or the Columbia River (USFWS 2015; Cappellini 2001). Peak migration of adult bull trout in Icicle Creek occurs from August through September, with spawning occurring from mid-September to mid-October (USFWS 2015). Bull trout may return to spawning areas weeks to months prior to spawning. A resident form of bull trout, which do not stray far from their headwater spawning areas, also likely exists given suitable spawning habitat conditions in the headwaters. Migratory and resident bull trout spawn in the colder headwater tributaries, including the lowest reaches of Eightmile Creek (Andonaegui 2001). The potential use of Icicle Creek by migratory bull trout and their status and interaction with the resident component are currently not well understood (USFWS 2009).

Icicle Creek provides spawning and rearing habitat for bull trout; however, little information is available on the abundance and size class distribution of bull trout in Icicle Creek and its tributaries.

Spawning ground surveys to enumerate bull trout redds were not conducted in the Icicle Creek watershed until 2008, when eight migratory-sized redds were found in French Creek (Nelson et al. 2009). Historically, bull trout were observed in Eightmile and French creeks (Brown 1992) and upper Icicle Creek (USFWS 2005). Prior to fish passage restoration at the site, migratory-sized bull trout were observed in Icicle Creek immediately upstream of the boulder field at RM 5.6 (USFWS 2011; Nelson et al. 2011; Dominquez et al. 2013). In addition, two migratory-sized bull trout x brook trout crosses have been documented in the upper reaches of Icicle Creek (Nelson et al. 2011).

USFWS conducted radio-tagging studies of seven Icicle Creek bull trout in 2009 captured and released downstream of the LNFH (Nelson et al. 2011). None of these fish moved upstream of the LNFH, and several of the fish overwintered in the Wenatchee and Columbia rivers. However, the LNFH is passable to migrating bull trout at some times of the year, as evidenced by the observation of large fluvial bull trout upstream of LNFH during the annual USFWS snorkel survey of lower Icicle Creek (USFWS 2009).

Adult fluvial bull trout returning to the base of the LNFH spillway structure may be recruits from resident fish above the structure but are more likely to be adults holding and straying from the Wenatchee River (WDFW 1997), where the water temperatures are warmer, using the cooler water in the LNFH spillway pool for thermal refuge and foraging opportunities during the summer and early fall (Nelson et al. 2011).

Summer-run Chinook Salmon

The summer Chinook run in the Upper Columbia is not listed under the ESA. This run is one of the largest naturally produced Chinook populations in the Columbia River Basin. Summer-run Chinook are considered ocean-type, as they spend less than 1 year in freshwater before migrating to the ocean as subyearlings.

Summer Chinook enter the Columbia River from late May to early July and enter the Wenatchee River beginning in late June (WDF and WWTIT 1993). Spawning begins in late September, continues through early November, and reaches a peak in early to mid-October. Fry emerge from January through April, and the fry rapidly emigrate from the mainstem Wenatchee River.

Summer Chinook have documented spawning in the lower 3 miles of Icicle Creek (WDFW 2020b; NWIFC 2020). The number of spawning summer Chinook in Icicle Creek is likely quite small when compared to the mainstem Wenatchee River near Leavenworth, where spawning densities are the highest in WRIA 45 (Peven 2003). Mixed summer/fall Chinook fingerlings were introduced to Icicle Creek in the 1940s (Peven 2003).

Westslope Cutthroat Trout

Westslope cutthroat trout are a native species that are widespread throughout Icicle Creek; although historical distribution was limited to the Lake Chelan and Methow River Basins, extensive stocking has established self-sustaining populations throughout the eastern Cascade Mountains. Cutthroat trout now found in the Wenatchee River Basin are either indigenous populations or are from past stocking and may have either a resident or a fluvial life history (Wydoski and Whitney 2003). While resident fish spend their entire life in tributary streams, migratory life forms can travel large distances as they move between adult and spawning habitat. Fluvial cutthroat spawn in tributary streams where the young rear from 1 to 4 years before migrating to a river system, where they grow to maturity, while resident fish stay in relatively proximity to where they were hatched for the duration of their life cycles. Fluvial forms may return to small tributaries for refuge during high flows.

Both life history forms spawn in tributary streams in the springtime months when water temperature is about 10°C and flows are high, and these areas are often nutrient poor. If other species are present in the lakes, Westslope cutthroat will use nearshore, littoral areas, otherwise they disperse

throughout the lake (Wydoski and Whitney 2003). Introduced eastern brook trout have displaced Westslope cutthroat trout in many low gradient reaches of tributary streams, including Eightmile Creek (Griffith 1988). Westslope cutthroat are a favorite prey item of both bull trout and lake trout.

Rainbow Trout

Rainbow trout have been extensively propagated and stocked in the mid-Columbia River Basin. From 1949 to 1994, over 12 million rainbow trout from at least 15 different brood sources were stocked in the basin (Chapman et al. 1994). Because of genetic interactions with non-native steelhead, rainbow trout, and cutthroat trout, few uncontaminated indigenous native rainbow trout populations remain (Proebstel et al. 1998).

Rainbow trout are commonly observed fish species in Icicle Creek and tributaries draining the Alpine Lakes (Potter 2016, 2017, 2018; Ringel 1997; WDFW 2020b). Snorkel surveys conducted in late summer 1994 on Icicle Creek between RM 4.0 and 20.1, found that rainbow trout were the dominant species in all reaches, comprising 99 percent of all fish seen (Ringel 1997).

Genetically identical to steelhead trout, rainbow trout exhibit a non-migratory resident life history. Steelhead have a complex, plastic life history where, in some cases, steelhead offspring can take on resident rainbow life histories in subsequent generations and vice-versa. Most fish that do not emigrate downstream early in life from the coldest environments are thermally fated to a resident (rainbow trout) life history regardless of whether they were the offspring of anadromous or resident parents (Mullan et al. 1992). Hybridization between rainbow trout and Westslope cutthroat trout is common, and hybrids may occur in the Icicle Creek drainage (Ringel 1997).

Rainbow trout prefer cool, well-oxygenated water but can tolerate broader temperature ranges than other salmon and trout. Growth and age at maturity vary greatly and occur between age 1 and 5 years, depending on water conditions. Rainbow trout spawn in late winter through the spring (February and June), and similar to steelhead, may spawn multiple times in their lifetime.

Other Resident and Anadromous Fish Species

Other native resident fish species observed in Icicle Creek include Pacific lamprey, longnose sucker, bridgelip sucker, mountain sucker, leopard dace, Umatilla dace, longnose dace, speckled dace, redside shiner, northern pikeminnow, and various sculpin species, as well as hatchery coho salmon and stray sockeye salmon (NWPCC 2004; USFWS 2009; Potter 2016). In addition, Eightmile Lake contains introduced Eastern brook trout, some of which now inhabit Icicle Creek (NWPCC 2004; WDFW 2020b). Lastly, several hybrids have been observed, including hybrid bull trout and eastern brook trout (Nelson et al. 2011).

8.4 Construction Impacts

Impacts from construction activities from any of the action alternatives have the potential to affect wildlife species throughout the study area because of increased disturbance above baseline conditions typical during the summer recreation season. This is due to disturbance from the transportation of equipment and materials, in addition to construction activities at the dam. Disturbance from transporting equipment and materials would result in an impact footprint that would extend out to the limits of the study area because of the emitted noise. However, the zone of disturbance would be concentrated around the transportation activities in the travel network. Construction activities at the dam site will persist at this location throughout the duration of construction.

Construction also has the potential to affect the resident fish within the lake and in several small tributaries to Eightmile Creek downstream of the lake. As no anadromous or ESA-listed fish species are distributed in these areas, construction activities would not affect these species.

Construction impacts, and their potential for affecting wildlife, wildlife habitat, fish, and fish habitat, are described below according to specific impact source.

8.4.1 Transportation of Equipment and Materials

Helicopter

Wildlife and Wildlife Habitat

Construction Options 1 and 2 for helicopter use differ in the number of trips that large and small helicopters would fly, as well as the total number of trips made and number of days helicopters are used (Chapter 2, Table 2-2). Option 1 would require fewer trips across fewer days, and would be facilitated by a larger helicopter. Option 2 would require more trips across more days due to primarily using a smaller helicopter. Research has shown that the noise from the two proposed helicopter types is comparable (USACE 1982); therefore, it is assumed that each would have the same area of disturbance for wildlife, and only the number of trips would lead to a differential between options. Option 2 would have a larger impact on wildlife due to regular helicopter use throughout project construction, while Option 1 would require helicopter use, with accompanying potential to impact wildlife, mostly at the beginning and end of construction, with as-needed use during construction. Any impact from helicopters would be incurred along the established flight path between Eightmile Lake and in the vicinity of Icicle Creek Campground (Chapter 2, Figure 2-11).

During helicopter use, the flight corridor would be subjected to helicopter noise beyond baseline conditions as equipment and materials are transported from their loading site to the drop-off point (refer to Chapter 9, *Noise*, for further discussion). Loading and unloading activities at the loading and drop-off areas would also result in concentrated areas of disturbance. These activities would disturb most wildlife species, displacing those that have ability to flee from the area. Stress levels would likely be heightened (Runnoe 2006) and suppression of normal behaviors would likely occur to some extent. Some of the more mobile species (such as large and small mammals) may leave the study area completely, but the extent is unknown and such displacement could lead to secondary conflict with other wildlife while the displaced individuals reestablish home ranges. Individuals that remain would continue to incur stress, although those in the center of the flight path, between the loading and drop-off sites, may habituate to some extent. Most individuals surrounding the loading and drop-off sites would likely flee these areas and remain displaced throughout construction. Actual impacts would depend on species and life stage, with greater impact occurring to less mobile individuals.

Impacts on wildlife habitat from helicopter use would be minimal as landing at the dam and staging area is not anticipated, and the staging area, with the exception of removal of up to 30 trees, does not need to be substantially altered from current conditions. Propwash, which would be strong from both helicopters but particularly strong from the double-rotor Chinook, would not eliminate or damage vegetation to the point that it is fundamentally unusable by wildlife. No wetlands occur in this portion of the study area that could be affected by these construction/transportation activities. Helicopter use would have less-than-significant impacts on wildlife habitat and vegetation because there would only be minimal loss of habitat.

Helicopter use would disturb avian species and terrestrial mammals, including those with state and/or federal protections. Protected bat species, which may roost near the loading and unloading areas, may also be disturbed and stressed by helicopters as cargo is shuttled during construction. No work will occur during winter months when bats hibernate. Therefore, use of helicopter may have

significant adverse impacts on individual bats locally if present, but would have **less-than-significant adverse impacts** on wildlife throughout the study area.

Fish and Fish Habitat

The multiple helicopter trips required for transport of construction equipment and material would not have an effect on aquatic species, including fish. Refueling of helicopters would occur in designated areas away from streams and outside of the wilderness area. **No significant adverse impacts** on fish or fish habitat would occur from helicopter use under any of the action alternatives.

Road Segment

Wildlife and Wildlife Habitat

The establishment of the road segment would require vegetation removal and road grading through the use of heavy equipment and hand-crews. These activities would cause localized noise disturbance and alter wildlife habitats along the segment. Noise would displace wildlife species able to flee the area, which would likely occur prior to the associated physical habitat changes. Human presences, largely associated with the heavy equipment, would further disturb wildlife in the area. Because the road segment is currently overgrown with vegetation and not typically used by recreationists, the alterations would remove some wildlife habitat from the study area. The significance of impact on wildlife would depend on construction timing, as greatest use by wildlife of this area occurs during the spring and summer months. This is especially the case for many bird species, which likely nest in dense thickets along the road segment. Wildlife species with minimal capacity to move from the area, including amphibians and young birds and reptiles, could be injured or killed. Road design will meet Forest Service standards and incorporate appropriate sediment and erosion control measures near stream crossings, potentially including water bars to route and disperse runoff on vegetated slopes, to minimize or eliminate stream sedimentation. No wetlands occur in this portion of the study area that could be affected by these road construction activities. Likewise, where vegetation removal or grading occurs adjacent to streams, appropriate BMPs (e.g., use of straw wattles, no side-casting, etc.) will be applied. Therefore, road reconstruction would have **less-than-significant adverse impacts** on wildlife and wildlife habitats in and around the study area.

The same protected taxa with potential to be disturbed by helicopter use would also be susceptible to disturbance from the road segment reconstruction; however, the impact area would be much smaller. Western toads, which may occur in the downslope drainages, may also be affected by sediment input, noise, and vibration.

Fish and Fish Habitat

Repair and improvement of the currently closed road segment, located downslope of Eightmile Lake and outside of the wilderness area, would involve the removal of vegetation and downed woody material on the roadway and trimming of vegetation and tree limbs immediately adjacent to the roadway. All woody material moved or cut from the roadway surface will remain on-site, adjacent to the roadway, to provide habitat functions. Minor grading may also be required, as would some minor grading/clearing to create a small landing at the road terminus to provide adequate space for unloading and vehicle turn-around. The roadway has several existing culvert crossings of small fish-bearing streams that drain to Eightmile Creek. The roadwork could increase runoff of road sediments, which in some cases could enter streams. However, road design will meet Forest Service standards and incorporate appropriate sediment and erosion control measures near stream crossings, potentially including water bars to route and disperse runoff on vegetated slopes, to minimize or eliminate stream sedimentation. Likewise, where vegetation removal or grading occurs adjacent to streams, appropriate BMPs (e.g., use of straw wattles, no side-casting, etc.) will be

applied. **No significant adverse impacts** on fish or fish habitat would occur from repairing and improving the road under any of the action alternatives.

8.4.2 Dam Construction

Wildlife and Wildlife Habitat

Dam construction would disturb wildlife throughout the construction period in an area surrounding the east end of Eightmile Lake, and may extend out to the remaining portion of the Eightmile Lake Basin. The presence of humans and use of heavy equipment and other tools would displace wildlife from this area during construction. Similar to reconstruction of the road segment, noise and human presence would displace most mobile wildlife from the area prior to them being exposed to habitat alterations. During construction, the area may be mostly or partially unusable by taxa such as birds and large mammals, which would move to surrounding areas with less disturbance. The alterations that occur to existing wildlife habitat, such as the riparian zone around the dam, could harm species with limited mobility that are present. No wetlands occur in this portion of the study area that could be affected by these dam construction activities.

The same protected wildlife species affected by construction of the road segment would be affected by dam construction. However, the potential to affect aquatic species (amphibians) or species who rely on aquatic features for water or prey would be greater. Therefore, the dam construction could impact a few individuals in and around the dam construction; however, this would have **less-than-significant adverse impacts** on wildlife in the study area.

Blasting of large boulders is not expected to be necessary but is covered in this analysis as a contingency. Blasting could occur for 1 or 2 days between the hours of 11 a.m. and 3 p.m. Blasting would add a brief, high-intensity noise impact, affecting wildlife in the area. Blasting would likely surprise and displace wildlife from the area in a rapid, stressful manner. The high-intensity noise has potential to shock more mobile species, causing panic and frantic retreat that could lead to injury. The noise intensity could also directly harm less-mobile species, such as amphibians and reptiles, who are sensitive to sound and vibration. All wildlife species would be expected to be temporarily displaced from the area during blasting, if capable. Blasting, if used, would likely expand the area where wildlife would face impacts. As a result, blasting may cause significant adverse impacts on local, immobile individuals, but overall would result in **less-than-significant adverse impacts** on wildlife throughout the study area.

Fish and Fish Habitat

Construction would require substantial earthwork and the placement of large rock using an excavator. Blasting of very large boulders is not likely required. The use of boulder busters may be needed for breaking up smaller material. The project also requires the pouring of concrete to construct the spillways.

All alternatives would require in-water work in Eightmile Lake to construct the earthen dam and spillways, potentially affecting the resident trout species in the lake. The shoreline area where work occurs would be isolated in the lake by construction of a cofferdam consisting of bulk bags placed by an excavator. Dewatering of the isolated work area using pumps may also be necessary. Under all action alternatives, any dewatering pumps used would have WDFW-compliant screens on the intake hoses (to prevent fish impingement or entrainment). In addition, after partial drawdown of the water level behind the cofferdam, and prior to in-water excavation, qualified biologists would remove fish and aquatic life from the work area and relocate these organisms to the lake. The implementation of fish exclusion and fish removal/relocation would substantially reduce the potential of negative impacts on resident freshwater fish. Although a few individual fish would be impacted, these impacts

are small and would not measurably affect the local populations of freshwater resident fish present in Eightmile Lake and are therefore considered **less-than-significant.**

The installation and removal of the cofferdam would generate short-term and localized increases in suspended sediments and turbidity in the lake. Excessive suspended sediments resulting in turbidity can have physiological and behavioral effects on fish, including clogging fish gills, avoidance, and impaired foraging (Bash et al. 2001). These activities would be regulated under the state hydraulic code (HPA) and water quality permits, which would define required BMPs (e.g., turbidity curtains), set allowable mixing zones, and set monitoring requirements. The anticipated mixing zone for Eightmile Lake is 300 feet. Alternative 2 requires construction of a longer dam than Alternatives 1 and 3, thereby necessitating a longer cofferdam to dewater the work area and resulting in more potential for suspended sediments and turbidity.

For all action alternatives, the magnitude and extent of turbidity are expected to be minor, short-term, and localized based on the use of the BMPs described above. Although some behavioral impacts on fish would likely occur, such as avoidance and temporary behavioral changes, no substantial mortality is expected to result. Deposition of sediment on the lake bed from construction-generated suspended sediment would not be substantial and would be comparable to the natural deposition from sediment in the lake. For all action alternatives, impacts from turbidity and sedimentation associated with cofferdam removal on resident fish would be **less-than-significant.**

The in-water work and associated fish removal may result in some minor mortality, injury, or behavioral disturbance in the immediate work area (individual fish could be harmed or killed and larvae of some species could be entrained). However, the vast majority of fish in the lake would be unaffected and would likely avoid the work areas of active construction due to increased turbidity.

Construction of all action alternatives would include concrete pouring to construct a new spillway. As wet or curing concrete can negatively alter the pH of freshwater systems, all concrete pours will occur in the dry behind the cofferdam, and no wet or curing concrete will come into contact with Eightmile Lake or Eightmile Creek. Furthermore, none of the action alternatives would result in an expansion of the existing dam footprint into Eightmile Lake, so no benthic lake habitat would be lost.

Blasting of large boulders, while not anticipated, could impact fish species by transmission of sound pressure waves through the soil/bedrock and into Eightmile Lake. In-water blasting can, in certain cases, produce sound waves that can cause fish injury or death. However, any impacts on fish and aquatic resources from blasting are expected to be minor, as no in-water blasting would occur. At most, some temporary behavioral changes to fish would occur, such as startling. These impacts would only affect resident fish present in the lake, as no anadromous or ESA-listed species are within proximity to the blasting location.

8.5 Operational Impacts

Operational impacts of the project would have short-term effects on wildlife and wildlife habitat, but would likely not persist as habitats recover from the alterations and disturbance abates to pre-project levels.

Unlike construction activities, the operational aspects of the project could affect fish and fish habitat both within Eightmile Creek, and downstream of the lake in Eightmile Creek and Icicle Creek, extending to the confluence of Icicle Creek with the Wenatchee River. Additionally, operational impacts of the project would affect both resident fish and anadromous fish, including ESA-listed fish species such as bull trout, spring Chinook salmon, and summer steelhead. Potential impacts are described below, by alternative.

8.5.1 No Action Alternative

Wildlife and Wildlife Habitat

The No Action Alternative would result in the continued operation of the Eightmile Dam, which would result in no changes to wildlife resources or habitat, including wetlands and other waters.

It is probable, however, that the dam would eventually fail, or DSO would require the removal of the dam in the future. Dam removal or failure would result in a high-water lake level of 4,648 feet, with water levels continuing to reduce as the summer season progresses. Evidence (photos, engineering drawings) indicates that a lake existed at this location prior to the original dam construction, and the dam has functioned to increase capacity. Removal of the dam–either due to failure or active removal–would therefore decrease both its capacity and surface water height and area, but would not cause the demise of the lake. The reduction in the size of Eightmile Lake would, therefore, result in **less-than-significant adverse impacts** on wildlife and wildlife habitat because the lake would persist and habitats would not be fundamentally degraded or reduced.

Dam failure would result in downstream flooding on Eightmile and Icicle creeks. This flooding would alter habitat, to some extent, including Little Eightmile Lake, wetlands, and riparian areas. Little Eightmile Lake would likely become altered because it is relatively shallow and may become scoured during a flood event, although the extent of scour would likely not change the types of aquatic and wetland habitat present. Flooding farther downstream would also result in vegetation removal, scouring, and sediment deposition, likely altering habitat along Eightmile and Icicle creeks. These alterations, however, would emulate those from natural flooding events, and the ecosystem would likely fully recover over one to two decades. Impacts from a dam failure flood event on habitat downstream of Eightmile Lake would, therefore, be **less-than-significant**.

Hydrologic changes from dam failure or removal are predicted to reduce summer streamflows by up to 75 percent, which could affect amphibians, reptiles, and other species that depend on the current flow regime from Eightmile Lake. During the summer dry season, such a reduction in flow would result in less availability of water and aquatic habitat, as well as a reduction in the quality and diversity of aquatic habitat. Together, losing substantial flow during the dry season, when many wildlife species rely on it the most, would result in significant adverse impacts on some individuals that are directly associated with these aquatic habitats. However, because of the small affected area, **less-than-significant adverse impacts** would be expected to occur to wildlife species throughout the study area.

Fish and Fish Habitat

Under the No Action Alternative, there would be no changes to fish resources or habitats, as compared to existing conditions, if the dam continues to operate. However, if the dam condition warrants enforcement actions by the DSO, dam removal may be required. Under this scenario, the lake outlet elevation would likely be lowered to an elevation of 4,648 feet. This would reduce available habitat for fish in Eightmile Lake, and would also have an effect on downstream streamflow, where reduced water storage capacity would decrease the amount of water available for summer water releases, thereby reducing flows in Icicle Creek and potentially contributing to slightly warmer water temperatures in the summer months. Salmonids are sensitive to high stream temperatures and low dissolved oxygen (DO) levels. Ecology water quality standards for the mainstem Icicle Creek for core summer salmonid habitat include a temperature of less than 16°C and DO levels more than 9.5 mg/L. Dam removal would reduce the habitat quality and quantity for both anadromous and resident salmon species that utilize Eightmile Creek and the Icicle Creek mainstem downstream of the confluence. The anadromous fish species and life stages that would likely be most affected by lower summer flows in Icicle Creek, and potential increases in stream

temperature and reductions in dissolved oxygen, are spring and summer Chinook salmon and summer steelhead. In addition, those resident salmonids that utilize Icicle Creek and Eightmile Creek in the summer would also be negatively affected by low summer flows, including ESA-listed resident bull trout, rainbow trout, cutthroat trout, and mountain whitefish. The removal of the dam would also remove water storage, which would make the system more sensitive to the effects of drought, a condition that may increase in frequency and severity due to the predicted effects of climate change over time. With dam removal, flows in Icicle Creek will likely fall below the instream-flow rule levels more frequently, resulting in potential negative impacts on hatchery fish rearing and releases.

In summary, dam removal would cause **significant adverse impacts** on fish and fish habitat in both Eightmile and Icicle creeks.

There is also the potential for catastrophic failure of the dam under the No Action Alternative. If such failure occurred, it would likely be during spring rain-on-snow events when streamflow is at its highest. A partial or total dam failure would have substantial negative effects, both immediately and perpetuating into the future. A catastrophic failure would quickly drain substantial water volumes from the lake, although it would not empty its volume completely, resulting in up to 1,375 acre-feet of water being suddenly released in an uncontrolled manner. The lake would be partially drained and many of the resident fish within the lake would be killed as they became entrained in the downstream flows. Partial or total dam failure could result in debris torrents that would destroy downstream infrastructure, likely including infrastructure at the LNFH; cause severe channel scour (potentially to bedrock); denude riparian areas; mobilize, transport, and ultimately deposit large volumes of sediment; cause widespread flooding; and potentially lead to debris jams and stream avulsions. A large-scale or total failure would likely result in mortality to the vast majority of the fish present in Eightmile Lake, Eightmile Creek, and in Icicle Creek downstream of the Eightmile Creek confluence, and could also have substantial negative effects in the Wenatchee River. This would include ESA-listed species such as Chinook salmon, steelhead, and bull trout, as well as other salmonids that currently use the system during springtime. Flood flows may severely damage or destroy water intakes for both IPID and the LNFH, reducing or eliminating hatchery operations. Post-dam failure, Eightmile Creek would be a free-flowing riverine system. In addition, the significant volume of water in the lake that currently serves as lacustrine habitat for resident fish would be substantially reduced, but would not cause the demise of the lake. Stream substrate conditions may also be severely altered due to erosion of deposited sediments, with the system potentially taking years or decades to equilibrate. Other long-term effects on fisheries resources, both native and hatchery stocks, would also occur with the absence of the dam related to summer flow reductions, similar to those described above for dam removal, as well as the potential release of non-native lake trout into Eightmile and Icicle creeks, potentially negatively impacting native fish survival due to predation and resource competition. Catastrophic dam failure would cause **significant adverse impacts** on fish and fish habitat in both Eightmile and Icicle creeks.

8.5.2 Alternative 1: Narrow Spillway with Gates

Wildlife and Wildlife Habitat

Operation of the project would have short-term impacts on wildlife and wildlife habitat, including wetlands and other waters, but would likely not persist as habitats recover from the alterations and disturbance abates to pre-project levels. Changes in surface water elevation and flows through the riparian corridor would support wildlife species and habitats in these areas. Revegetation and removal of invasive plant species may result in habitat enhancement above existing conditions, if executed effectively. Changes in operation of the project could influence the overall size, boundaries, vegetation composition, and type of wetlands present in the study area (especially the existing wetland at the inlet/west end of Eightmile Lake). Such changes would depend on how project operations affect lake levels and related hydrological conditions, both seasonally and over the long

term. The specific changes are difficult to predict over the long term given the multiple variables, including changing snowpack levels associated with climate change. The most likely changes would include long-term shifts in vegetation composition within the wetland areas, such as the recruitment of woody vegetation. Modeling the predicted changes in wetland conditions is outside the scope of this EIS analysis. But overall, hydrological and soils conditions are expected to support the existing wetlands into the future, and the characteristics of the existing wetlands are not expected to substantially change.

Operation of Alternative 1 would result in **less-than-significant adverse impacts** on wildlife and wildlife habitat.

Fish and Fish Habitat

Alternative 1 would provide increased storage capacity, while adding safety features that drain the lake during extreme storm events. This alternative would not alter existing water rights or withdrawals or exceed historic use. In addition, Alternative 1 has a smaller footprint than the wide spillway alternative (Alternative 2) and also allows the lake to be drawn down to 4,636 feet during drought conditions to provide water for both downstream water supply and instream flow needs. Alternative 1 has a maximum WSEL of 4,671 feet, which would produce a lake surface area of 81.4 acres. Compared to existing conditions (and the No Action Alternative), this alternative provides a WSEL 4 feet higher, which equates to 4.8 acres more lake surface area. This elevation is similar to historical maximum WSEL with the existing dam in place. These increases in the horizontal and vertical profile of the lake under Alternative 1 would provide an increase in total maximum lake volume of 310 acre-feet and an increase of active storage volume of approximately 460 acre-feet. This increase in storage capacity would potentially provide more water for summer instream flow supplementation, which would provide benefits to fish downstream of the lake in Eightmile and Icicle creeks, including ESA-listed fish species and other anadromous salmonids that use these waterbodies. The additional flow supplementation would consist of cooler water from below the lake surface, potentially providing lower temperatures downstream and higher dissolved oxygen levels, which also would benefit these fish species. Compared to existing conditions, where the lake is drawn down annually to the lowest level, Alternative 1 is predicted to only reach low levels during drought conditions (approximately once every 5 years).

Additionally, Alternative 1 includes an automated 464-foot-long low-level outlet pipe draining the lake into Eightmile Creek. The pipe inlet in the lake under Alternative 1 would be at 4,632 feet, where the water is likely substantially cooler than the surface water temperature. The automated nature of the outlet pipe would allow IPID to remotely provide a relatively consistent source of colder water for summer instream flow supplementation and irrigation, as compared to the No Action Alternative. The resulting relatively dependable (as compared to existing conditions) summer flow augmentation would benefit those anadromous and resident salmonid species that utilize Eightmile Creek and the Icicle Creek mainstem downstream of the confluence. This includes providing more wetted aquatic habitat in the summer, as well as potential improvements to stream temperatures and increased DO levels.

Furthermore, the automated spillway gates on the primary spillway, combined with the construction of intermediate spillways and a secondary spillway, would provide multiple control systems that are designed to pass all storm events, even in the most extreme storm scenarios (e.g., a 1,000,000-year storm event), while maintaining required freeboard. These systems would allow lake level regulation on a real-time basis and would not require physical access to the site to adjust lake levels, although damage to the power system or communications systems could temporarily disable these features. Overall, however, the combination of these features and the construction of a new dam would substantially reduce any risk of catastrophic dam failure, while allowing regulation of water levels in the lake that cannot occur under existing conditions.

Alternative 1 would allow the lake to fill to a level that provides 4.8 acres more lake surface area than existing conditions, and would also allow the lake to be drawn down to a level that would provide a lake area of 2.5 acres less than could occur under existing conditions. Although the lake area (and volume) has the potential for larger fluctuations as compared to existing conditions, the relatively small increases and decreases would not substantially alter lake biology, and would have a minimal effect on aquatic species within the lake. The current lake has relatively steep side slopes consisting of bedrock, talus slopes, and scattered coniferous trees. Slight alterations in the lake level will not impact the existing levels of riparian function. Similarly, ecological processes in the lake that affect fish abundance and species biodiversity (such as fish densities, nutrient and insect recruitment, sediment transport and deposition, and functioning of the lacustrine riparian zone) would not be substantially altered under Alternative 1, and no detectable changes in fish abundance, species composition, or lake water quality would occur, compared to existing conditions, resulting in **less-than-significant adverse impacts** on fish and fish habitat.

8.5.3 Alternative 2: Wide Spillway without Gates

Wildlife and Wildlife Habitat

Impacts on wildlife and wildlife habitat would be the same as those described above for Alternative 1: Narrow Spillway with Gates. Operation of Alternative 2 would result in **less-than-significant adverse impacts** on wildlife and wildlife habitat, including wetlands.

Fish and Fish Habitat

Alternative 2 is identical to Alternative 1 in the high and low WSELs and lake areas and volumes for these metrics. The primary differences from Alternative 1 are the design of the spillways, including spillway size, and the absence of gates to control WSELs. With an earthen embankment and reinforced concrete dam proposed under Alternative 2, the primary spillway length of 180 feet is 120 feet longer than under Alternative 1. The construction of Alternative 2 would require about 10,000 cubic yards of materials to be excavated from elsewhere on the site and used to build the dam. The primary spillway would be fixed and completely passive, with the lake draining over the primary spillway when the lake fills to an elevation above 4,671 feet. Alternative 2 has only the single primary spillway, and does not include any gates or automatic equipment that would control the spillway or adjust the spillway crest elevation. As with Alternative 1, water would be released from the lake through a new 30-inch diameter low-level outlet pipe/siphon. The operation and configuration of the low-level outlet pipeline would be essentially the same described for Alternative 1. The fixed spillway would provide slightly less control of high-water surface elevations as compared to Alternative 1, and would require some additional disturbance to adjacent areas for construction of the larger earthen dam structure, but overall would essentially function the same and provide equivalent benefits to downstream summer flows to anadromous and ESA-listed salmonids in Eightmile and Icicle creeks. As with Alternative 1, Alternative 2 would not result in substantive changes in the fish resources or fish habitat in Eightmile Lake, and would result in **less-than-significant adverse impacts**.

8.5.4 Alternative 3: Narrow Spillway without Gates

Wildlife and Wildlife Habitat

Impacts on wildlife and wildlife habitat, including wetlands, would generally be the same as those described above for Alternative 1: Narrow Spillway with Gates. However, should pumping be required by IPID at low-water levels, the site would be accessed by a work crew, either by foot or helicopter at times during operations when additional water is required downstream. Such an action would disturb

wildlife species in the area due to noise and human presence. Species impacted include those described under dam construction (Section 8.4.2). Because the expected use of pumping would be infrequent, operation of Alternative 3 would result in **less-than-significant adverse impacts** on wildlife around the dam site during pumping activities.

Fish and Fish Habitat

Under Alternative 3, the dam type and configuration would be almost identical to that for Alternative 1, having a narrow spillway and a concrete spillway apron, but with no mechanical gates. The spillway would consist of one continuous 60-foot-wide primary spillway section with no dividing walls and would be designed to store water up to a maximum WSEL of 4,667 feet, which is 4 feet less than Alternatives 1 and 2. The maximum volume of water that could be stored for release by the dam would be less for this alternative than for the other action alternatives. The total lake volume at maximum WSEL for Alternative 3 is 1,698 acre-feet, approximately 312 acre-feet less than under Alternatives 1 and 2. Similarly, the useable storage volume under Alternative 3 is 302 acre-feet less than the two other action alternatives.

In addition, under Alternative 3, pumping would be required by IPID to access additional water needed and as allowed by their water right. This would involve flying pumping equipment to the dam site, likely including the use of diesel or gasoline to power a pump or generator. The use of such equipment would result in a slight increase in the potential for spills of hazardous materials. In addition, in drought conditions and without pumping, water storage available for release to enhance downstream flows would be less than under Alternatives 1 and 2, resulting in potentially less benefit to fish habitat and water quality in downstream reaches of Eightmile and Icicle creeks. As with Alternatives 1 and 2, Alternative 3 would not result in substantive changes in the fish resources or fish habitat in Eightmile Lake, and would result in **less-than-significant adverse impacts**.

8.6 Avoidance, Minimization, and Mitigation Measures

During construction of any action alternative, standard in-water construction and demolition BMPs would be implemented in accordance with environmental regulatory permit requirements. Specific in-water construction periods would also be confirmed through the project permitting process to minimize potential impacts of in-water construction activities on salmonid species.

Other BMPs common to all action alternatives include the following:

- During construction, the IPID would use BMPs (for example, sediment curtains) to avoid unintentional impacts on habitat and water quality during construction.
- Cofferdams or other appropriate measures will be used to isolate work areas from open-water areas for construction of the dam and spillway.
- Cleared upland areas, including FSR 7601-116, will be restored, and the areas replanted with appropriate native herbaceous and woody species.
- Invasive species control and management will be implemented during construction and operations by following guidelines provided by the Forest Service.
- Temporary erosion and sediment control measures will be implemented to limit sediment inputs to receiving waters during and after construction.

- Spillage of concrete and releases of other construction materials into the water will be prevented through isolation of the work area and implementation of proper waste handling measures. Poured concrete will be allowed to cure prior to contact with any surface water.
- Pollution control measures will be implemented to ensure appropriate storage, handling, and use of petroleum products and other potential pollutants on-site during construction. Spill response materials will be maintained on-site during construction.
- Native vegetation will be replanted in disturbed areas, following a plan approved by the Forest Service. Vegetation management will include the removal and monitoring of noxious weeds disturbed by the project.
- Additional coordination with WDFW and the Forest Service may be necessary to ensure that construction activities comply with regulatory requirements for species and habitats covered by the ESA and MBTA.
- If blasting with explosives at the dam site is necessary, a pre-blasting survey will be performed to locate any wildlife (terrestrial and aquatic) in the area that could be impacted by such a high-intensity noise. If wildlife are found, they should be hazed from the area to prevent their injury. An option may be to ramp-up construction noise prior to the blast to disturb and eventually displace any individuals from the area in a more controlled manner that has let potential to cause injury.

8.7 Significant Unavoidable Adverse Impacts

The longer duration that helicopters are used, the more disturbance events on wildlife would be incurred. Construction activities would also disturb wildlife, but in a much smaller area than what would be affected by helicopters, which would be largely confined to surrounding each area of construction. Virtually all protected wildlife species would be negatively affected by construction, as many have potential to be present in the study area. Large mammals, birds, amphibians, and reptiles would likely incur in the most substantial negative impacts–mobile animals would be forced to flee the action areas, and less-mobile animals risk being mortally harmed if present in the construction areas. Implementing avoidance and minimization measures would somewhat reduce these impacts.

It is not expected that significant, unavoidable impacts on wildlife habitat would be incurred by any of the alternatives, as the work areas are largely sites with a history of disturbance and alterations. With invasive management and replanting of native species, impacted vegetation may be returned to conditions potentially better than under existing conditions.

Alternatives 1, 2, and 3 would not have significant and unavoidable adverse impacts on fish within, or downstream, of the project area. A catastrophic dam failure, if it were to occur under the No Action Alternative, would have large-scale significant and unavoidable adverse impacts on fish within both Eightmile Lake, extending downstream to at least the Wenatchee River, and potentially farther.

CHAPTER 9: NOISE

Noise is defined as an unwanted sound that can adversely affect humans as well as other terrestrial and aquatic species. This chapter describes existing conditions and anticipated impacts primarily from the use of helicopters and other construction equipment. Impacts of noise on wildlife and aquatic species are described in Chapter 8*, Plants and Animals*.

Key Findings for Noise

- The Special Warranty Deed preserves IPID's right to maintain and repair the dam. In early spring, small planes fly low to inspect conditions and helicopters are used to transport personnel and equipment to maintain the dam as necessary.
- With or without the project, noise-related impacts from heavy equipment used to demolish or construct the project on recreationists in the wilderness area would be unavoidable. However, because of the limited scale and duration of the project, construction noise impacts are considered **less-than-significant**.
- Noise from helicopters transporting personnel and equipment would be audible during daytime hours along trails, lakes, and campsites in the Enchantments Permit Area zones. Maximum noise from the heavy lift helicopter would be higher than the lower payload helicopter, but the number of trips from the heavy lift helicopter would be fewer. While the noise may be considered a nuisance by some visitors, noise from helicopter flights is considered a **less-than-significant** impact due to the timing and limited duration of the project.
- Noise from the operation of heavy construction equipment and blasting with explosives (if needed) at the dam would be audible in the Eightmile / Caroline Zone. Noise from blasting would be temporary and used sporadically and is considered a **less-than-significant** impact.
- During operation, noise levels would return to existing conditions and there would be no adverse noise impacts.

9.1 Aircraft Noise and Background Information

The measurement and human perception of sound involve two basic physical characteristics: intensity and frequency. Intensity is a measure of the acoustic energy of sound vibrations, expressed in terms of sound pressure. The higher the sound pressure, the more energy carried by the sound and the louder the perception of that sound. The second important physical characteristic is sound frequency, which is the number of times per second the air vibrates or oscillates. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches.

The typical human ear is not equally sensitive to all frequencies of the audible sound spectrum. As a consequence, when assessing potential noise impacts on humans, sound is measured using an electronic filter that de-emphasizes the frequencies below 1,000 Hertz (Hz) and above 5,000 Hz in a manner corresponding to the human ear's decreased sensitivity to extremely low and extremely high frequencies. This method of frequency weighting is referred to as A-weighting and is expressed in units of A-weighted decibels (dBA). A-weighting follows an international standard methodology of frequency weighting and is

typically applied to community noise measurements. Some representative noise sources and their corresponding A-weighted noise levels are shown in Table 9-1. As shown, the relative perceived loudness of a sound doubles for each increase of 10 dBA, although a 10-dBA change in the sound level corresponds to a factor of 10 changes in relative sound energy. Generally, single-event sound levels with differences of 2 dBA or less are not perceived to be noticeably different by most listeners.

Table 9-1. Common Sounds on the A-Weighted Decibel Scale

Sound	Sound level (dBA)	Relative loudness (approx.)*	Relative sound energy**
Rock music, with amplifier	120	64	1,000,000
Thunder, snowmobile (operator)	110	32	100,000
Boiler shop, power mower	100	16	10,000
Orchestral crescendo at 25 feet, noisy kitchen	90	8	1,000
Busy street	80	4	100
Interior of department store	70	2	10
Ordinary conversation, 3 feet away	60	1	1
Quiet automobiles at low speed	50	1/2	0.1
Average office	40	1/4	0.01
City residence	30	1/8	0.001
Quiet country residence	20	1/16	0.0001
Rustle of leaves	10	1/32	0.00001
Threshold of hearing	0	1/64	0.000001

SOURCE: U.S. Department of Housing and Urban Development 1972.

*Relative loudness refers to the perceived doubling of noise level per 10 dBA increase over levels typical of ordinary conversation.
**Relative sound energy is the sound pressure level in micro pascals (uPa) divided by the threshold of human hearing (20 uPa) in air.

9.2 Methodology

This section describes the methods used to analyze the potential for environmental noise impacts from the construction and operation of the project in the study area. The study area includes the helicopter flight path and areas of the Enchantment Permit Area, including portions of the Eightmile / Caroline and Stuart Zones, where construction noise would be audible.

The limits of acceptable change defined in the Alpine Lakes Area Land Management Plan (USFS 1984) were used to evaluate the potential for short-term and long-term impacts. The noise management standards, summarized in Section 9.3, restrict the nature and frequency of sounds experienced in wilderness areas based on the level of development. The most restrictive are defined for campsites in trailless zones where people-caused sound levels are not typically detected more than twice per day and were used as the basis to determine whether short-term and long-term

impacts would be significant. Sound level changes of ± 1 dBA are not usually discernable by the human ear, even under ideal laboratory conditions. Changes between 1 and 3 dBA are detectable by some people under quiet, controlled conditions. But a change of 5 dBA or more is readily discernable to most people in outdoor environments (FTA 2018).

Short-term construction impacts are considered significant as follows:

- Impacts are considered significant if noise from construction activity is detectible (exceeding ambient levels by 5 dBA or more) in wilderness areas and campsites at night, between the hours of 10 p.m. and 7 a.m.

Long-term (operational) impacts are considered significant as follows:

- Impacts are considered significant if people-caused noise levels are detectible (i.e., exceed ambient levels by 5 dBA or more) in wilderness areas and campsites more than two times per day for more than two full construction seasons.

To determine the potential for impacts, ESA predicted environmental noise levels from helicopters and construction equipment using the Aviation Environmental Design Tool (AEDT) and the Computer Aided Noise Abatement (CadnaA) models, respectively. Project-related noise levels were calculated at five nearby lakes, where most recreationalists visit or camp. To estimate detectability, predicted noise levels were compared to typical noise levels experienced in wilderness areas during summer months. Additional details regarding helicopter noise modeling are provided in Section 9.2.1. Additional details regarding the construction equipment noise modeling are provided in Section 9.2.2.

9.2.1 Overview of Helicopter Noise Modeling

For the noise analysis, a single event noise metric was used as opposed to a time-averaged noise metric, which is generally the standard when considering aircraft noise impacts. Given how irregular the helicopter activity would be, a time-averaged noise metric would not convey the brief helicopter noise following long periods of relative low sound levels that this helicopter activity would bring. The Maximum Sound Level (or Lmax) metric was selected to identify the absolute highest noise impact that the helicopter flights to and from the dam site would cause. The Lmax metric is A-weighted as discussed above in order to calibrate the metric to the frequencies heard by the human ear.

To assess noise levels associated with the use of helicopters, the AEDT (which is the Federal Aviation Administration's [FAA] approved model for assessing noise and emissions at civilian airports) was used. AEDT has been used for environmental review of aviation noise and emissions impacts for airport projects since 2015 and is used for 14 CFR Part 150 (Airport Noise Compatibility Planning) studies, Environmental Assessments, and Environmental Impact Statements under NEPA. AEDT was used to simulate the noise emissions from the construction-related helicopter operations.

For construction activities, helicopters would be used to transport equipment to and from the dam site. Depending on the option selected, two types of helicopters would be used: a heavy-lift helicopter (e.g., Columbia Chinook CH-47D, or similar) with a 20,000-pound payload capacity, and a small helicopter (e.g., Bell UH-1 Huey or similar) with a 5,000-pound payload. However, only one helicopter would be in operation at any one time so the operations for each helicopter were modeled and are presented separately.

The path of the helicopter flights is integral to measuring the noise along the path of the flight. The flights to the construction would begin at the "fly yard" near Icicle Creek at an elevation of 2,278 feet, and helicopters would fly along the valley generally following the path of Eightmile Creek to the construction site at an elevation of 4,675 feet. The return flights would fly back down the valley to the northeast to the fly yard. Figures 9-1 through 9-8 (presented at the end of this chapter) show the modeled flight path from the construction location to the fly yard. Due to the very short flight path

and the unique difference in altitudes over such a short distance, the decision was made to model the departure and arrival at each helipad separately. AEDT assigns a standard flight profile to each aircraft type, and when modeling both helipads with this standard flight profile, the departure flight profile would result in helicopters overshooting the arrival pad and flying directly through the mountains beyond. Separating the analysis preserves the unique acoustic characteristics associated with arrival and departure flight profiles without including extra noise associated with the overshot flight path.

AEDT also requires weather data. The Cashmere-Dryden Airport has a weather station 17 miles east of the construction site that was used to approximate the weather data in the vicinity of the helicopter flights. The weather data used are the average annual values from 2011–2020 from the Integrated Surface Database (NOAA 2001). Table 9-2 gives the weather parameters used in the modeling. Given the mountains on either side of the helicopter flight path, using terrain data in the modeling was considered essential. The data were pulled from the United State Geological Survey (USGS 2021).

Table 9-2. AEDT Modeling Weather Parameters

Weather Parameter Name	Weather Parameter Value
Temperature (Fahrenheit)	48.91
Pressure(millibars)	971.37
Sea Level Pressure (millibars)	1,016.24
Relative Humidity (%)	55.72
Dew Point (Fahrenheit)	33.75
Wind Speed (knots)	5.56

Source: Prepared by ESA 2022

The results on the noise modeling are presented in Section 9.5.1, *Transportation of Equipment and Materials* of this chapter.

9.2.2 Construction Noise Modeling Overview

Construction noise from clearing, demolition, and dam construction would be audible when heavy equipment is in use. The construction assessment evaluated the potential for short-term impacts from excavator, generator, concrete mixer, and blasting (with explosives) noise. Modeled noise emissions, summarized in Table 9-3, were based on the maximum noise levels from the Federal Highway Administration (FHWA) Roadway Construction Noise Model (RCNM) (FHWA 2008).

Table 9-3. Construction Equipment Noise Emission Levels

Equipment Type	Lmax Noise Level at 50 Feet (dBA)
Excavator	85
Generator	82
Vibratory Concrete Mixer	80
Blasting	94

Source: FHWA 2008

To simulate construction noise, the CadnaA software program by DataKustik was used. CadnaA is the leading software for the calculation, presentation, assessment, and prediction of environmental noise from multiple sources, including construction equipment. The model predicts sound levels using algorithms that comply with the international standards in ISO-9613-2:1996 (ISO 1996). Effects of distance, terrain, ground surface types, and meteorological conditions are considered by the model. Using CadnaA, noise levels were predicted at the Eightmile Dam construction site and at dispersed Eightmile Lake campsites, approximately 3,000 feet west of the dam.

9.3 Regulatory Context

Soundscapes within the study area are protected by a variety of federal, state, and local plans, laws, and policies (Table 9-4). These plans and policies were reviewed to determine how the project alternatives would comply with noise regulations in the study area. Of these regulations, the Alpine Lakes Area Land Management Plan contains objective thresholds for sources of noise affecting receiving locations in wilderness zones. These standards are further summarized in the next section.

Table 9-4. Regulations and Guidelines for Noise Applicable in the Study Area

Program, Plan, or Policy	Description
Alpine Lakes Area Land Management Plan	Provides noise standards for the wilderness management areas, which include the transitional zone, semi-primitive zone, primitive zone, and trailless zone.
36 CFR § 261.18 - National Forest Wilderness	Prohibits the use of motor vehicles and motorized vehicles unless authorized by federal law or regulation. Also prohibits the landing of aircraft or dropping or picking up anything via an aircraft (including helicopter) in a wilderness area.
Noise Control Act of 1972	Authorizes federal action to address sources of noise, including motor vehicles, machinery, appliances, and other commercial products. The act authorized the EPA to issue noise emission regulations for the above sources.
Washington State Noise Control Act of 1974	Recognizing the harm that excessive noise can have on public health, safety, and well-being, the State of Washington established rules to abate and control noise pollution (RCW 70.107, Noise Control). The regulations on Maximum Environmental Noise Levels (WAC 173.60) apply to a variety of activities and facilities.
Chelan County Noise Ordinance – Chapter 7.35 Chelan County Code	Provides control of noise in a manner that promotes commerce and continues the community events, values, and traditions of Chelan County; the use, value, and enjoyment of property; sleep and repose; the health, safety, and welfare of the general public; and the quality of the environment. Sounds from construction noise during the hours of 7 a.m. to 10 p.m. are exempt from county regulations (Chelan County Code [CCC] 7.35.040).

9.3.1 Alpine Lakes Area Land Management Plan

The Alpine Lakes Area Land Management Plan was adopted in 1984 to preserve and protect the Alpine Lakes Wilderness and primitive areas. This plan sets objectives for the “Limit of Acceptable Change” to the soundscapes in four wilderness zones. Each zone represents different opportunities for visitors wishing to experience wilderness settings. Noise objectives establish standards for the

intensity and frequency of detectible people-caused sounds in each zone. The plan describes the four wilderness zones as follows:

- Transition Zone – Characterized by predominantly unmodified natural environment. These zones usually are adjacent to major trailheads where the user makes the transition from motorized access to foot or horse travel and is first introduced to the wilderness. They normally extend from the wilderness boundary inward along primary travel routes up to 3 miles and 500 feet on either side of the travel route. Day use of an area often predominates or is equally mixed with destination travelers also using the interior of the wilderness. A transition zone exists 500 feet on either side of FSR 7601 and Eightmile Lake Trail and includes the area immediately surrounding the project.
- Semi-Primitive Zone – Characterized by predominantly unmodified natural environment of moderate to large size. Concentration of users is low, but there is often evidence of other area users. The zone is managed in such a way that minimum on-site controls and restrictions may be present but are subtle. Spacing of groups may be formalized to disperse use and provide low to moderate contacts with other groups or individuals. Near the project, a semi-primitive zone exists 500 feet on either side of Eightmile-Trout-Creek Trail.
- Primitive Zone – Characterized by essentially unmodified natural environment. Concentration of users is very low and evidence of other area users is minimal. The zone is managed to be essentially free from evidence of restrictions and controls. Spacing of groups is informal and dispersed to minimize contacts with other groups or individuals. Campsites in the Eightmile/Caroline and Stuart Enchantment permit areas are considered primitive zones.
- Trailless Zone – Characterized by an extensive unmodified natural environment. Natural processes and conditions are not measurably affected by the actions of users. The zone is managed to be as free as possible from the influence of human activities. Trailless zones exist in the project vicinity, more than 500 feet away from trails and campsites.

Maximum acceptable detectability values, as measured using the System for the Prediction of Acoustic Detectability (SPreAD) (Harrison et al. 1980) are provided in Table 9-5. This assessment considers any people-caused sound levels detectible if the predicted noise level exceeds ambient levels by 5 dBA or more.

Table 9-5. Wilderness Noise Management Standards

Wilderness Zone	Maximum Acceptable Detectability Levels (D')
Transition Zone	People-caused sound rated at D'-10 are not heard on an average of more than 4 times per hour from a distance 1/4 mile within the zone.
Semi-Primitive Zone	People-caused sound rated at D'-5 between camps and are not heard on an average of more than 12 times per day by traveling groups.
Primitive Zone	People-caused sounds rated at D'-1 between camps are not heard on an average of more than 6 times per day by traveling groups.
Trailless Zone	People-caused sounds rated at D'-1 are audible between camps and not heard on an average of more than 2 times per day by traveling groups.

D' values based on SPreAD estimation guidelines. The D' scale represents noise levels detectable in the following conditions:

- D'-1: Wilderness / primitive areas.
- D'-5: Trail camps / semi-primitive areas.
- D'-10: Underdeveloped roadside campgrounds / semi-primitive areas.
- D'-20: Roadside campgrounds / semi modern areas.
- D'-40: Highly developed campgrounds / modern areas.

Source: USFS 1984

9.4 Affected Environment

The study area includes the Enchantment Permit Area within the Alpine Lakes Wilderness and is primarily used for recreational purposes. Transition zones exist within 500 feet of the Eightmile Lake Trail leading to and surround the dam. A semi-primitive zone exists approximately one-half mile from the dam and extends 500 feet from either side of the Eightmile-Trout-Creek Trail. Dispersed campsites in the Enchantment Permit Area are considered primitive zones. All other undeveloped areas are considered trailless zones and have very low noise levels. A telemetry repeater station would be installed in the Wenatchee National Forest near an existing Forest Service repeater station, located outside of the Alpine Wilderness (see Figure 1-2). Existing noise sources include occasional overhead air traffic and traffic on Forest Service roads in the area and at trailheads, voices, streamflows, and birds and other wildlife sounds. Ambient background noise levels in wilderness areas are typically around 45 dBA during summer months.

9.4.1 Sensitive Noise Receptors and Soundscapes in the Study Area

The Enchantment Permit Area is considered a sensitive soundscape that includes several lakes where recreationists would be considered sensitive receptors. Some of these lakes are popular destinations and are listed in Table 9-6 below.

Table 9-6. Sensitive Receptor Locations

Location Name	Latitude	Longitude	Elevation (ft)
Eightmile Lake	47.522575	-120.870633	4,880
Caroline Lake	47.540350	-120.863347	6,167
Lake Stuart	47.498167	-120.878379	5,078
Colchuck Lake	47.498366	-120.833343	5,590
Upper Snow Lake	47.458262	-120.749749	5,439

Source: Prepared by ESA 2022

The noise environment surrounding Eightmile Lake and other lakes is generally quiet as a result of the surrounding wilderness and rural land uses. Natural sounds predominate in the study area, including streamflows, bird songs, and wind. Noise-causing activities near the boundary of the wilderness areas include traffic traveling on FSR 7601 and Icicle Road.

9.5 Construction Impacts

This section analyzes short-term impacts during the project's temporary construction phase. Construction-related noise levels within the Enchantment Permit Area were evaluated from four scenarios: noise from helicopters, noise during road repairs, noise from use of heavy equipment for dam construction, and noise from blasting with explosives (if needed) at the dam. These noise-generating activities and equipment would likely be used for all alternatives, including future emergency repairs resulting from the No Action Alternative and the project's action alternatives. Such activities are permitted under the dam's Special Warranty Deed that preserves the IPID's right to maintain and repair the dam.

Noise generated from standard construction equipment that would expose people to, or generate, noise levels that would result in sustained and substantial annoyance at campsites and when most people are trying to sleep would be considered significant.

Impact equipment that would only operate during daytime hours, such as jackhammers and blasting, would expose people to, or generate, noise levels that could result in sustained and substantial annoyance and disruption of activities for receptors. Blasting with explosives is considered a contingency activity and, if necessary, based on site conditions, would only occur on one or two days.

9.5.1 Transportation of Equipment and Materials

Helicopter

The results of the noise modeling are shown below and in over eight figures, one for each modeled helicopter arriving at each helipad and departing from each helipad. Results showing noise level contours can be found in Figures 9-1 through 9-8. Noise levels are shown for the flight path and surrounding area, ranging from 50 dBA to 75 dBA.

The maximum helicopter noise was also assessed at trails and popular sites surrounding the construction site: Eightmile Lake, Carolina Lake, Lake Stuart, Colchuck Lake, and Upper Snow Lake. The latitude, longitude, and elevation of each location are given in Table 9-6. The maximum A-weighted helicopter noise was calculated at nearby trails and for each site, and these noise levels are presented in Table 9-7. Over the course of construction, helicopter use and type would vary by the option selected. Table 2-2 (in Chapter 2) presents the two construction options and lists the anticipated number of trips associated with each option. Unless an emergency transport is required, helicopter flights would only occur during daytime hours, between 7 a.m. and 7 p.m. While the noise may be considered a nuisance by some visitors, noise from helicopter flights is considered a less-than-significant impact due to the timing and limited duration of the project.

Table 9-7. Maximum Helicopter Noise at Area Sites

Site Name	Lmax Value (dBA)
Eightmile Lake Trail	116 [a]
Eightmile-Trout-Creek Trail	116 [a]
Eightmile Lake	61
Caroline Lake	51
Lake Stuart	52
Colchuck Lake	52
Upper Snow Lake	42

Notes:
a) Maximum noise level of 116 dBA predicted from fully loaded heavy-lift helicopter (e.g., Columbia Chinook CH-47D, or similar) hovering directly overhead. Actual noise levels from helicopter overflights along these trails likely 75 dBA or lower.
Source: Prepared by ESA 2022

FSR 7601-116

To reduce reliance on helicopter transport, the project proposes to partially restore and use the first 4,280 feet of FSR 7601-116. Road repairs would allow the crew to drive closer to the site and avoid

400–500 feet of elevation gain, allowing crew to carry more supplies in and out by foot and requiring fewer helicopter flights. Clearing would require approximately 16 hours for a crew of 4 members with a 305 CAT excavator. Excavator noise levels, shown in Table 9-3, generally decrease at a rate of 6 dBA per doubling of distance. The Lmax excavator noise level of 85 dBA at 50 feet attenuates to 79 dBA at 100 feet, 73 dBA at 200 feet, and down to 49 dBA at 3,200 feet. In wilderness areas with ambient noise levels of approximately 45 dBA, noise from excavator use would be detectible by most people when within 3,200 feet. Because of the short duration of the noise and sporadic use of the road, noise impacts would be considered less-than-significant.

Telemetry Repeater Station

Under existing conditions, IPID staff hike to Eightmile Lake and manually release water as necessary. Under the action alternatives, this process would be automated using telemetry equipment at Eightmile Lake and a repeater station on Icicle Ridge. While exact locations have not yet been determined, the proposed telemetry equipment would be installed on the northeast side of the dam within the Special Warranty Deed Area. The repeater station would be installed in the Okanogan-Wenatchee National Forest near an existing Forest Service repeater station and outside of the Alpine Wilderness (see Figure 1-2).

Telemetry equipment and installation materials would be flown in by helicopter and installed over the course of 1 to 3 days. Equipment at both locations would be bolted down and secured with guyed wires. Installation would not require the use of heavy construction equipment, but noise from the helicopter used during transportation would be audible in wilderness areas and to hikers in the area during that time. Because of the limited scale and duration of the equipment installation, construction noise impacts are considered less-than-significant.

9.5.2 Dam Construction

The goal for noise modeling was to ascertain the range of maximum possible noise levels likely to be experienced during construction by visitors along trails and at campsites. The maximum noise levels for equipment in Table 9-3 were modeled in CadnaA during daytime hours (7 a.m. to 10 p.m.) when construction activity would likely occur. Equipment was modeled along the lake, next to the dam, at approximately 4,700 feet elevation.

Model calculated noise levels are shown in Table 9-8. In the unlikely event that blasting with explosives is required to complete construction, cumulative noise levels due to typical construction sources and blasting are provided separately. Receiving locations for the Eightmile Lake Trail and Eightmile-Trout-Creek Trail were modeled approximately 200 feet and 2,000 feet from the construction site, respectively. Noise levels at dispersed Eightmile Lake campsites were modeled approximately 3,000 feet from the construction site. Other popular lake destinations are more than 7,200 feet from the construction site. As shown in the table, sound from dam construction activity would not be detectible at more distant lakes due to noise attenuation from distance and intervening terrain.

Maximum model predicted noise levels resulting from dam construction at the loudest point along nearby trails ranged from 42 dBA to 80 dBA. Noise levels between 21 dBA and 36 dBA were predicted at dispersed Eightmile Lake campsites approximately 3,000 feet from the construction site. Based on typical ambient wilderness noise levels and model results, construction-related noise at campsites 3,000 feet or more from the construction site would be difficult to detect. Furthermore, construction activity is not anticipated between the hours of 10 p.m. and 7 a.m., and therefore disturbance to sleep would not likely occur. Temporary noise increases due to construction would be detectible by most people using the Eightmile / Caroline Zone wilderness trails and would be viewed

as a strongly negative impact by some users. However, because of the limited scale and duration of the project, construction noise impacts are considered **less-than-significant.**

Table 9-8. Maximum Construction Noise Levels at Area Sites (dBA)

Receiver Location	Typical Construction Noise Sources				Contingency Activity	
	Excavator	Generator	Concreate Mixer	Cumulative	Blasting	Cumulative
Construction Site	110	107	105	112	119	119
Eightmile Lake Trail	70	67	65	72	79	80
Eightmile-Trout-Creek Trail	47	44	42	49	56	57
Eightmile Lake campsites	26	23	21	29	35	36
Caroline Lake	Undetectable – Less than 15 dBA					
Lake Stuart	Undetectable – Less than 15 dBA					
Colchuck Lake	Undetectable – Less than 15 dBA					
Upper Snow Lake	Undetectable – Less than 15 dBA					

Source: Prepared by ESA 2022

9.6 Operational Impacts

This section describes any operational impacts from noise from the alternatives.

9.6.1 No Action Alternative

Currently, maintenance and inspection of the dam occurs several times per year. Helicopters are used to transport equipment and personnel as needed for maintenance. Small planes fly low and slow over the dam during the spring months to inspect the site when snow levels preclude hiking to the dam. Under the No Action Alternative, it is likely that the dam would eventually fail and require repair or replacement. During this construction, heavy equipment and materials would be flown in by helicopter, resulting in noise impacts similar to that of the action alternatives.

9.6.2 Alternative 1: Narrow Spillway with Gates

Operation of the dam does not typically generate any noise. Maintenance of the dam is currently performed with transport to the site via helicopter or personnel hiking to the site. Under this alternative, approximately 1–3 times per year, crew members would run a compressor to fill the air bladders and lift the dam gates. Gates are assumed to be low through early snowmelt and raised once during the summer. Noise from operation of the dam would be similar to existing conditions and is considered **less-than-significant.**

Maintenance of telemetry equipment would occur roughly once every 5 years, and would consist of one helicopter flight to the site to replace batteries. Because of the limited scale and short duration of the maintenance activities, noise impacts from telemetry equipment maintenance are considered **less-than-significant.**

9.6.3 Alternative 2: Wide Spillway without Gates

Gates would not be used under this alternative and, therefore, compressors would not be required. Operational impacts from Alternative 2 would be similar to or less than those described for Alternative 1, and would be **less-than-significant.** Noise impacts from telemetry equipment maintenance are the same as Alternative 1 and are considered **less-than-significant.**

9.6.4 Alternative 3: Narrow Spillway without Gates

Operational impacts from Alternative 3 would be similar to those described for Alternative 1. While a compressor would not be used to control gates, pumping may be required when water levels are low. If pumping is required at low-water levels under this alternative, additional helicopter flights may be necessary to transport equipment. Pumping would be infrequent and would likely produce noise levels similar to or less than operation of compressors under Alternative 1. Therefore, noise from operation of Alternative 3 is considered **less-than-significant.** Noise impacts from telemetry equipment maintenance are the same as Alternative 1 and are considered **less-than-significant.**

9.7 Avoidance, Minimization, and Mitigation Measures

During construction, recreationists near active construction areas would experience short-term, temporary increases in sound levels from heavy equipment use at the Eightmile Dam, near FSR 7601, and along the helicopter flight path. BMPs for mitigating construction noise and reducing detectability include:

- Require all equipment be fitted with an appropriately sized muffler.
- Require all equipment to be in good working order.
- Consider replacing typical pure-tone backup alarms with ambient sensing technology or broadband backup alarms.
- Post allowable construction hours at trailheads near construction sites.
- Use “quiet” models where available (e.g., for compressors).
- Prohibit unnecessary idling of internal combustion engines.
- As described in Chapter 3, *Wilderness Character*, and Chapter 10, *Recreational Resources*, notify the public and potential users about construction so people who find the noise incompatible with their wilderness recreation can avoid using the area.

9.8 Significant Unavoidable Adverse Impacts

It is unavoidable that recreationists in the Alpine Lakes Wilderness and using Forest Service lands will find the impacts from construction noise and helicopters to detract from their experience, and some individuals may perceive this as a strongly negative impact. Because noise would only occur during active construction and the helicopter noise would no longer be present following completion of the work, the impacts would not be significant. The project alternatives would not result in long-term significant noise impacts in the Enchantment Permit Area during operation. There would no long-term sources of noise from the project within the Enchantment Permit Area.

Figure 9-1. Southwest Helipad Arrival, CH47D
(Source: Prepared by ESA with AEDT model results)

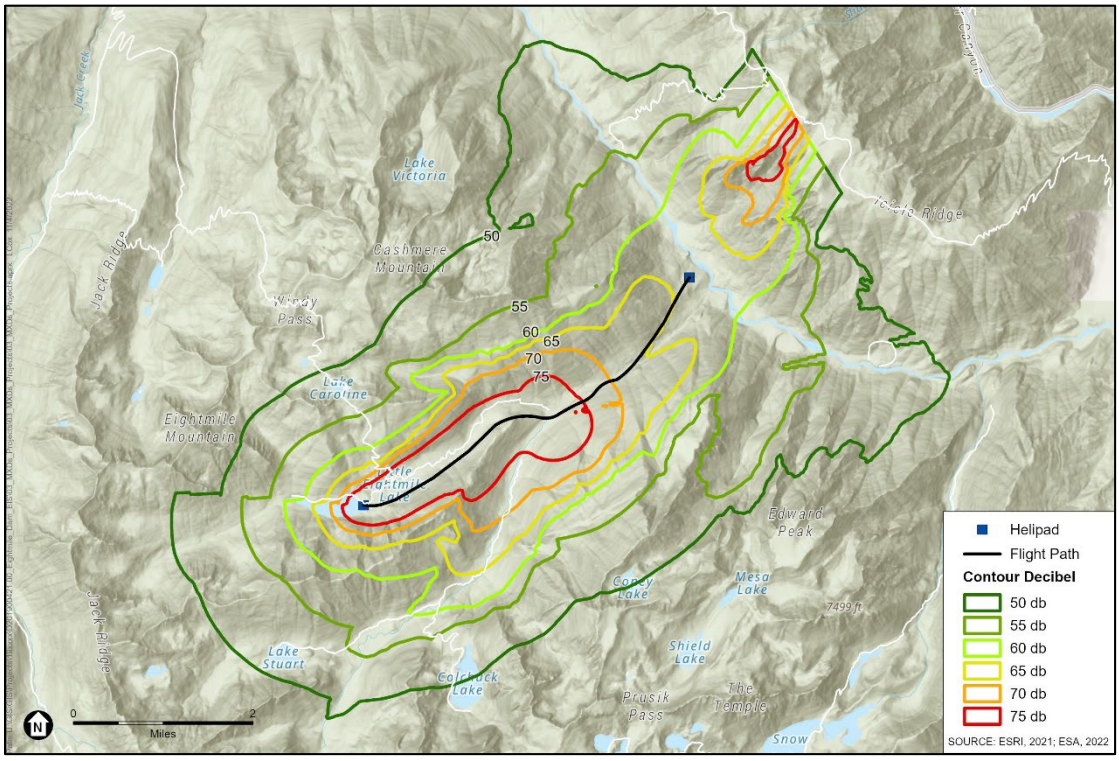


Figure 9-2. Southwest Helipad Departure, CH47D
(Source: Prepared by ESA with AEDT model results)

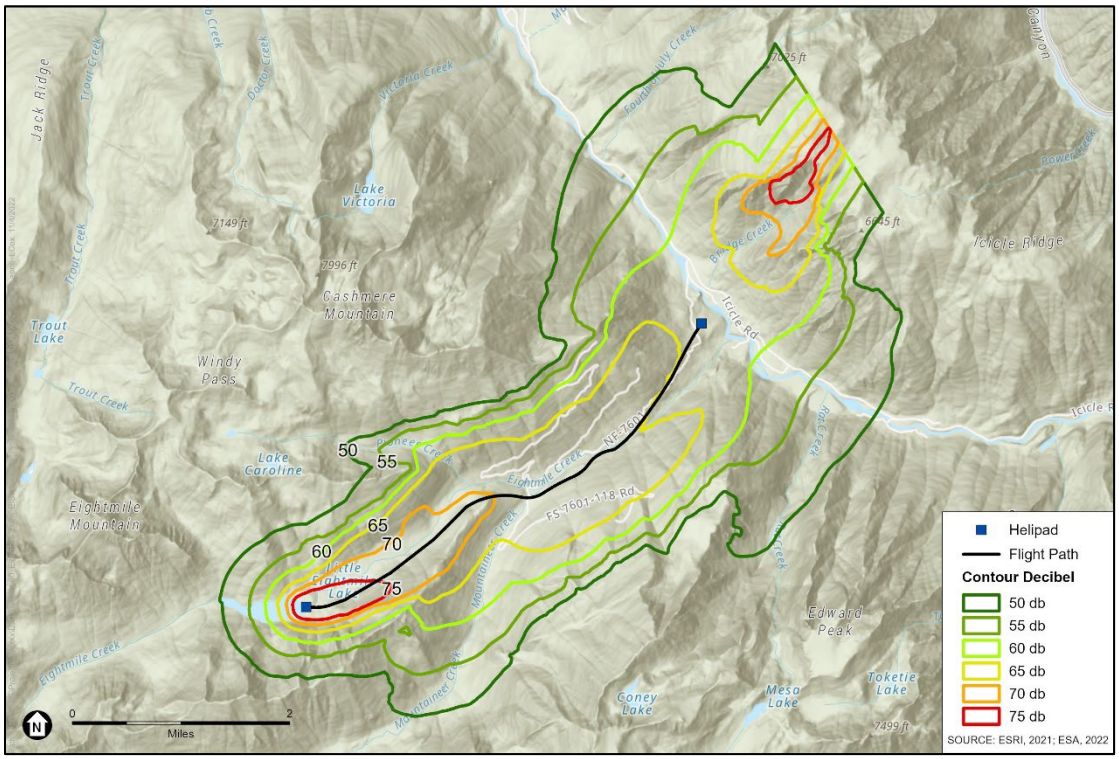


Figure 9-3. Northeast Helipad Arrival, CH47D
(Source: Prepared by ESA with AEDT model results)

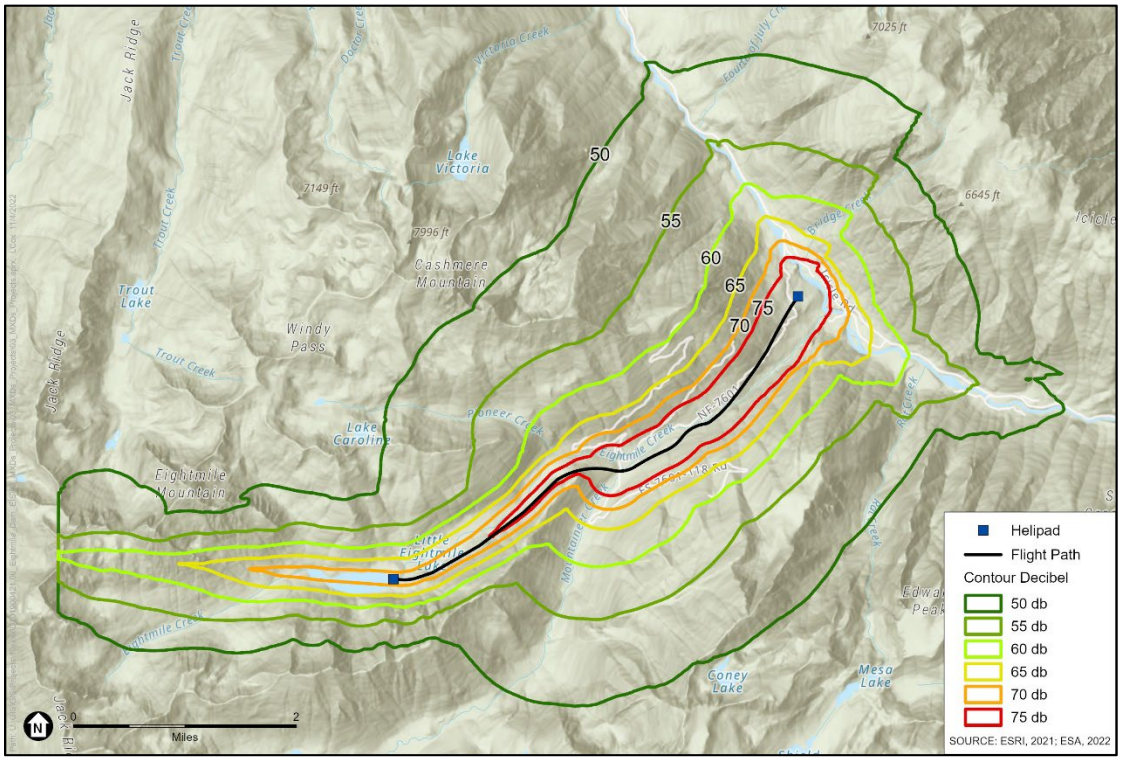


Figure 9-4. Northeast Helipad Departure, CH47D
(Source: Prepared by ESA with AEDT model results)

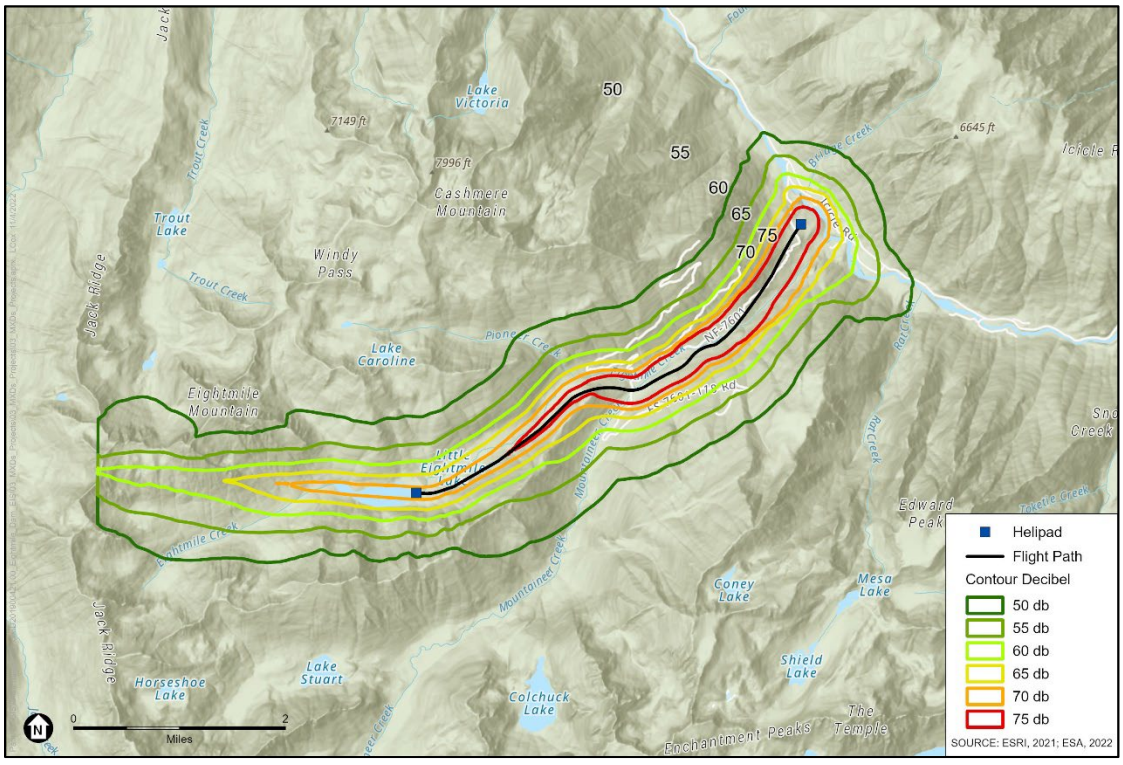


Figure 9-5. Southwest Helipad Arrival, H500
(Source: Prepared by ESA with AEDT model results)

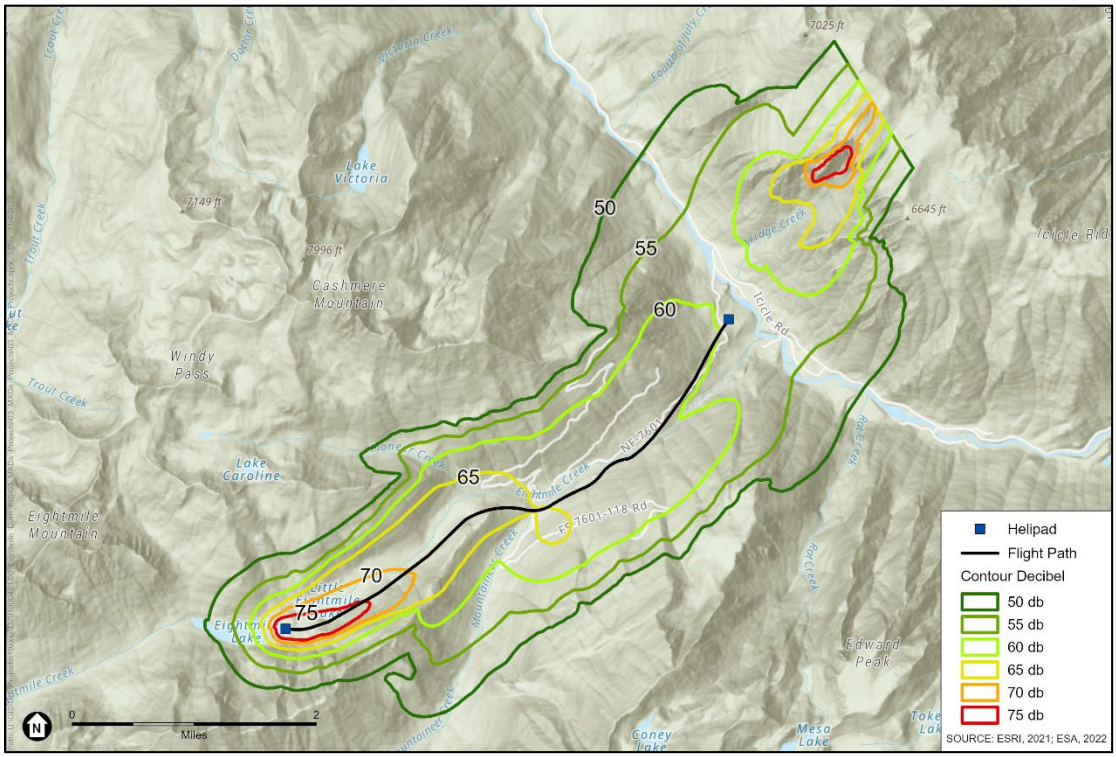


Figure 9-6. Southwest Helipad Departure, H500
(Source: Prepared by ESA with AEDT model results)

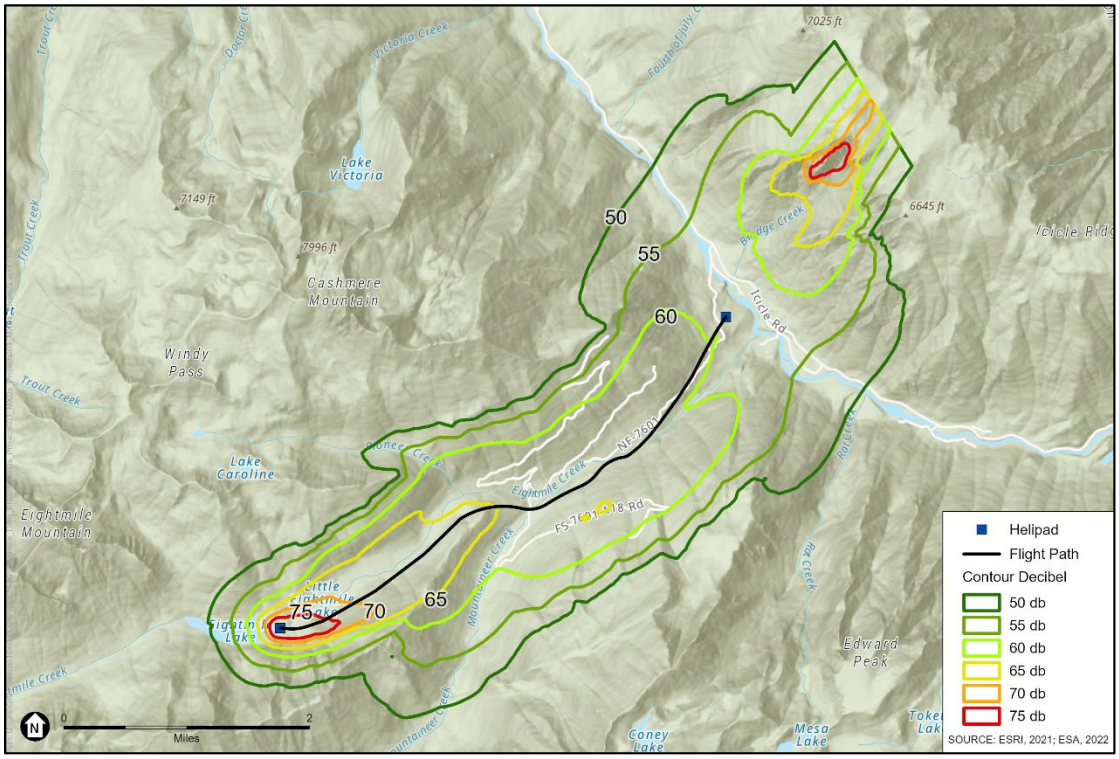


Figure 9-7. Northeast Helipad Arrival, H500
(Source: Prepared by ESA with AEDT model results)

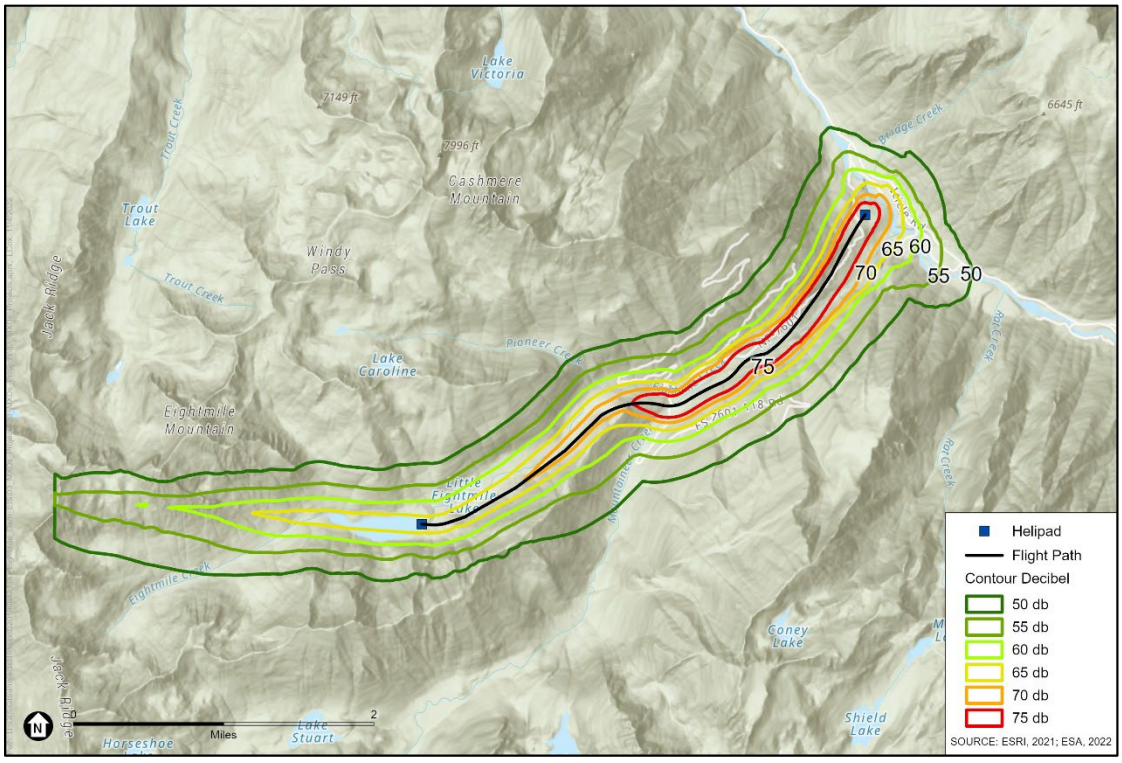
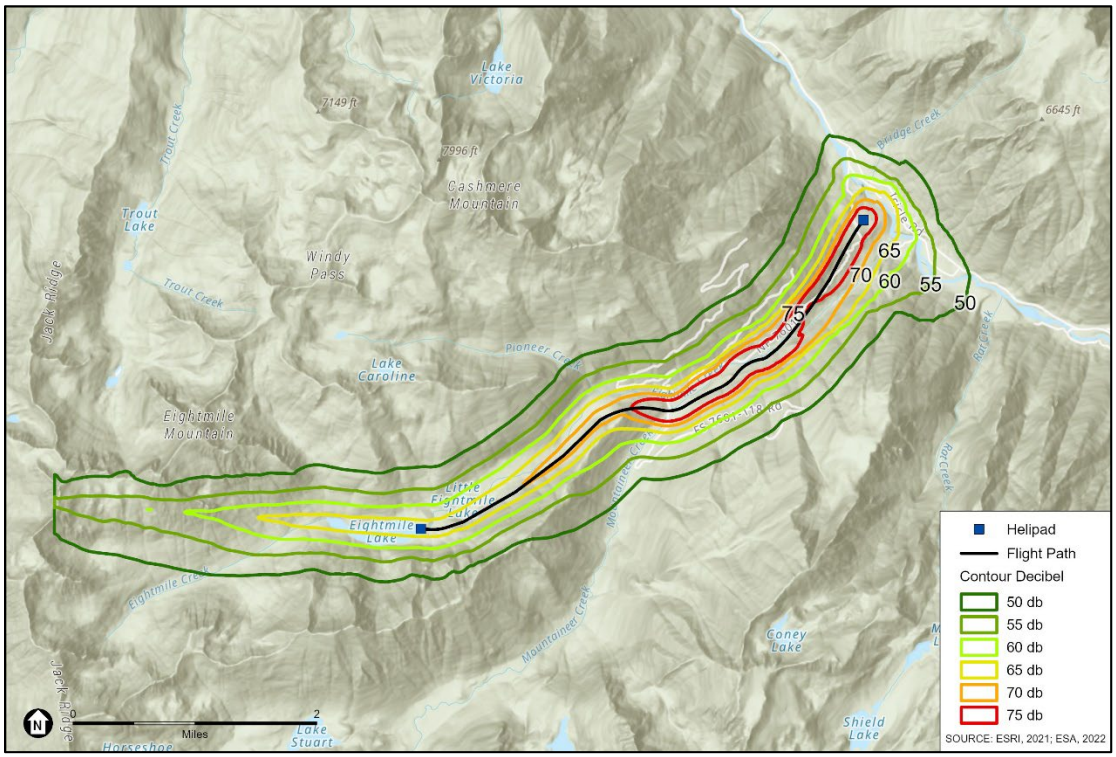


Figure 9-8. Northeast Helipad Departure, H500
(Source: Prepared by ESA with AEDT model results)



CHAPTER 10: RECREATIONAL RESOURCES

Recreation provides people with the opportunity to engage with and enjoy the natural environment. The Alpine Lakes Wilderness provides numerous opportunities for unconfined recreation as required by the Wilderness Act of 1964. Additionally, the project area is located within the Enchantment Permit Area, a popular hiking and camping destination that draws people from across Washington State and beyond.

Key findings for Recreation

- Recreation in the Enchantment Permit Area includes, but is not limited to, hiking, backpacking, fishing, rock climbing, and stock use.
- The Enchantment Permit Area is an increasingly popular hiking and backpacking destination.
- Permits via lottery system are required for overnight stay in the Enchantment Permit Area from May 15–October 31.
- Demand for overnight permits greatly exceeds the number of permits available.
- Primary destinations within the Eightmile /Caroline Zone are Eightmile Lake, Little Eightmile Lake, Caroline Lake, Cashmere Mountain, and Windy Pass.
- The 15- to 20-week construction period will occur during the peak summer use timeframe; however, impacts from construction noise will be temporary, with peak levels occurring for several minutes or less. Impacts are considered less than significant
- Dam failure under the No Action Alternative could result in significant impacts on downstream recreational opportunities and users.
- Operation of the action alternatives will result in lower lake levels during drought years, and higher lake levels during the summer months, but lake access routes, trails and camping areas are not expected to be affected. There are no significant unavoidable impacts under the action alternatives.

10.1 Methodology

This chapter describes how the rebuild and restoration of Eightmile Dam would affect recreational opportunities in the project area. The study area for the recreation analysis includes areas used for recreation directly adjacent to the dam, Eightmile Lake and shoreline, and trail, as well as areas downstream of the dam adjacent to Icicle Creek and the Wenatchee River. The study area also includes a section of Icicle Ridge adjacent to the repeater station (**Figure 10-1** and **Figure 10-2**). The existing and potential opportunities for recreation in the study area were identified by reviewing maps, agency websites, and other information sources.

This chapter focuses on general recreational activities, such as hiking, fishing, and camping. It does not address the wilderness designation of the area and its relationship to recreation, which is instead covered in Chapter 3, *Wilderness Character*.

Figure 10-1. Enchantment Permit Area Zones

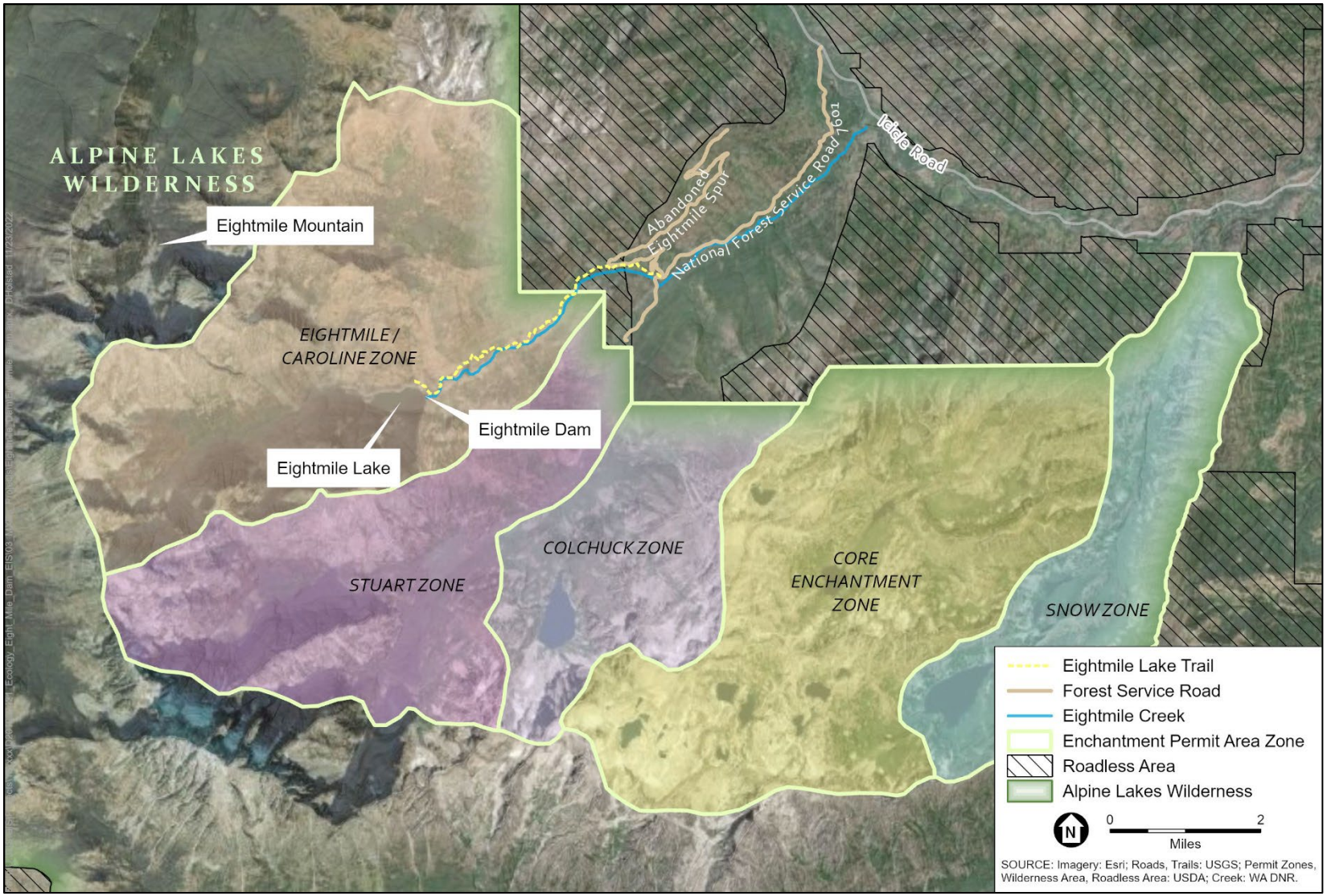
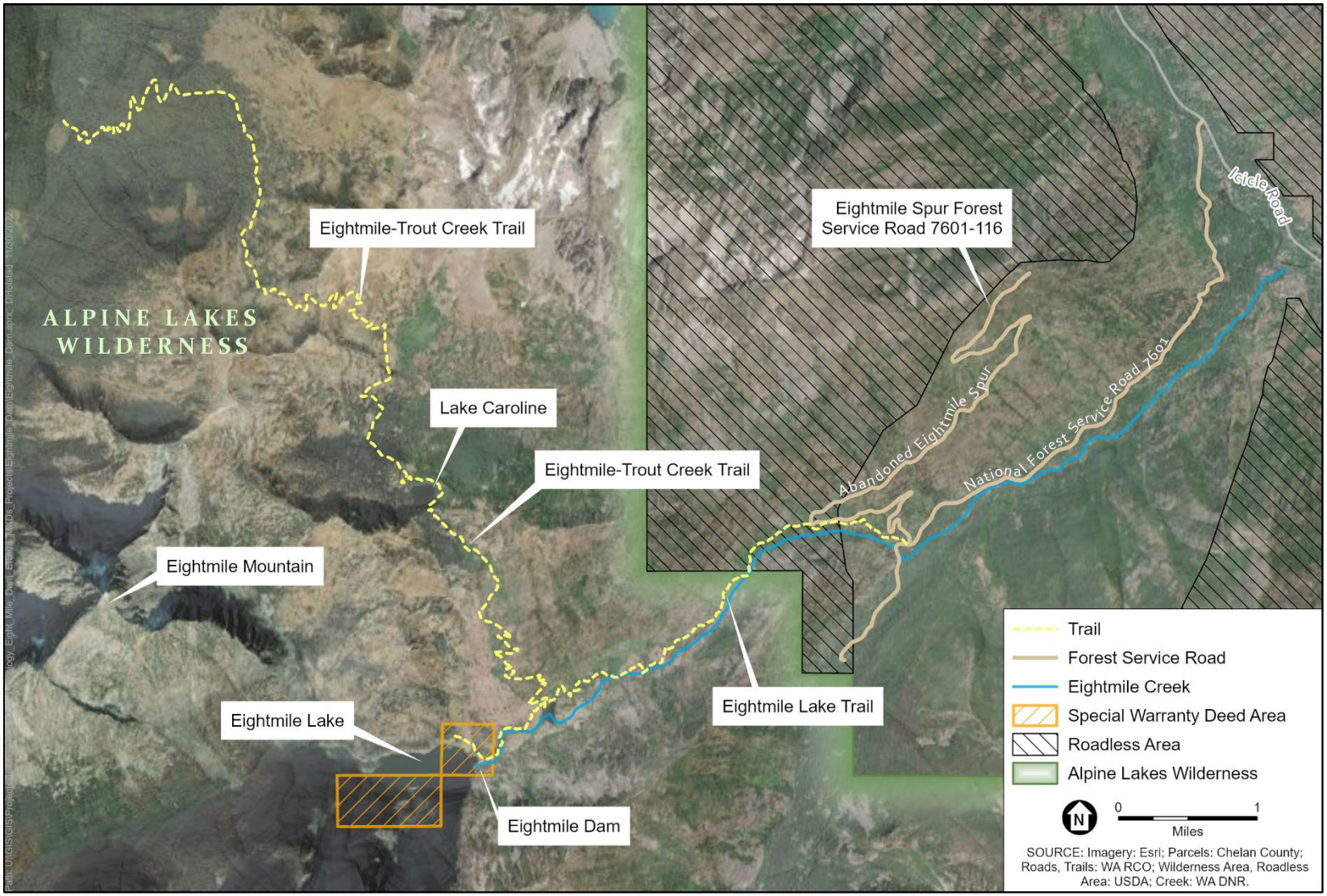


Figure 10-2. Recreation Study Area



For the evaluation of short-term impacts (construction), short-term impacts on recreation would be considered significant, as follows:

- Impacts are considered significant if a substantial portion of the recreational resources in the study area would be closed or become unusable due to disruption for a period greater than two full seasons or longer due to staging, construction activity, or noise that interferes with public enjoyment of the resource.

For the evaluation of long-term impacts (operational), long-term impacts on recreation would be considered significant, as follows:

- Impacts are considered significant if recreation in the Eightmile/Caroline Zone would be permanently closed or if large-scale recreational opportunities within the remainder of the study area were closed.

10.2 Regulatory Context

Recreational resources in the study area are protected by a variety of federal, state, and local plans, policies, and laws (Table 10-1). These plans and policies were reviewed to determine how well the project alternatives would conform with recreational resources in the study area. The policies reviewed generally establish and protect recreational opportunities in the Alpine Lakes Wilderness.

Table 10-1. Regulations and Guidelines Applicable in the Study Area

Program, Plan, or Policy	Description
Wilderness Act of 1964 (16 U.S.C. 1131-1136, 78 Stat. 890; Public Law 88-577)	The Wilderness Act created the National Wilderness Preservation System and provides the highest level of conservation protection of federal lands. The purpose of the act is to manage wilderness areas to preserve and, where possible, to restore their wilderness character. Wilderness areas are defined as "outstanding opportunities for solitude or a primitive unconfined type of recreation," which refers to the following: • Solitude means having few encounters with other people and encountering no distractions from modern society. • Primitive recreation refers to traveling through wilderness without mechanization (i.e., by hiking, walking, or horseback riding). • Unconfined recreation provides the opportunity for self-discovery, exploration, and freedom from societal or managerial controls.
National Wilderness Preservation System (43 CFR Part 19)	Designates more than 111 million acres of protected wilderness areas in the United States for enjoyment of the public.
Alpine Lakes Area Management Act of 1976 (Public Law 94-357)	Established the area between Snoqualmie and Stevens Pass as the Alpine Lakes Wilderness for public outdoor recreation by present and feature generations.
Alpine Lakes Area Land Management Plan 1981 (USFS 1981)	Provides recreation management objectives for the Alpine Lakes Wilderness, with a focus on providing opportunities for primitive recreation that features a natural wilderness

Program, Plan, or Policy	Description
	environment, solitude, and physical and mental challenges consistent with wilderness values. To protect wilderness resources and minimize overlap with and conflict between different types of wilderness, the plan establishes four Wilderness Use Zones (Transition, Semi-Primitive, Primitive, and Trailless). Each of zone calls for slightly different management strategies.
Alpine Lakes Wilderness regulations and restrictions	Describes regulations for recreation within the Alpine Lakes Wilderness, including, permit information, group size limitations, trail use, equipment restrictions, restoration areas, dog use and stock, camping, and fire restrictions.

10.3 Affected Environment

The study area provides opportunities for hiking, backpacking, camping, swimming, fishing, horseback riding, trail running, rock climbing, wildlife viewing, skiing, snowshoeing, and the general enjoyment of nature. Visitors from across the globe utilize the Alpine Lakes Wilderness and the Enchantment Permit Area.

10.3.1 Alpine Lakes Wilderness

Encompassing an area of approximately 414,322 acres, the Alpine Lakes Wilderness is located within the Central Cascades Mountain Range (Wilderness Connect 2022). The area offers approximately 615 miles of trails with access at 47 established trailheads. As noted on the Forest Service's website, approximately 150,000 people visit the Alpine Lakes Wilderness yearly (USFS 2021d). There are numerous opportunities for recreation, including day hiking, backpacking, horseback riding, fishing, whitewater kayaking and rafting, climbing, and various winter sports like skiing and snowshoeing. Trails in the Alpine Lakes Wilderness are managed by the U.S. Forest Service. Backpackers and climbers often access recreation opportunities and features that do not have system trail access, creating informal trail systems (USFS 1981). The maximum group size allowed within the Alpine Lakes Wilderness is 12 (combined people and stock). Permits are required for all visitors between May 15 and October 31 and are self-issued at the trailhead for all areas except the Enchantment Permit Area.

As shown in Table 10-1, the Alpine Lakes Area Land Management Plan designates Wilderness Use Zones for different areas within the Alpine Lakes Wilderness, including the Transition Zone, Semi-Primitive Zone, Primitive Zone, and Trailless Zone. The zones were established to protect the wilderness and reduce conflict between different types of recreational users and are related to trail access systems.

Transition Zones are usually adjacent to major trailheads, where wilderness visitors begin to make the transition from roadways to foot or horse travel and are first introduced to the wilderness. The *Semi-Primitive Zone* is the second zone in the progression to isolation in the wilderness. Within this zone, the concentration of users should be lower than the Transition Zone, but there is still evidence of other users within the wilderness area. Facilities in this zone are typically for the protection of natural resources and the safety of users. *Primitive Zones* should have low concentrations of users, and evidence of other users in the area should be minimal. This zone is managed to be essentially free of restrictions and controls imposed by humans, and only facilities essential for resource protection should be used and constructed of native materials. The *Trailless Zone* is intended to preserve the most extensive natural environments and should be as free as possible from human

influence. No facilities should be provided in the Trailless Zone, and people are only viewed as visitors to the area (USFS 1981). The above definitions outline the desired conditions for each of the zones, but it is possible that designated zones may not always reflect such conditions.

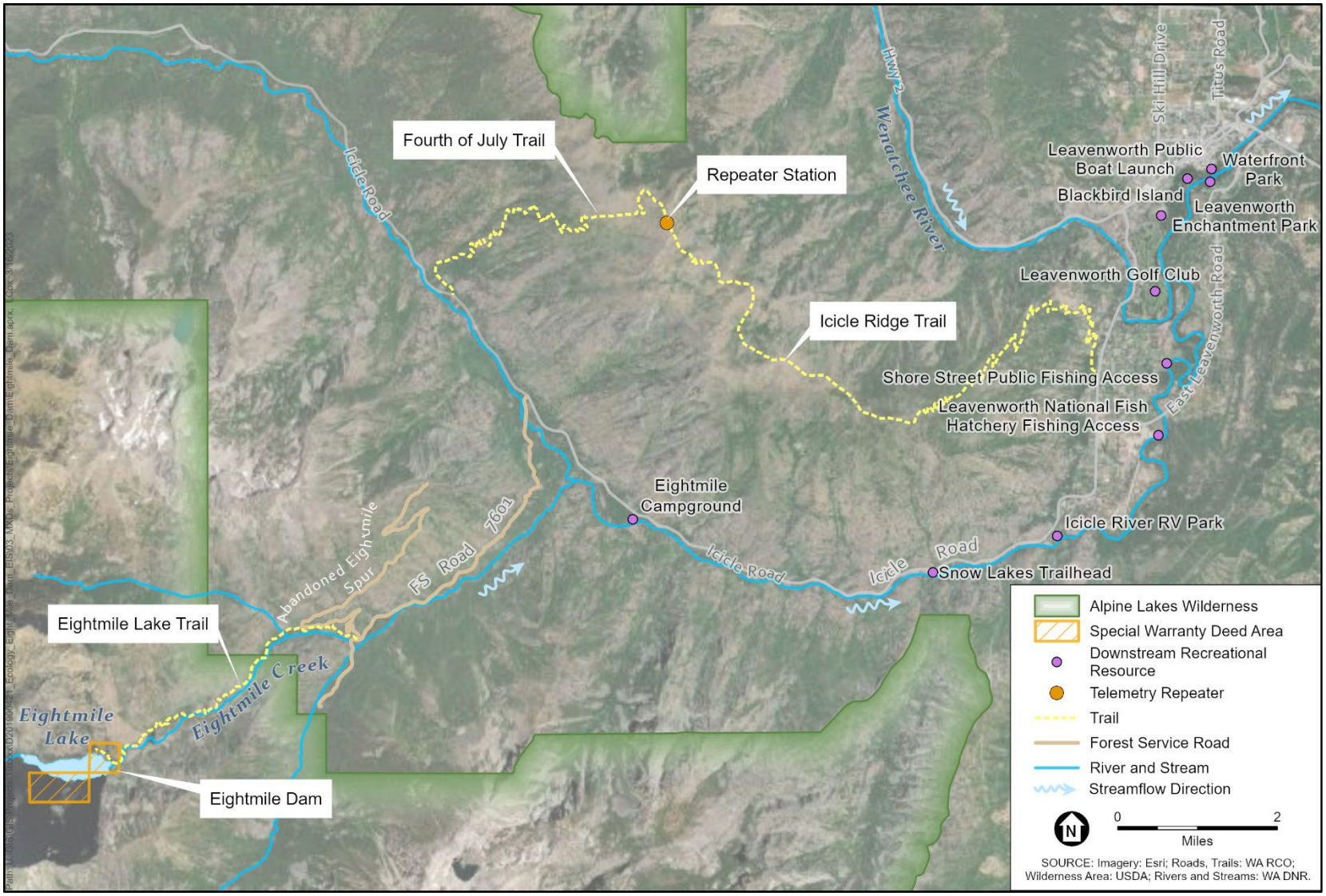
Numerous opportunities in and near the Alpine Lakes Wilderness utilize the same roadway networks as the study area, including recreational activities off of Icicle Road, FSR 7600, and FSR 7601 (**Figures 10-2 and 10-3**). Recreational opportunities with access from Icicle Road and FSR 7600 include, but are not limited to, car camping, hiking, backpacking, fishing, kayaking, bouldering, rock climbing, and horseback riding. Some of these opportunities are located directly adjacent to the roadway, but others may require travel up Forest Service Roads, sometimes for several miles. Recreational opportunities from FSR 7601 include direct access to three of the Enchantment Permit Area zones: the Eightmile/Caroline Zone, the Stuart Zone, and the Colchuck Zone (Figure 10-1). The remaining Enchantment Permit Area zones can be accessed indirectly from FSR 7601 via the Colchuck Zone.

10.3.2 Enchantment Permit Area

The Alpine Lakes Enchantment Permit Area is an increasingly popular hiking and backpacking destination. The Forest Service reported that combined day and overnight use has increased from 19,678 visitors in 2009 to 58,844 in 2021, a 199 percent increase over 12 years (USFS 2017; Reed, C. personal communication, 2022). However, due to a low compliance with self-registering at trailheads and permit boxes not being full, the number of day users within the Enchantment Permit Area in 2021 is likely higher than the reported 58,844 people. Additionally, the ongoing COVID-19 pandemic has increased the use of outdoor recreation areas, including the Enchantment Permit Area. The area contains five different zones: Snow Zone, Core Enchantment Zone, Colchuck Zone, Stuart Zone, and the Eightmile/Caroline Zone (Figure 10-1). All Wilderness Use Zones are found in the Enchantment Permit Area, varying in location across the five permit zones. Transition areas within the Enchantment Permit Area Zones include the Eightmile Lake Trail (Forest Service Trail #1552), the Stuart Lakes Trail (Forest Service Trail #1599) from the trailhead to its junction with the Colchuck Lake Trail, and the Snow Lakes Trail (Forest Service Trail #1553) to the area between the lower and upper Snow Lakes. Semi- Primitive areas include the Eightmile-Trout Creek Trail from Caroline Lake to Windy Pass, the Stuart Lake Trail from its junction with Colchuck Lake Trail to Stuart Lake, and the Colchuck Lake Trail to the base of Aasgard Pass. Primitive areas include the Snow Lakes Trail from the area between upper and lower Snow Lakes to Aasgard Pass. The Trailless areas are those that do not have system trails; these areas include off-trail routes to climbing destinations like Colchuck Peak and Dragontail Peak. The majority of the Core Enchantment Zone is zoned as trailless (USFS 1981).

Permits are required for both day and overnight use within all permit zones, with the number of overnight (camping) users strictly limited in number and by location on any given night. Overnight use from May 15 to October 31 requires submitting a request to an online, pre-season lottery. Permits are drawn from the lottery randomly through the recreation.gov advance reservation system. An additional 25 percent of permits are held at the Wenatchee River Ranger District in Leavenworth for day-of overnight trips (i.e., walk-up lottery). However, due to the COVID-19 pandemic, the in-person walk-up lottery was suspended for 2020 through 2022, and it remains suspended until further notice. Permits that would have been issued in the walk-up lottery were placed back into the recreation.gov website every Sunday and then released for the week (USFS 2021e).

Figure 10-3. Recreational Resources on Icicle Creek and the Wenatchee River

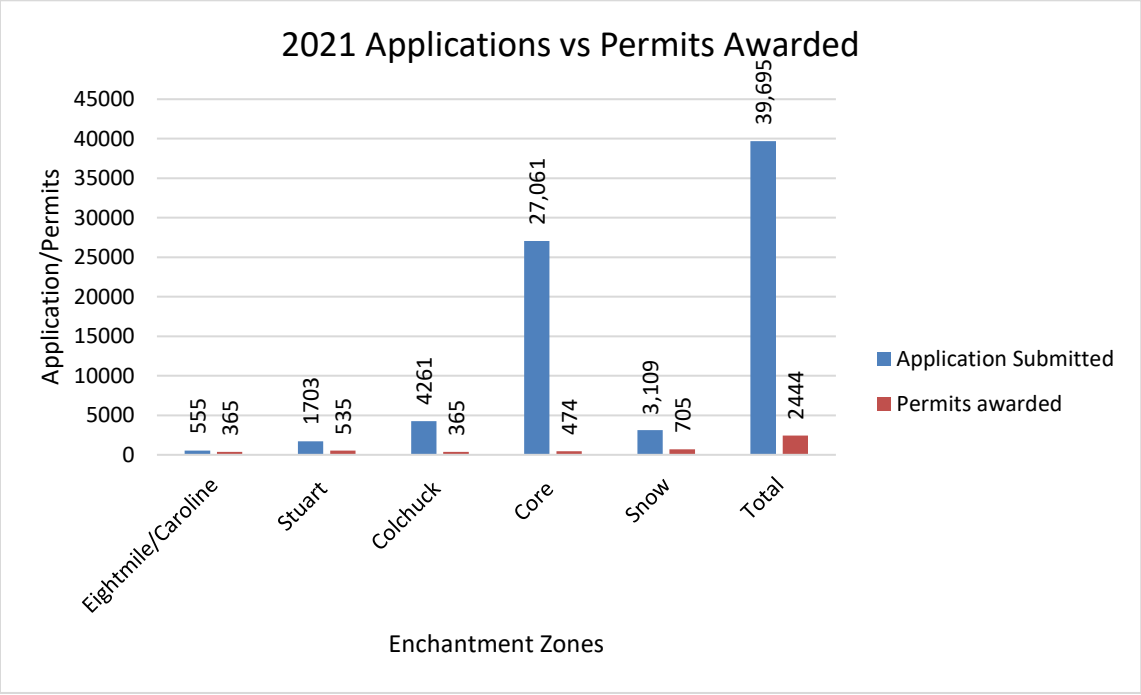


Demand for overnight permits in the Enchantment Permit Area greatly exceeds the number of permits available (**Graphs 10-1 and 10-2**). The Forest Service has made changes to the daily permit quotas and expanded the permit season in the past, due to an increasing number of observable impacts from recreation in the area (such as overflowing parking lots, increased need of toilets for human waste, and very high traveling encounters). There have also been impacts on the natural environment, including an increased number of social trails, which are informal trails created by soil compaction and erosion from foot and stock traffic, campsites, damage to vegetation, and the presence of human waste (USFS 2017). Graphs 10-1 and 10-2 and **Table 10-2** provide details on permit applications from 2018, 2019, and 2021 (USFS 2019a, 2021f).

Although the Forest Service does not restrict the number of day users on a given day, a self-issued permit available at the trailheads is still required for day use in the Enchantment Permit Area. **Table 10-3** provides the total number of day users who self-registered at the trailhead in 2019 and 2020. The Forest Service reports that day use permit compliance from the log book is on average 70 percent, so use of the area is likely higher because of individuals who do not fill out a permit (USFS 2019b, 2020).

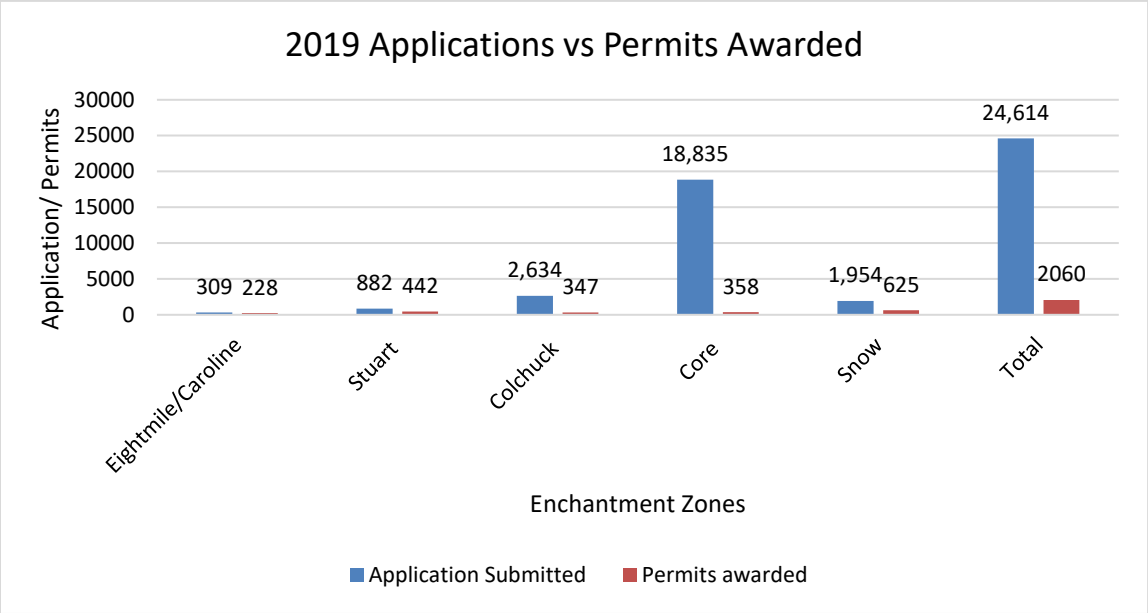
The Forest Service has prepared a visitor use analysis report for the Enchantment Permit Area from 2007 to 2017. This document contains information regarding overnight and day use of the area, assessing group size, popularity of the area, trip length, and visitor encounters. Over the 10 years of data examined, it is clear that the Enchantment Permit Area has increased in popularity among recreational users. Day use has more than doubled, while increases in overnight use range from 70 percent to 703 percent, depending on the zone (USFS 2017).

Graph 10-1. Total Applications and Permits for Overnight Use Awarded per Enchantment Permit Zones in 2021, Excluding the Walk-up Lottery



Source: USFS 2021f

Graph 10-2. Total Applications and Permits for Overnight Use Awarded per Enchantment Permit Zones in 2019, Excluding the Walk-up Lottery



Source: USFS 2019a

Table 10-2. Total Applications Submitted vs. Awarded Permits for Overnight Use and Success Rates, 2019 and 2021

	2019	2021
Awarded Permits	2,060	2,444
Total Applicants	24,614	39,695
Success Rate	8.36%	6.15%
Success Rate (Core Enchantments)	1.9%	1.75%

Source: USFS 2019a and 2021f

Table 10-3. Combined Day and Overnight Use in the Enchantment Permit Area, 2019, 2020, and 2021

Year	# of day users (groups)	# of day users (individuals)	# of overnight users (groups)	# of overnight users (individuals)
2021[1]	19,988	47,971	2,613	10,873
2020[2]	12,198	31,668	3,354	12,990
2019	12,049	30,361	3,419	15,452

Source: USFS 2019a, USFS 2020, Reed (USFS) 2022
1 2021 day use numbers are likely higher than what is shown in the table because Forest Service permit boxes were not full on critical use weekends due to a low compliance rate and the trail counter being stolen at the Eightmile/Caroline Trailhead.
2 Permit compliance from the log books is on average 70 percent for day use, but that compliance is expected to be less in 2020 due to lower staffing at the trailhead to educate on the permit process.

In addition to hiking and backpacking, recreation in the Enchantment Permit Area includes fishing, rock climbing, and stock use (horseback riding). Historically, most of the high lakes were barren of fish, but WDFW stocked lakes in the Enchantment Permit Area with trout species, as described in Chapter 8, *Plants and Animals.* Stocking in the Enchantments has not occurred since the early

2000s (WDFW 2021a). Lakes are open to fishing year round, but anglers must have a valid freshwater fishing license and comply with WDFW restrictions and regulations while fishing in the Alpine Lakes Wilderness (WDFW 2021b).

The area contains the Cashmere Crags, which is rated as one of the best sites for rock climbing in the western United States. Peaks used for climbing include Bloody Tower, Cruel Thumb, Cynical Pinnacle, and Crocodile Fang. Dozens of solid granite spires also offer routes from the low class 5s to 5.11 and faces as long as 1,500 feet (USFS 2021d). These climbing routes are classified using the Yosemite Decimal System, which is a class scale from 1 to 5—1 would be equal to walking on an established flat trail, while 5 would include technical climbing requiring belayed roping and protective equipment; a fall from a class 5 route could result in serious injuries or be fatal, and a class 6 cannot be climbed. Within class 5, subcategories range from 5.1 (easy) to 5.15 (very difficult) (REI 2021). In 2019, the most popular climbing destinations as designated on self-issued permits at trailheads included Dragontail Peak, Prusik Peak, Colchuck Peak, Snow Creek Wall, Little Annapurna, and Cashmere Mountain (USFS 2019b).

Stock use such as horseback riding is permitted within some portions of the Enchantment Permit Area, including the Eightmile/Caroline Zone (year round) and the Stuart Lake Trail (in the fall between the Saturday after Labor Day until the end of the year). Stock are prohibited on the Snow Lakes and Colchuck Trails. Camping with stock in the permit area is allowed only at suitable sites and not permitted within 200 feet of water. Camping with stock is not allowed within one-half mile of Eightmile Lake, but there is a designated campsite at Upper Caroline Lake (USFS 2021c).

The Enchantment Permit Area can be accessed directly via three trailheads: Snow Lakes Trailhead, Stuart and Colchuck Lake Trailhead, and the Eightmile Lake Trailhead. As discussed above, access to the Stuart and Colchuck Lake Trailhead and the Eightmile Lake Trailhead is provided by FSR 7601, while access to the Snow Lakes Zone is off of Icicle Road. All zones of the Enchantment Permit Area, with the exception of the Eightmile/Caroline Zone, provide access to the others. Recreationalists often start in one zone, with their primary destination in another. Access to the Core Enchantment Zone requires travel through the Snow Zone or the Stuart Zone and the Colchuck Zone. Backpackers and hikers typically travel through multiple zones during their trips into the Enchantment Permit Area. The Eightmile/Caroline Zone does not provide a direct route or formal trail to access other zones. Similarly, there are no routes or formal trails that offer access to the Eightmile/Caroline Zone from other zones.

10.3.3 **Eightmile/Caroline Zone**

Eightmile Lake, Eightmile Creek, Eightmile Dam, and Caroline Lake are located in the Eightmile/Caroline Zone and accessed via the Eightmile Lake Trail (Forest Service Trail #1552) or Eightmile-Trout Creek Trail (Forest Service Trail #1554, also called the Caroline Lake Trail). The zone also contains routes for climbing Jack Ridge, Cashmere Mountain, and Eightmile Mountain. Primary destinations within this zone are Eightmile Lake, Little Eightmile Lake, Caroline Lake, Cashmere Mountain, and Windy Pass. Recreational opportunities within this zone include but are not limited to hiking, backpacking, fishing, rock climbing, skiing, and horseback riding.

The Forest Service reports that from 2009 to 2016, the Eightmile/Caroline Zone had a 703 percent increase of overnight visitation, the highest of any zone, while day use has remained relatively stable (USFS 2017). However, due the COVID-19 pandemic and rise in outdoor recreation, day use within the Eightmile/Caroline Zone has likely increased, as well as the demand for overnight permits. Although the Eightmile/Caroline Zone has experienced the greatest increase in overnight use, it still offers the fewest overnight permits of any zone (Table 10-4). The increase in overnight use may be because historically this zone has had the least amount of permit applications, making the chance of getting a permit in the lottery higher. In 2021, 67 percent of those who applied for a permit for the Eightmile/Caroline Zone received one.

In 2020, the average maximum group size for overnight use was three people (USFS 2020). Visitor information on day use and overnight use is shown on in Table 10-4. Day use data are based on self-issued permits at the trailhead. The Forest Service estimates 70 percent compliance with day use permitting, and additional use of the area likely occurs by individuals who do not fill out a day use permit at the trailhead. During the permit season, three overnight groups are permitted to enter the Eightmile/Caroline Zone daily. There are seven campsites at Eightmile Lake and seven campsites at Caroline Lake. These campsites vary in size from individual to group sites (Moscoso, L. personal communication, 2021). Camping within the Eightmile/Caroline Zone is not confined to Eightmile and Caroline Lakes, as multiple other campsites are located within this zone.

Table 10-4. Number of Self-issued Day Use Permits for the Eightmile/Caroline Zone

Year	# of day users (groups)	# of day users (individuals)	# of overnight users (groups)	# of overnight users (individuals)
2020	1,212	3,065	394	1,516
2019	1,581	3,982	*	*

Source: USFS 2019a and USFS 2020
*represents that data were not available.

10.3.4 Eightmile Lake and Shoreline

Recreation opportunities specific to Eightmile Lake and shoreline primarily include camping, fishing, swimming, and nature watching. Recreationists have also been known to pack in watercrafts such as kayaks and paddle boards for recreation on the lakes surface. There are seven campsites at Eightmile Lake; however, the 2017 Jack Creek Fire has limited the number of campsites available at Eightmile Lake (Moscoso, L. personal communication, 2021). During the fire, many of the campsites and trail on the northwest side of the lake were burned and are currently closed for natural restoration and resource recovery. Camping at Eightmile Lake is available at sites along the northeast side of the lake. Because of the limited number of campsites, permits for the Eightmile/Caroline Zone have been reduced since the fire (USFS 2021e).

Eightmile Lake was historically stocked with rainbow and cutthroat trout. Rainbow trout were last stocked in 2003 (10,740 trout) and 2005 (10,800 trout), and cutthroat trout were last stocked in 2000 (12,549 trout) (WDFW 2021a). Eightmile Lake is one of the only alpine lakes with a naturalized population of lake trout (WDFW 2005).

10.3.5 Icicle Creek and Icicle Creek Watershed

Whitewater kayaking occurs in Icicle Creek between the Rock Island Campground and the Leavenworth National Fish Hatchery, a distance of approximately 17.1 miles. Kayaking occurs when the streamflow is between 700 and 2,000 cfs. Difficulty in this span of Icicle Creek ranges from Class II to IV+ under normal conditions (American Whitewater 2021a). The class difficulty was determined using the International Scale of River Difficulty, which has six different classes. Class I rapids include fast-moving water with riffles and small waves. Risk to swimmers in Class I rapids is slight and self-rescue is easy. Class VI rapids are almost never attempted due to the extreme difficulty, danger, and unpredictability; rescue may be impossible (American Whitewater 2021b). In the summer when flows are low, stand-up paddle boarding and tubing are popular activities on lower Icicle Creek downstream of the Leavenworth National Fish Hatchery.

Icicle Creek supports two non-tribal fisheries: a spring-run Chinook salmon fishery (that runs from mid-May through July 31), and a resident trout fishery (that runs from the Saturday before Memorial Day through October 31) (Ecology 2019a).

WDFW manages fishing in Icicle Creek and conducts yearly creel surveys for the spring-run Chinook salmon fishery to gather data for producing estimates of harvest, angler effort, and incidental catch, as well as release of other species. This fishery is very popular and has been a mainstay for many years, drawing local and out-of-area anglers (Ecology 2019a). From 2005 to 2017, an average of 2,380 anglers fished 12,145 hours per year and caught an annual average of 502 hatchery-origin spring-run Chinook salmon in Icicle Creek and the Wenatchee River (Table 10-5; Potter et al. 2018). WDFW does not conduct creel surveys for the resident trout fishery in the creek. The Icicle Creek trout fishery is primarily made up of rainbow trout, but line sampling conducted by WDFW and anecdotal reports show there are also occasional catches of bull trout, cutthroat, and eastern brook trout (Ecology 2019a).

Table 10-5. Sport Fishery Effort for Hatchery-origin Spring-run Chinook Salmon on Icicle Creek and/or the Wenatchee River

Year	Fishery Season	Anglers	Hours Fished	Fish Harvested
2017*	June 24–July 31	197	800	41
2016	May 16–July 31	1,377	7,939	303
2015	May 20–July 31	990	5,064	433
2014	May 23–July 31	1,587	7,299	390
2013	May 18–July 31	1,979	9,644	323
2012	May 19–July 31	4,922	21,492	971
2011	May 21–July 31	5,229	25,934	873
2010	May 13–July 31	5,231	23,549	993
2009	May 22–July 31	1,530	8,235	640
2008	May 28–July 31	1,147	7,144	347
2007	May 22–July 31	1,058	7,754	115
2006	May 26–July 31	2,402	13,553	529
2005	May 28–July 31	1,108	8,131	103
Average (2005–2016)*		2,380	12,145	502

*Harvest for spring-run Chinook salmon in Icicle Creek was delayed until the Leavenworth National Fishery Hatchery acquired adequate numbers to meet broodstock goals.

The areas adjacent to Icicle Creek and the Wenatchee River, which flow into the City of Leavenworth, provide numerous opportunities for formal and informal recreation. Eightmile Campground is a popular campground located 8 miles west of Leavenworth adjacent to Icicle Creek. The campground offers 41 single sites and four double sites, with many of the sites available to reserve ahead of time. Other recreational opportunities adjacent to Icicle Creek and the Wenatchee River include access to rock climbing, bouldering, fishing, golfing, and several parks (Figure 10-3). Leavenworth and the surrounding area provide recreationalists with opportunities for hiking and backpacking in the summer as well as backcountry skiing, snowboarding, and skiing in the winter.

10.3.6 Icicle Ridge

Icicle Ridge is located to the north of Eightmile Lake and the Enchantment Permit Area. The northwestern portion of the ridge is located within Alpine Lakes Wilderness. The ridge can be accessed via Icicle Ridge Trail to the east and Fourth of July Creek Trail to the west (Figure 10-3). These trails are popular hiking destinations with opportunities for camping. The trailhead for both of these trails can be accessed from Icicle Road. The Icicle Ridge Trail continues east and provides access to the Alpine Lakes Wilderness. Within the Alpine Lakes

Wilderness, Icicle Ridge and the surrounding area provide numerous opportunities for hiking, backpacking, and other recreational opportunities.

10.4 Construction Impacts

This section describes the impacts that recreationists would experience during the roughly 15– to 20-week (June to October) construction period, including noise from helicopters and construction equipment (see Chapter 9, *Noise*), increased personnel at the site, vegetation removal, and closure of the recreation area around the dam. Some recreational users come to the Enchantment Permit Area to experience the five qualities of wilderness character as outlined within the Wilderness Act. Impacts associated with the Wilderness Act are addressed in Chapter 3, *Wilderness Character.*

10.4.1 Transportation of Equipment and Materials

Helicopter Use

Option 1: Heavy-lift Helicopter with Limited Use of Small Helicopter Throughout Construction

Under this option, a heavy lift helicopter with a payload lift capacity of 20,000 pounds would be used. Option 1 would require using the heavy-lift helicopter approximately 70 to 105 trips over 3 to 5 days at the beginning of the project, and 11 trips at the end of the project.

After the initial 3 to 5 days of flights with the large helicopter, a smaller helicopter with a payload lift capacity of 5,000 pounds would be used for approximately 20 trips to the site on an as-needed basis over the course of construction to deliver food and supplies. Flights for the smaller helicopter would likely take place between the hours of 7:00 a.m. and 6:00 p.m.

Noise levels from helicopters would have the greatest impact at Eightmile Lake utilizing the larger helicopter during the initial 3- to 5-day period and at the end of construction. Noise levels from the heavy-lift helicopter would be the loudest and most disruptive at Eightmile Lake during equipment drop-off and could range as high as 115.9 dB for a period of several minutes during each drop-off. Noise impacts from the smaller helicopter would create similar impacts on recreation, but would be smaller in scale (from 75 to 78 dB) and more frequent throughout the remainder of the construction period (see Chapter 9, *Noise* for details regarding helicopter noise levels).

Noise from the helicopter would have an impact on the users of the Eightmile Lake Trail and Eightmile-Trout Creek Trail. Helicopter noise would also be audible from other parts of the Enchantment Permit Area, but is not expected to have impacts on recreation use because noise generated from the helicopter would be similar to ambient noise levels in those areas. The use of the helicopters would disrupt the natural soundscape of the project area and result in short-term impacts on recreationists. Some visitors to the area may find helicopter noise very disruptive; other visitors may not be bothered.

Helicopter noise would be temporary and limited to the 15- to 20-week construction period. Recreationists who are disturbed by helicopter noise may choose to day hike or apply for overnight permits in other zones in the Enchantment Permit Area or elsewhere. Because impacts would be temporary and other nearby recreational areas are available with similar attributes, impacts on recreation from helicopter use are considered less than significant.

Option 2: Limited Use of Heavy-lift Helicopter with Small Helicopter Use for the Majority of Materials.

This option would utilize a heavy-lift helicopter to transport the excavator, other equipment, and a portion of the supplies to the site at the beginning of the construction period. This would take approximately 20 trips over 2 days. After the initial trips with the heavy-lift helicopter, the smaller

helicopter would make approximately 245 trips to deliver other supplies over the duration of the project construction. Following completion of construction, the heavy-lift helicopter would also be used for 1 to 2 days to remove equipment and any remaining materials.

Noise levels would be similar to those described under Option 1; however, noise levels from the large helicopter would occur for a shorter portion of time, approximately 4days while it is utilized. Noise from the smaller helicopter would occur much more frequently over a longer period of time throughout the construction period. The overall impact would be the same as for Option 1.

Road Segment

Under all action alternatives, approximately 0.75 mile of the currently closed FSR 7601 would be restored from the Eightmile Lake Trailhead. The road would terminate in the Okanogan-Wenatchee National Forest outside of Alpine Lake Wilderness. This road would allow light trucks to bring personnel and supplies closer to the project site. Reopening of the roughly 4,300 feet of road segment would not have an impact on recreation because the roadway would be located away from the trail. Hikers may see construction vehicles at the trailhead, but once on the trail would not encounter the road. Vehicle traffic on the road may be noticeable at some points along the lower portion of the trail, but limited vehicular trips are anticipated on the road. Therefore, impacts on recreation from reopening FSR 7601 and using it to transport equipment and personnel would be less than significant.

10.4.2 Dam Construction

During the 15- to 20-week construction period, access to the area directly adjacent to the dam and the staging area would be restricted, and a small portion of the trail would be temporarily relocated to direct hikers safely around the construction area. However, recreational opportunities would not be limited during construction. The Eightmile/Caroline Zone would remain open for hiking, camping, rock climbing, fishing, and horseback riding. Additionally, no campsite closures or limitations on overnight permits would occur during construction. Construction workers would stay at the site and camp within the IPID Special Warranty Deed Area (Figure 10-2), not in camping areas generally used by the public. The presence of construction workers in the area around Eightmile Lake could be noticeable to recreationists and could detract from the experience for some.

Construction at the lake would result in an increase of noise, dust, equipment, and people at the lake. Construction noise would be the loudest when approaching the lake on the trail and arriving at the lake; maximum noise levels adjacent to the construction area from construction equipment are anticipated to be approximately 119 dBA (as described in more detail in Chapter 9, *Noise*). Heavy equipment could typically be in use during the hours of 7 a.m. to 6 p.m. However, if heavy equipment is in use during a helicopter delivery, noise levels are predicted to be 121 dBA. Ambient background noise levels in wilderness areas are typically around 45 dBA during summer months. These access restrictions and increased noise levels are likely to disrupt some recreationist enjoyment of the area, and may cause some potential recreationists to visit other wilderness areas during this time period. This could result in noticeable increased usage on other trails.

Should blasting with explosives be needed during construction, the Eightmile Lake Trail from its junction with the Caroline Lake Trail could be closed periodically over the course of 1 or 2 days. Blasting would be scheduled for mid-week (Tuesday–Thursday) between 11 a.m. and 3 p.m. IPID would provide personnel at the trailhead and the Caroline Lake Trail junction to stop recreationists from entering the area during times of active blasting. During blasting with explosives, the Caroline Lake Trail, Eightmile Lake camping area, latrine area, and trail uphill from the Eightmile Lake camping area would remain open to recreational use. Recreationists at the camping area would be

alerted by IPID prior to the start of blasting and could choose to remain at the camping area or uphill side of the trail during blasting, or leave prior to the start of any blasting.

Although IPID does perform maintenance on the dam regularly, the scale of construction activities for the dam replacement would be much larger than from maintenance activities. Construction activities would be noticeable to recreationists who are using the project area during construction, and may result in some users deciding to choose to visit other areas. Other users may find that their experience is less enjoyable due to increased noise and the presence of construction workers and equipment. However, no campsites would be closed, no other recreational opportunities would be foreclosed during construction, and construction is planned to be completed within one season. Therefore, impacts on recreation during construction would be less than significant.

Telemetry equipment would be installed on Icicle Ridge at the repeater station site, outside of the Alpine Lakes Wilderness. It is anticipated that the equipment would be brought in by a small helicopter and the installation would occur in 1 to 3 days. While the helicopter noise would be audible during this time, the short installation duration would result in less than significant impacts.

During project construction, access to the site could be limited due to the Icicle Creek Rockfall Mitigation Project, which would be under construction at the same time. This project would result in intermittent road closures for 10 weeks from August 28 to November 8, 2023. During this time, Icicle Road would be closed from 8 a.m. to 5 p.m. Monday through Friday, with a 1-hour opening from noon to 1 p.m. The road would be open on weekends from 5 p.m. on Friday until 8 a.m. on Monday. During the closures, no vehicles would be permitted to use Icicle Road, which would limit recreationists' access to the Eightmile Lake Trailhead as well as affect their ability to leave the area. The road closure, coupled with the construction at Eightmile Dam, could further dimmish recreational enjoyment during construction.

10.5 Operational Impacts

This section describes the general operational impacts on recreation from the fluctuating lake levels under the project alternatives. Some recreational users come to the Enchantment Permit Area to experience the five qualities of wilderness character as outlined within the Wilderness Act. Impacts associated with the Wilderness Act are described in Chapter 3, *Wilderness Character*.

10.5.1 No Action Alternative

Under the No Action Alternative, direct recreation impacts from the operation of the project would not occur. Recreational opportunities would essentially remain the same as they currently are, in the short term. However, if the No Action Alternative is implemented, it is probable that the dam would fail or require more emergency repairs in the future, which would have impacts on recreation.

If dam failure occurs, flooding could pose a risk to the health and safety of recreationists in the areas downstream of the dam, as described in Chapter 12*, Public Safety*. Dam failure would result in an additional 15,000 cfs of water to Icicle Creek, which would flow through Eightmile Creek and the Eightmile/Caroline Zone of the Enchantment Permit Area. Further impacts on recreation from dam failure could include damage to the Eightmile Lake Trail and FSR 7601. Damage to FSR 7601, particularly where it crosses Eightmile Creek, could have impacts on access to the trailheads of the Eightmile/Caroline, Colchuck, and Stuart Zones of the Enchantment Permit Area. Dam failure could also result in impacts on or temporary closures of other recreational resources downstream on Icicle Creek and the Wenatchee River due to flooding. Potentially impacted resources on Icicle Creek and the Wenatchee River could include those facilities shown on Figure 10-3.

Additionally, if the dam remains at risk of failure, emergency repairs may be required. Repairs would likely be similar to those that occurred in 2018, which could potentially result in intermittent closures

of recreation (such as trails and campsites) in the area, as well as impacts from increased noise from construction equipment and helicopters. Further emergency repairs would not bring the dam up to DSO standards and could not be guaranteed to prevent dam failure in the future.

Under the No Action Alternative, the DSO could require abatement of the dam, which would result in the lowering or removal of the dam in the future. If this were to occur, the lake level would be substantially lowered, which could make the lakeshore inaccessible in many areas currently used to access the lake, reduce locations used for informal fishing, and generally make the area less desirable for recreationists.

The No Action Alternative has the highest probability of dam failure of all the alternative considered. Due to the potential closure of the area from dam failure, impacts on recreation from the No Action Alternative are considered **significant**.

10.5.2 Alternative 1: Narrow Spillway with Gates

The narrow spillway with gates dam design would result in the existing trails, campsites, and lakeshore access routes remaining generally the same as existing conditions, with some seasonal fluctuations in lake water levels. Alternative 1 would result in the ability to fill the lake to 4,671 feet, roughly 4 feet higher than existing conditions. This higher water level would impact recreation by seasonally inundating some informal lake access routes and reducing the shoreline available for recreational activities and leisure by approximately 4 feet. Due to site topography, the higher water level would not inundate any recreational opportunities in the area, including the designated trail and camping areas. These impacts would be most likely to occur from late-spring to mid-summer, when recreational use in the area is high and the lake is held at its highest levels.

Alternative 1 would also result in the ability to draw the lake down to 4,636 feet, which is approximately 4 feet lower than the current low water level (**Table 2-1**). However, a drawdown of this level would only be utilized during drought years, which are predicted to occur roughly once every 5 years. This lower water level would create an expanded shoreline, resulting in changes in recreational areas due to topography and slope. Some areas around the lake may be more accessible, while others may be less accessible, but an overall reduction in access to recreational activities along the lake shoreline is not anticipated as a result of the lower water level.

Flows from Eightmile Creek make up a small portion of the flow contribution to Icicle Creek, so it is unlikely that additional water from lake drawdown under Alternative 1 would provide any noticeable changes to the late season flows of Icicle Creek, and would not likely change any recreational opportunities.

Recreationists at Eightmile Lake would experience visual changes due to fluctuating water levels, as described in Chapter 11, *Visual Resources*. Fluctuating water levels would also alter informal fishing opportunities around the lake, potentially making some areas less suitable for fishing and other areas more desirable, depending on the water level.

While the operation of Alternative 1 would change recreational opportunities at Eightmile Lake, some of these changes could be experienced as improvements by some recreationists, and there would be no permanent closure of recreation. Recreational opportunities would remain substantively the same, with no net loss of recreational access or facilities. Therefore, **no significant adverse impacts** from the operation of Alternative 1 on existing recreational activities around Eightmile Lake, including hiking, camping, and fishing, would occur.

10.5.3 Alternative 2: Wide Spillway without Gates

Operational impacts on recreation from Alternative 2 would be the same as those described above for Alternative 1. **No significant adverse impacts** on recreation would occur.

10.5.4 Alternative 3: Narrow Spillway without Gates

Under Alternative 3, the high-water level would remain at 4,667 feet. However, water levels would be lowered to 4,636 feet during drought years, which are predicted to occur roughly once every 5 years (as described for Alternative 1). Impacts from Alternative 3 would result in an expanded shoreline that may increase the size of the camping area and offer some additional space for other recreational activities along the lake, as described above for Alternative 1. Conditions at Eightmile Lake would generally be similar to current conditions with the exception of the lower water level during drought years, which is not expected to impact any recreational resources. No recreational opportunities would be closed or become unavailable, so no significant adverse impacts from the operation of Alternative 3 on existing recreational activities at Eightmile Lake, Icicle Creek, or the Wenatchee River are anticipated.

10.6 Avoidance, Minimization, and Mitigation Measures

This section describes the mitigation measures proposed that would reduce and compensate for impacts from construction and operation of the project on recreation. Measures to reduce impacts from construction include:

- Establish and maintain clear construction boundaries.
- Maintain detour trail around site during construction.
- After construction is complete, restore trail and cleared areas to Forest Service standards, consistent with the Wilderness and Backcountry Site Restoration Guide (Therrell et al. 2006).
- Coordinate with the Forest Service to forewarn visitors of potential disruption of wilderness experience due to construction activities, including notice to people seeking reservations through the lottery and to those awarded reservations.
- Provide signage to alert trail users regarding construction activity, including dates and hours of helicopter use, heavy equipment operation, and blasting with explosives.
- Provide a general description of work period and work impacts, including potential areas that will be closed to the public such as the staging and construction areas, prior to the Forest Service lottery for overnight permits in the Enchantment Permit Area.
- Provide alert of construction on the Forest Service Website for Alpine Lakes Wilderness: Okanogan-Wenatchee.
- Provide notification and signage at the Leavenworth Ranger Station and suggestions of other recreational opportunities in the area.
- Measures to reduce impacts from blasting with explosives include:
    - Minimize trail closure extent and duration.
    - Use blasting mats to reduce noise and dust and prevent flyrock.
    - Limit the Eightmile Lake Trail closure to the segment from the Caroline Lakes Trail Junction westward to the minimum safe distance from the blast location.
    - Identify extent of blast safety zone on a map.
    - Identify camping areas outside of safety zone that can be used during blasting if desired.

- Provide personnel at Eightmile Lake Trailhead, Caroline Lakes Trail junction, and upper limit of safety area on trail, on the day of blasting.
- Schedule blasting to minimize impact on trail users:
  - Schedule for midweek (Tuesday through Thursday), and non-holiday (if July 4th falls on a mid-week day).
  - Avoid full-day trail closure by scheduling blasting to occur between 11:00 a.m. and 2 hours before sunset.
- Allow trail users to use the trail in the morning before blasting or in the evening after blasting.
- Providing a general description of work period and work impacts, including potential for closure for blasting, prior to the Forest Service lottery for overnight permits in the Enchantment Permit Area (by October 1).
- Providing description of closure area and timing to Forest Service once known, at least 10 days prior to blasting.
- Posting notices at Eightmile, Caroline Lake, and Jack Creek trailheads. These notices should be pre-approved by the Forest Service prior to posting.
- Notifying occupants of campsites on Eightmile Lake the day before blasting that there will be a temporary trail closure.
- Providing notice, such as a press release, to organizations such as Washington Trails Association, The Mountaineers, Sierra Club, and Alpine Lake Protection Society once schedule is known. The notice should be pre-approved by the Forest Service prior to sending.

Impacts from the operation of the project are not anticipated to result in any disturbances to recreation within the Enchantment Permit Area; therefore, no mitigation measures are currently proposed.

10.7 Significant Unavoidable Adverse Impacts

It is unavoidable that recreationists will find the impacts from construction to detract from their wilderness experience, and some individuals may perceive this as a strongly negative impact. Because the construction is anticipated to occur only during one recreation season (15–20 weeks), the area will be restored following construction, and the helicopter noise will no longer be present, the short-term impacts associated with construction would not be significant. The action alternatives would not result in significant impacts on recreation in the Enchantment Permit Area, during operation. There would no long-term closures of recreational areas within the Enchantment Permit Area.

Under the No Action Alternative, dam failure could occur, which would pose a risk to the health and safety of recreationists in the area downstream of the dam. Dam failure could result in inundation, temporary closures, or other impacts on the Eightmile Lake Trail, FSR 7601, and recreational resources downstream on Icicle Creek and the Wenatchee River. Due to the potential recreation closure from dam failure, impacts from the No Action Alternative are considered **significant**.